Rethinking trade: developing and applying an explanation to the Australian water technology and management industry

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Abstract

Rethinking Trade: Developing and Applying an Explanation to the Australian Water Technology and Management Industry

This thesis seeks to explain how trade develops, applying the ideas to the Australian water management and technology industry. Disparate explanations and gross generalisations at the macro-level of national economies have hindered the development of a unified theory of trade. While understanding trade at the macro-level is foundational, analysis at the level of the firm is necessary for a comprehensive understanding. Four main strands of explanation have been identified from the literature: competitive advantage and corporate strategy, innovation creation and acquisition, markets and networks, and state and institutional influence. The strands combined form a framework that can explain how and why trade occurs for firms in a particular industry. Innovation leads to competitive advantage which extends a firm’s spatial influence in the market. Networks interconnect the firm with its external environment. The state’s role is to facilitate various processes such as amplifying competitive advantage.

The framework is applied to firms representing the Australian water technology and management industry. This industry is diverse, encompassing small and large firms, and specialist manufacturers and producer services. The diversity is ideal for testing a comprehensive explanation. In addition, the water industry - as a subsector of the environmental goods and services sector – is a potentially valuable export activity.

The empirical work demonstrates that rethinking trade involves insights from the various explanatory strands. Creating competitive advantage and innovation involves processes internal and external to the firm. In the water industry, competitive advantage is a multifaceted concept and can be created by firms possessing a specialist product or service, or having a cultural affinity with clients. Corporate strategies such as inter-firm alliances and intra-firm multinational linkages also reinforce competitiveness. While the size of firms has some influence on competitiveness, size and age do not determine propensity to export. The use of innovation proxies by manufacturing firms increases propensity to export. A weak correlation is revealed between R & D proportion and
export proportion; however, there is no evidence of a correlation between the proportion of patents and export proportion. Innovation expressed as appropriate technology, or embedded in specialist services, provides a more convincing explanation of export activity. Localised linkages between related and supporting industries are not a prerequisite for creating competitive advantage or innovative activity. Network theory explains how competitiveness transmits across space. Networks link the internal environment of the firm with external determinants, and explain how actual export contacts are made. Once networks and trust are established, spatial separation is not detrimental to sustaining relationships between key actors. The quantitative evidence does not reveal significant relationships between innovation, competitive advantage and trade. Qualitative factors explain these relationships more satisfactorily. Cultural affinity, appropriate technology and networks help firms create competitive advantage, leading to trade. The state has a strong indirect influence in facilitating trade and should be an important part of a theory.

Thus an explanation of trade must shift networks to central importance and de-emphasise the role of localisation economies. The concept of innovation also needs to extend beyond an interpretation confined to technological change. The limitation of these interpretations is that they only apply to one industry in a particular place. However, the framework is flexible enough to be adapted to other industries, with certain strands being emphasised and de-emphasised accordingly. The empirical findings also have practical implications for the development of trade and industry policy; for example, flexible industry assistance that facilitates the creation of international networks by small and medium-size firms.
Declaration

This is to certify that
i) the thesis comprises only of my original work,
ii) due acknowledgement has been made in the text to all other material used,
iii) the thesis is less than 100,000 words in length, exclusive of tables, maps, bibliographies and appendices.

Signed ……………………………………………………………

Andrew Nadolny
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Chapter 1
Introduction

This thesis combines two disparate areas of investigation. Its purpose is to develop an explanation of trade and apply it to the Australian water technology and management industry. But why trade and why this particular industry? It is argued that a comprehensive theory of trade has not been developed by economic geographers. The industry is of interest because sustainable water management is a pertinent global issue, with international markets having developed for such expertise. The following rationale expands on these reasons.

1.1 Rationale

*The need for rethinking explanations of trade*

Although usually studied within the domain of economics, trade still has traditionally been of interest to geographers because it involves the flows across space of goods, services and financial capital that affect localities in various ways. Geography and trade are closely interrelated: different localities produce different commodities, goods and services to trade; trade forms linkages between localities; and the type and volume of trade also partially accounts for varying degrees of prosperity and the unique characteristics of nations and regions.

Yet for such an important process, the development of a comprehensive trade theory has been largely unsatisfactory. Two decades ago Conkling and McConnell (1981) and McConnell (1986) lamented that geography, despite being ideally capable, has made little contribution to understanding international trade and to policy formulation. In McConnell’s (1986: 480) assessment: “Geographers have been conspicuous by their general lack of attention to the theoretical underpinnings of international business”. Geographers’ interest in international trade waned during the 1970s and 1980s, in Grant’s (1994) view, because simplistic theoretical assumptions such as comparative advantage with which empirical work was difficult to reconcile.
There have been developments since the 1980s. Economists such as Krugman (1991) have incorporated traditional concerns of economic geography, such as regional development, into explanations of trade. Building on earlier work, Dunning (1977; 1993b; 1993c) has developed theories of multinational corporation behaviour, given that intra-firm transfers form a large proportion of global trade flows. To explain why nations and firms become internationally competitive - with trade as an outcome - the concept of competitive advantage has been developed. Porter’s ideas (1985; 1990) are prominent, with a geographic component to this work as the clustering of economic activity is emphasised.

Despite these developments, Grant (1994: 298) voices a bleak evaluation: “Unfortunately, the current geography of international trade is no more than the sum of many individual studies. Few researchers have been able to specify an overall comprehensive framework”. As the literature review is developed in this thesis, support is given to Grant’s concern. There are several explanations of trade, some of which offer valuable insights. The problem is that the useful elements are not combined into an overall theory.

A further deficiency with the current state of knowledge is that explanations tend to be based at the macro-level and usually do not regard particular characteristics of the industry, and overlook the level of the firm. Macro-level perspectives are argued in this thesis to be blunt theoretical tools that have limited capability for dissecting exactly how and why trade occurs. As O’Farrell and Wood (1998) and Lindahl and Beyers (1999) note, most studies on the internationalisation of economic activity neglect the role of small and medium size firms, and generally neglect trade in services. A core argument of this thesis is that a study of trade at the micro-level (i.e. firms in particular industries) can contribute to a better understanding by specifying the processes that enable the firm to interact with the wider external environment. There is a body of work that uses network analysis to investigate how firms acquire innovation and form inter-firm linkages (e.g. Grabher 1993; Vatne 1995; O’Farrell and Wood 1998; Vatne and Taylor 2000). This work provides useful insights but - as yet - is not integrated into an overall theory of
trade. A coinciding development has been a recent interest in economic geography of defining ‘the firm’ as a central actor of economic activity and its links with the wider economic environment (e.g. Dicken and Malmberg 2001; Maskell 2001). Thus the time is ripe to integrate micro-level concepts about the firm and networks with the macro-level approaches of trade theory.

This thesis takes up this challenge of developing a comprehensive explanatory framework of trade in which different ideas are linked. The firm is the unit of analysis but the broader macro-level environment is also considered. The argument is that analysing trade at the level of the firm by using several explanatory strands is necessary for a comprehensive understanding.

Why water?

This argument is tested using firms involved in the Australian water technology and management industry. The industry is defined as encompassing manufacturing and service activities that are directly related to the management of useable water and treatment of wastewater. Services such as design, consultancy and management are included, as well as the production of inputs (e.g. pumps and treatment equipment). The water industry comprises a diversity of firms: small and large manufacturers, producer services, Australian firms and multinational foreign-owned firms. The diversity provides a suitable testing ground for a theory.

It is also timely to study an industry that addresses the challenges associated with sustainable water management. Between 1950 and 1990 the world population doubled, whereas global water use tripled (World Resources Institute 1996). Such trends are likely to continue; water scarcity in many parts of the world will almost certainly be a critical environmental, economic and political issue in the new millennium. The World Bank estimates that US $ 600 - 800 billion needs to be spent in the first decade of the 21st century to reduce water and sanitation problems in developing countries (Tolhurst 1999, Masons Water Yearbook 2000: 5). It is estimated that about one third of the world’s population will not have access to a sustainable quality or quantity of potable water by
2020 (United Nations 2000). Furthermore, China is expected to face deteriorating water quality and shortages, leading to large scale social and political unrest if problems are not addressed (Brown and Halweil 1998; O’Donnell 2000). At the domestic level, the widespread drought over much of eastern Australia during 2002 saw water become an often discussed media issue, with State and Federal Governments implementing (or at least promising) improved future management practices. The prospect of global warming - with the associated uncertainties of climatic impacts - will make long-term water resource management even more challenging (Smith 1998).

Clearly, the technology and expertise required for sustainable water management will continue to play an essential role in the societies of the 21st century, regardless of how advanced the economic basis may be. While most of the major technological developments in water and wastewater treatment occurred by the early twentieth century in the industrialised nations of Europe and North America, incremental improvements continue to the present day (Smith 1998: 334-5). Despite the relative technological maturity of the industry, the issue of water scarcity is likely to see the demand for technological advancement, however incremental, and management expertise to be more pressing than ever before. Some of the avenues of likely development include advanced tertiary treatment of wastewater and smaller in situ treatment plants, improved catchment management practices, extensive reuse of wastewater, and more efficient management of stormwater and urban runoff (Bainbridge 1997; Smith 1998; Cooperative Research Centre for Waste Management and Pollution Control 1999).

**Why is Australia relevant?**

Nations with expertise in water technology and management have goods and services to offer those nations that lack this expertise. Australia has been identified as having such expertise which is marketable internationally (e.g. Doherty 1991; Gebbie 1994; Economic Development Committee [EDC] 1995; Sheehan et al. 1995; Department of Industry, Science and Tourism 1996; Macleay 1996; Lunn 1997; Perkins 1997; Environment Management Industry Association of Australia [EMIAA] 1998; Tolhurst 1999). It has been argued that a competitive edge has evolved because Australia’s dry

Yet there has been little critical examination of Australia’s competitive advantage in water technology and management, something this thesis seeks to redress. The largest water companies in the world are vertically integrated French enterprises, followed by UK firms that are active in parts of Asia (Finger and Lobina 1999). Contrary to what some publications claim (e.g. Sheehan et al. 1995; EDC 1995: 17), Australia’s geographic proximity to large Asian water infrastructure projects, relative to European competitors, does not necessarily guarantee competitive advantage. Also, since the Australian water industry reforms of the mid 1990s - largely initiated by the Hilmer report (1993) and COAG (Council of Australian Governments) recommendations (COAG 1992; 1995a; 1995b) to make utilities more efficient - the domestic market has seen an influx of foreign players, rather than Australian firms flexing competitive muscle overseas.

Against this background of global dominance by gigantic Anglo-Franco firms, and although a minor player, Australia has, nevertheless, produced a number of water technology and management firms that have attained an international profile. These include exporting firms such as CDS Technologies (stormwater litter traps), Sinclair Knight Merz (engineering consultancy and design) and Perth-based Environmental Solutions International (specialists in microbial sludge management). One of the more prominent examples from the 1990s was Memtec - a water filtration specialist. Memtec still conducts R & D (research and development) and some production in Australia, although controlling interests in the firm were acquired by US Filter in late 1997, which in turn was acquired by the French giant - Vivendi - in early 1999 (Carson 1997; Ogier 1999). Such situations of tension, where small but dynamic ‘David-like’ firms face the ‘Goliaths’ of the global water industry, create fertile ground for interesting research.
Understanding how trade develops in an industry can contribute to the national interest. This assumes that vigorous competitive export industries are an economically and socially desirable goal. Australia is a small open economy, still largely dependent on commodity exports and chronically running a high current account deficit (Australian Bureau of Statistics [ABS] 2000 #5302.0). Like many OECD economies, Australia has restructured its economy over the past two decades to lock into changing global economic conditions. Numerous commentators have highlighted the impediments to moving away from commodities and toward exporting value-added goods and services (e.g. Jones 1989; Button 1998; Brain 1999; Baldwin 2000; Coombes 2000). These impediments include lack of domestic venture capital, disincentives in the taxation system for ‘high-tech’ investment, declining R & D expenditure, and a risk-adverse entrepreneurial culture. Many of these discussions, due to their broad scope, do not provide a detailed micro-economic focus of how Australian innovations can be developed in particular industries to realise their commercial potential. By focusing on one industry, a more thorough understanding is arguably achieved of how innovation, competitive advantage, corporate strategies and government programs interact to produce successful exporting firms.

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1 This assumption is the view of the dominant paradigm. It is noted that while economic theory can demonstrate how trade can increase a nation’s wealth and raise the average standard of living (see Harris 1985; Varian 1992), this says nothing about how the benefits should be distributed. Furthermore, the belief that increasing trade is an incontestable national goal does have critics (e.g. Hirst and Thompson 1996; Thompson 1998). Even a prominent economist like Krugman (1994b) comments that the emphasis given to trade and international competitiveness in popular economic and political discussion is misplaced, since it only involves about 10% of GDP when averaged over the United States, Japan and the European Union (the three largest trading regions). Having noted this, this thesis still maintains that trade is generally a desirable national aspiration.
1.2 The research aim and its scope

The aim of the thesis is to explain trade at the micro-economic level, using the Australian water technology and management industry to test ideas. One fundamental question underpins the research: *how does trade develop for firms involved in this industry?* A detailed answer requires critiquing the literature and constructing a theoretical framework. This process generates a number of sub-questions (see Table 3.3, pp. 95 - 97) to bolster the main question. The next stage involves identifying the relevant firms and organisations. Information is gathered and analysed to test, support and challenge the various ideas. An important corollary of addressing *how* trade develops is to explain *why* certain findings prevail. By building up answers, the theory is tempered by the feedback of empirical evidence. The aim is to have a comprehensive and flexible framework capable of explaining how trade develops in this industry. With modification, the framework is possibly adaptable to other industries. The research has theoretical relevance for the discipline of economic geography and also provides practical insights of export development for an industry relevant to the national interest.

At this stage, it is necessary to qualify the scope of the research. A fully comprehensive study of trade would consider both the supply and demand-side factors that influence trade. In order to keep within reasonable bounds, this thesis concentrates on the supply-side with the primary concern being trade emitting from Australia. The factors driving international demand for water-related goods and services are not considered in detail, but only noted where relevant. Also because the focus is trade by an intermediate goods and services industry, the complex influences of consumer tastes and preferences are not explored. Furthermore, this is a study of only one industry in a relatively small economy. Thus there is an underlying caution about overgeneralising, such as claiming that the theoretical framework and empirical interpretations apply unconditionally and without modification to other industries and geographies. The latter chapters address this issue.
1.3 Structure of the Thesis

The thesis is organised into four parts. Part One (Chapters 2 and 3) develops an explanation of trade. Chapter 2 evaluates the main debates over trade theory. It draws together the useful elements to construct a broad framework applicable to explaining contemporary international trade where technology gaps and competitive advantage between nations provide more convincing reasons for observed patterns than theories based on factor advantages. Additionally, the state should be considered in this macro-level explanation. Yet limitations remain. To address these, the refinement of the theoretical framework continues in Chapter 3 where it is argued that a comprehensive understanding of trade needs to occur at the level of the firm, using several separate but complementary theoretical strands. Four main strands have been identified: competitive advantage and corporate strategies, innovation creation and acquisition, the function of networks, and the role of state and institutions. A central contribution of the thesis is to combine these strands to overcome limitations inherent in single strands. In developing a framework, a number of research questions are generated (Table 3.3). These questions provide a direction for the empirical work.

Part Two provides the necessary context in which to situate the empirical work. Chapter Four’s purpose is descriptive. It offers a detailed definition of the water industry, as this provides a research boundary. The chapter also presents a background of the global industry, and outlines the emergence of an exporting water industry in Australia. Water industry reforms during the 1990s are discussed as these have created conditions that have produced opportunities and constraints for domestic firms. The chapter reviews what is known about how exports develop for this sector and overviews the forms of institutional support. Chapter 5 discusses the research methods. The philosophical underpinnings of the research derive from critical realism. Building on this, the chapter describes how the empirical work - involving questionnaire surveys and personal interviews - is approached. The rationale for the choice of subjects is explained. The research involves 124 firms and 9 related non-commercial organisations, thereby providing a detailed insight of the water industry.
With the theory and background in place, Part Three (Chapters 6 - 10) addresses the main research question by systematically tackling the numerous sub-questions from Part One. Cumulatively, a detailed understanding is formed of the processes that explain how trade develops in this industry. Chapter 6 describes the characteristics and organisation of the industry and evaluates the strength of linkages between firms. Chapters 7 to 10 deal respectively with each of the four theoretical strands. The general approach is to describe what has been found and to analyse why. Chapter 7 defines competitiveness for this industry, tests the robustness of Porter’s framework of competitive advantage, and explains why certain corporate strategies are used. Chapter 8 investigates the relationship between innovation proxies (i.e. R & D and patent counts) and performance measures of firms, and how innovation is created and acquired by firms. Chapter 9 discusses how competitiveness, once it is created, extends across space. The methods firms use to access export markets are investigated; the functions of networks and trust in trade are analysed. Chapter 10 evaluates how state and institutional organisations directly and indirectly influence trade in the water industry. Normative questions addressed include considering whether targeting would be feasible, and assessing if institutional capacity is sufficient for the industry.

Part Four concludes the thesis by tying together the findings and appraising the work. The implications for economic geography are highlighted. Chapter 11 summarises the findings and reconciles the theoretical and empirical work. In the light of knowledge created by rethinking trade, some theoretical aspects arguably should be emphasised, with other aspects relegated to secondary importance. The research is appraised by discussing the limitations and suggesting improvements. Chapter 12 highlights the theoretical and practical contributions of the research. Given the relatively small size of the Australian water technology and management industry, it is considered whether the industry can be internationally competitive. To close, opportunities for further research are outlined.
Chapter 2
Developing an explanation of trade: macro-economic explanations and their limitations

To explain how trade develops in the Australian water technology and management industry, it is necessary to find out what determines trade. While much theory and explanation\(^1\) is discussed at the international level as relationships between trading nations, ultimately, it is firms within nations - and units within firms - that trade. An adequate explanation needs to consider the macro-economic and political conditions within which firms operate, in addition to relationships at the micro-economic level between firms, trading partners, governments and other organisations. This and the following chapter (Part One) review what is known and highlight limitations and issues of contention. This guides the construction of a unified framework, applied in subsequent chapters when analysing the empirical evidence.

Chapter 2 provides a critique of macro-economic theories of trade. The critique is based upon assessing how adequately different ideas explain what determines trade. Macro-economic (or macro-level) trade theories are defined as generalised explanations applicable to nations, regions or industries within these. Section 2.1 begins by justifying why such a review is needed. Assumptions about the economic characteristics of the water industry are also outlined to provide a context for assessing how useful these theories might be for this industry. In the remaining sections, the review is sequential in that the limitations identified in one section guide the choice of ideas to critique in subsequent sections. The breadth of the discussion means that only the central propositions of each theory are described, with an emphasis on the limitations and approaches taken to redress these. Section 2.2 outlines traditional trade theories and highlights their deficiencies. Section 2.3 discusses more recent theories that are argued to better reflect empirical observations. The common themes underpinning this collection are

\(^1\) In the strict critical rationalist sense, an explanation or hypothesis only qualifies as a theory if it can continually withstand the rigours of Popper’s falsification testing (Gregory 1994a). However, much of the literature reviewed uses the terms, ‘explanation’ and ‘theory’, or ‘explanatory’ and ‘theoretical’, interchangeably. While this epistemological distinction between the terms is acknowledged, in practice a
that technology is an endogenous determinant of trade and that geography influences the process of innovation (including technological change). Section 2.4 reviews explanations about the internationalisation of multinational activity, given that foreign direct investment is a significant component of trade flows. Section 2.5 critiques the concept of competitive advantage, with an emphasis on Porter’s ideas. The strength of this concept is that it accommodates some of the earlier theories of trade. Section 2.6 argues that the state should be considered in a comprehensive explanation and evaluates two main ways that this role is exercised. Section 2.7 concludes by drawing together the useful elements identified to construct a framework applicable at the macro-economic level. However, the framework still falls short of a comprehensive trade explanation because a number of limitations and contentious issues remain. This provides a direction for further development and refinement in Chapter 3.

2.1 Why macro-economic explanations?

Macro-economic explanations such as factor endowment assume that the nation is the unit of analysis. If the eventual aim is to apply a theoretical explanation of trade at the level of the firm, why is such a review necessary? Figure 2.1 illustrates the answer. Understanding processes at the macro-economic level informs explanations at the micro-economic level. To neglect a review of trade theory at the macro-level would falsely imply that trade at the level of the firm occurs devoid of wider national influences. These diverse and important influences include factor conditions, related industries, actions by the state, the institutional capacity of regions and the national innovation milieu. National influence varies for different firms and industries. If there are strong national determinants over firms, then processes at the national level are more significant. For example, firms involved in defence industries or energy-resource commodities are often subject to influential national determinants, more so than highly specialised or parochial firms.
Macro-economic trade theories, however, are generalisations that usually apply to primary commodities or manufactured mass-market products (Harris 1985; Grant 1994). Industries such as water technology and management - comprising diverse activities that include elaborately transformed manufactured products and specialised producer services that are sold in intermediate markets (see Sections 4.1.2; 5.3.3) - may not readily fit with the standard industry examples discussed in trade theory (e.g. studies by Noponen et al. 1993). To assess how useful a theory or explanation might be when applied to the water industry, Table 2.1 provides a context for the review.

### Table 2.1 Comparison of standard trade theory with characteristics of the water industry

<table>
<thead>
<tr>
<th>Points of comparison</th>
<th>Characteristics of the standard industry studied in trade theory</th>
<th>Characteristics of the water technology and management industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of product</td>
<td>Commodities, final-demand goods.</td>
<td>Usually intermediate goods and services (e.g. elaborately transformed manufactured products and producer services).</td>
</tr>
<tr>
<td>Reason for demand</td>
<td>Driven by consumer mass market.</td>
<td>Demand created because of state initiative, policy and legislation. Essential service for population settlements.</td>
</tr>
<tr>
<td>End-users</td>
<td>Consumers</td>
<td>Intermediate users (e.g. other manufacturers and contractors, water utilities, governments).</td>
</tr>
<tr>
<td>Type of demand</td>
<td>Usually elastic (downward sloping demand curve). Price sensitive.</td>
<td>Generally inelastic due to necessity of product/service. However, some degree of substitution between different treatment technologies.</td>
</tr>
<tr>
<td>Geographic characteristics</td>
<td>Usually an emphasis on regional concentration of production (e.g. steel, semiconductors).</td>
<td>Clusters of water-related activity not evident.</td>
</tr>
<tr>
<td>Type of firm</td>
<td>Often a multinational focus.</td>
<td>Mixture of small and large firms.</td>
</tr>
</tbody>
</table>
Source: summarised from Harris (1985); Grant (1994); Dicken (1998) for Column 2; author’s own research (Sections 4.1; 4.4; 6.1) for Column 3.
2.2 Limitations of traditional theories

There are several traditional explanations for international trade. The core of explanation depends on what is being traded. Comparative advantage has relevance when explaining trade for commodities. Modifications such as the Heckscher-Ohlin version help explain some trade in manufactured goods. The trend in the post-war period for trade to occur between countries with similar factor endowments has led to other developments. This section reviews these major debates.

2.2.1 Factor endowment theory

Comparative advantage and the Heckscher-Ohlin theory - collectively referred to as factor endowment theory - have emerged from neo-classical economics. The central tenet is that trade results from differences in factor endowments between countries or regions. A country or region can produce some commodities at a lower opportunity cost than a foreign competitor. Hence, international trade results from attempting to minimise opportunity cost. A country or region will export those commodities or products that use relatively more of its abundant factor. This factor could be a resource, labour or capital capacity. Key assumptions include perfect competition, identical technologies across countries, and constant returns to scale in production (Harris 1985; Leichenko 2000). Comprehensive reviews of factor endowment theory are provided by Caves and Jones (1973); Grotewold (1979); Harris (1985); McConnell (1986); and Johnston (1989).

When the theory was developed it seemed a reasonable explanation for existing trade patterns. However, the limitations of factor endowment theory have been exposed by the greatly changed patterns of global trade over the past several decades. Empirical evidence since the 1960s has shown that the majority of trade flows are between advanced countries with similar factor endowments, whereas developing economies with abundant labour and limited capital account for less than 10% of world trade (Harris 1985: 36-45; Hanink 1988; Porter 1990: 12-13; Martin and Sunley 1996; Webber and Rigby 1996: 240). The assumption of identical technologies in the Heckscher-Ohlin version, although mathematically convenient, does not reflect the reality of technology gaps between
trading partners. Further limitations are that trade continues to shift toward goods with rapid technological evolution, financial capital is increasingly geographically mobile, and services comprise an increasing proportion of trade (Dicken 1992). Particularly in the past two decades, much trade is either intra-industry or intra-firm (Dicken 1998). These developments cannot be explained by factor endowment theory.

Yet as several commentators note (e.g. Harris 1985; Martin and Sunley 1996; Webber and Rigby 1996, Brain 1999; Leichenko 2000), explanations based on factor endowment theory persist and provide the ideological foundation for policies of free trade. In such interpretations the state is relegated to setting market conditions and facilitating the reproduction of the labour force. Theoretically, factor endowment theory still has some relevance for explaining trade in commodities (Harris 1985; Brain 1999). Some of the tenets have been subsumed by contemporary explanations, for example as a subset of competitive advantage (Porter 1990; Brain 1999). Also, the theory has merit for arguing why trade can be mutually beneficial (e.g. specialisation raising real wages), rather than as a comprehensive explanation of why trade might occur (Webber and Rigby 1996).

Does factor endowment theory have any relevance for the water industry? While water itself is not usually traded (notwithstanding dire emergencies), the products and expertise needed to supply it are internationally traded (Section 4.2). The water industry firms that are internationally active are located in developed countries where water is relatively abundant. Yet the abundance of the resource has little to do directly with having an advantage in water technology and expertise. Rather, trade results because of embedded technology and expertise in water-related goods and services due to those countries being advanced industrialised economies. Factor endowment theory is not an adequate explanation in this case. Other explanations need to be considered.

Paradoxically, a comparative ‘disadvantage’ in a product is sometimes turned into a competitive advantage through innovation. Porter (1990) argues that an abundance of factors may undermine rather than enhance competitive advantage because selective disadvantage in factors can positively influence strategy and innovation. Using the Dutch tulip industry as an example, Porter (1990: 85) shows that a factor disadvantage in the
form of a climate adverse to large-scale flower production has resulted in innovative production that has led to a vigorous export industry. Extrapolating from this example, a supposition is that an arid climate or a scarcity of useable water might also produce innovations in water technology that can be exported. Section 7.3.1 ascertains if there is any evidence of this from the Australian water industry.

Such insights offered by factor endowment theory, however, cannot compensate for its limitations. It does not explain trade between industrialised countries where closely similar products are distinguished by innovative characteristics, rather than by different input requirements. Nor can the theory predict the type of goods exchanged by countries with similar resource endowments (Martin and Sunley 1996; Brain 1999).

2.2.2 Alternative explanations: Linder demand

To address these problems, other traditional explanations have been developed. A notable development is the Linder demand model. The main feature is that demand - neglected in other explanations - is considered a central tenet. The emphasis is on who is involved rather than what is traded (Linder 1961). In this model, trade intensity is an increasing function of market homogeneity and a decreasing function of distance. Trade among similar markets is a function of overlapping demands. Export intensity increases as per capita incomes converge, resulting in demand for similar products. Conversely, distance deters trade, not solely because of transportation costs but due to it limiting the market horizons of producers as distant markets are unfamiliar (Linder 1961; Grotewold 1979; Hanink 1988). It is demand-induced innovation within each country, not supply factors, that determines comparative advantage.

The explanation though has a number of limitations. There is too much focus on final consumer goods to the neglect of intermediate inputs and services (Grant 1994). Recent work on the internationalisation of services has somewhat rectified this neglect by recognising converging demand conditions between exporters and importers (O’Connor and Daniels 2002). Importantly, Porter (1990: 785) argues that Linder’s ideas do not expose the specific attributes of local demand that allow one nation to gain competitive
advantage in a particular industry. Another problem is that although the model includes a spatial dimension, the logic on which this is based is debatable. Distance does not necessarily diminish the intensity of trade between partners, especially if they trade value-added intermediate goods and high-level producer services. Information technologies allow knowledge of distant markets (Cornish 1997a; 1997b).

It is generally true that as countries industrialise some demands do become similar (Hanink 1988; Dicken 1992). Pertaining to the water industry, the demand in Asia for water infrastructure is partly an outcome of industrialisation (e.g. urban growth and factories requiring adequate input and output treatment of water/wastewater). Indirect demand for water industry products and services also derives from social transformation because an increasingly educated and politically active citizenry are likely to demand higher environmental and health standards. (Broadbent [1998], for example, discusses links between Asian industrialisation and environmental activism.) However, the actual purchase of such goods and services is directly by governments or private sector firms and organisations acting in response to government initiatives, not usually the consumers themselves (OECD 1996). In this case demand is generated by government responses rather than by consumerism. Overlapping consumer demand is unlikely to be a satisfactory explanation of trade in water technology and management.

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2 The Linder demand model is a possible explanation for trade in bottled water and domestic water filters. Some European firms have found lucrative export markets in Asia for these products (Karp 1995; Ogier 1999). However, such consumer items are not considered part of the water industry for this research (Section 4.1.2).
2.3 Incorporating technology and geography into trade theories

The limitations inherent in traditional theories - namely assumptions of perfect competition, uniform technology across space and constant returns to scale - have resulted in improved explanations of observable trade patterns. Section 2.3 overviews and critiques some of the main ideas. Although not all these explanations are strictly trade theories, understanding about trade is advanced in two respects: technology (and more broadly innovation) is an endogenous determinant that influences trade; and geography influences how innovation is created and diffused. Some of the explanations make provision for the state to positively influence outcomes, hitherto not considered in traditional theories.

Section 2.3.1 establishes the relationship between innovation and trade, which is a foundational concept. Section 2.3.2 critiques explanations based on concepts of technological change. Product cycle theory is an important early contribution. Technology gaps are more recent explanations. Section 2.3.3 explores how geographic clusters help create technology gaps that drive trade. Included in this strand are ideas about increasing returns to scale and endogenous growth. Yet clusters are not necessarily a causation of trade, as Section 2.3.4 explains. Section 2.3.5 acknowledges the limitations of these various ideas.

2.3.1 The link between innovation and trade

Differences in innovation (including technology) provide the basis for specialisation and trade between countries (Fagerberg 1995; Wakelin 1997). A basic definition of innovation is the introduction or improvement of a product, process or service that results in better or cheaper goods and services. Innovation includes not only technical change to a product or process, but new and better ways of doing things such as new approaches to marketing, distribution and servicing (Porter 1985; 1990; Ceh 1996; Cornish 1997a; Wakelin 1997).

The theoretical reason why trade results is as follows. A more innovative region or firm has higher productivity than a less innovative competitor. Higher productivity is defined as an increase in revenue per unit of cost because of a higher turnover per employee, or greater output in value per unit of capital (Webber and Rigby 1996: 182-183). Higher
productivity, as a result of innovation, results in better quality or cheaper goods or services that are more attractive to international buyers than those products of less competitive (i.e. less productive) foreign rivals. Higher productivity creates competitive advantage over rivals (Porter 1990). Nations, regions within nations, and firms within these, have greater propensity to access spatially larger markets (i.e. trade) if they have competitive advantage over rivals.

Yet this theoretical claim has been questioned by some researchers (Leichenko 2000). Rather than trade being driven by productivity growth, it is possible that exposure to foreign competition spurs productivity growth. Empirical work by Bernard and Jensen (1995) shows that manufacturing plants that become exporters exhibit superior performance compared to plants that cease exporting. This suggests that while productivity and exporting success are related, it is not necessarily a simple one-way causation. The relationship between productivity and exporting is discussed further at the level of the firm (Sections 3.2; 3.3), and empirically tested (Section 7.1).

2.3.2 Explanations based on technology

There is strong evidence that technology and trade are interrelated (Fagerberg 1995; Wakelin 1997). Product cycle theory is an important foundation that was developed in the context of post war trade to explain US dominance (Posner 1961; Vernon 1966). More recent explanations propose that technology gaps between nations and regions drive trade. Gaps persist because technology is rooted in the skills, capabilities and knowledge that have accumulated over time (Dosi et al. 1988; Nelson 1993a; 1993b). The following subsections critique these ideas.

2.3.2.1 Product cycle theory

The main feature of product cycle theory is that technological differentiation is an essential driver of trade as new technology results in new products that are eventually exported. The theory proposes that manufactured goods follow three general stages of product development. In the early phase small volumes are produced for the domestic market in highly specialised plants; if successful, demand increases and more
manufacturers enter the market, with product differentiation occurring. Markets begin
developing in other economically similar countries and so domestic firms export.
Eventually a mature phase is reached where the good is mass-produced for the mass
market in capital intensive plants. This third stage is characterised by domestic market
saturation and product standardisation. Production shifts off-shore as lower cost countries
begin demanding and producing the product. The country of origin then becomes an
importer of the standardised product. Meanwhile, new product cycles begin domestically
(Harris 1985; Dicken 1992).

When first proposed, product cycle theory seemed to explain patterns of international
trade and industrial organisation from the perspective of the United States. However, the
growth of Japanese and European economies during the 1960s and 1970s caused the
theoretical preconditions of the product cycle to be eroded because similar demand
conditions were found in different nations (Harris 1985; Porter 1990). Importantly,
developments such as multinational growth and global capital markets meant that firms
were not confined to the demand and factor constraints of their home country. As Porter
(1990) observes, the theory has little relevance at the level of the firm as it cannot explain
why some firms in different countries become industry leaders, often for many decades.
The model has also been criticised for being deterministic because it assumes that the
transitions from one stage to the next, as well as location patterns and trade, are inevitable
(Leichenko 2000). Nor can it account for the range of multinational spatial behaviour in
services or basic resource-processing industries.

Despite minor modifications by Abernathy and Utterback (1978) to distinguish between
product and process innovation stages, product cycle theory is not representative of many
industries (Porter 1985; Webber and Rigby 1996). There have been limited attempts to
apply the theory to producer services, such as Tordoir’s (1994) hypothesis of an evolution
of highly customised and knowledge intensive processes at the early stage to one of
service standardisation in the latter stages. Competition in terms of product differentiation
(i.e. quality) is substituted for price differentiation. To date there has been scant empirical
testing of Tordoir’s hypothesis (Lindahl and Beyers 1999).
Because the water industry is characterised by a specialised market for its products and services, rather than mass production and mass market consumer demand (Table 2.1), it seems unlikely that product cycle theory can explain such trade. Its main theoretical value is that it introduces fundamental concepts such as innovation, product differentiation and technological evolution (or change) into a theory of trade (Harris 1985; Porter 1985). Modified, product cycle theory is the basis of the ‘flying geese model’ of East Asian industrialisation (Kojima, 2000; Tung 2003).

2.3.2.2 Technology Gaps

Traditional product cycle theory assumes that technology gaps between nations are temporary because knowledge eventually diffuses over space (Posner 1961; Vernon 1966). Yet even a cursory examination of global trade would indicate that technology gaps persist between many nations (Wakelin 1997). There are several explanations for this. Path dependence explanations assert that the export success of certain sectors and regions is explained by a historically specific process of cumulative learning by innovative firms. Small chance events may dramatically alter the entire history of innovation creation and diffusion in a region because of feedback effects (Nelson 1981; Nelson and Winter 1982; Dosi et al. 1988; Patel and Pavitt 1997). The evolutionary model offers a similar perspective that recognises technological change has several sources, such as direct technological creation, imitation because of diffusion, and localised learning by doing (Nelson 1981; Nelson and Winter 1982; Dosi et al. 1988).

Nation-specific factors also account for different rates of technological change in different geographies. These ‘national systems of innovation’ comprise linkages between public and private sector research institutions and industry (Nelson 1993a; 1993b; Mowery and Oxley 1994; Patel and Pavitt 1994). An important insight gained from these perspectives is that technology is socially constructed with the characteristics of innovation and learning dependent not just on scientific knowledge, but also on cultural and political factors, and the institutional structures of different regions (Porter 1990; Lundvall 1992; Nelson 1993b; Malmberg 1997).
2.3.3 Explanations based on geographic clustering

Underpinning some contemporary trade explanations is the importance of geographic clusters of economic activity that create positive externalities for some firm, resulting in competitive regions (Hall and Markussen 1985; Malmberg 1994; 1996; 1997; Baptista 1998; Baptista and Swann 1998). Porter’s recent research (2003) shows that the performance of US regional economies is strongly influenced by the strength of local clusters. Concentrations of demanding customers and suppliers have a strong effect on competitiveness because knowledge spill-overs induce innovation and organisational improvement (Oakey 1985; Feldman 1994; Fagerberg 1995; Malmberg 1997; Porter 1990; 2003). Clusters instigate the processes that can result in technology gaps between competing regions. In Baptista’s (1998: 51) assessment, “these clusters - constituted as 'transactions-intensive' regional economies which themselves are interdependent across the globe - set up the foundations for much contemporary international trade”.

Even with the prevalence of information technology, a great deal of knowledge cannot be codified or expressed in blueprints or patents. Much technology is specific, tacit and complex; this often requires geographic proximity and face-to-face contacts (Pavitt 1987; Feldman 1994; Gertler 1995; Swann et al. 1998). Globalisation may have eroded the advantages of some locational factors, but as Markusen (1996) eloquently describes, in the increasingly ‘slippery’ global space economy there remains the ‘stickiness’ of some forms of knowledge and learning processes. It is widely acknowledged that proximity in various forms - social, cultural, organisational and spatial - creates innovations by interaction (Saxenian 1994; Malmberg and Maskell 1997). There are, however, also ideas that challenge these interpretations, discussed in Section 2.3.4.

The following subsections outline two contemporary trade theories where clustering is a central tenet of explanation. These ideas also link with the previous discussion of technology.

2.3.3.1 New international trade theory (NITT)

NITT emphasises that increasing returns to scale and imperfect competition result in regional specialisation and trade. In Krugman’s (1979) interpretation of NITT, scale
economies and oligopolistic market structures (i.e. imperfect competition) drive trade. Trade will occur even between countries with similar tastes, technology and factor endowment.

To explain the mechanism for increasing returns to scale, Krugman (1990; 1991) links Marshallian ideas of external economies with ideas of regional concentration of production and trade. Trade in the presence of external economies leads to regional concentration of scale-intensive industries, with production costs falling as the scale of output increases. There is a cumulative and self-reinforcing effect as regional concentration grows. Once particular regions become established as centres for production and exporting, economies of agglomeration give these centres a permanent cost advantage over other locations. Because of Keynesian income multiplier effects, higher wages in these centres stimulate the growth of local markets. Additional scale economies result, leading to further growth of regional exports. However, some commentators (e.g. Martin and Sunley 1996; Leichenko 2000) have noted that this explanation does not account for the initial establishment of these centres and for shifts in their location.

To explain oligopolistic markets, Krugman (1979; 1991) combines the above ideas with the Chamberlinian model, an approach that assumes competition among similar firms producing differentiated products that are close but not perfect substitutes. Each firm faces a downward sloping demand curve but is an oligopolist because the entry of new firms, producing slightly different products, reduces monopoly profits and results in several oligopolists. Building on Marshallian and Chamberlinian concepts, this interpretation of NITT assumes that firms can achieve both economies of scale and meet demand for differentiated products by locating at one site and engaging in intra-industry trade (Helpman 1981; Helpman and Krugman 1985; Krugman 1991). The different preferences of consumers in diverse locations provide incentive to producers to create a variety of products, with different attributes for various market segments (Krugman 1980).

NITT has led to reformulated thinking on trade policy. In theories based on differences in factor endowment, trade liberalisation improves a country’s welfare by fostering
specialisation in the goods that can be produced most efficiently. In NITT, if increasing returns and external economies are present, then instruments of the state that increase domestic production - such as tariffs, subsidies and R & D support - may provide firms with long-term cost advantages over foreign competitors (Brander and Spencer 1985; Grant 1994). Yet Krugman (1984, 1994a) generally opposes trade policies, arguing that they are based on crude misconceptions and are unlikely to be effective in practice (see Section 2.6.3). (Some of Krugman’s works, as reviewed by Martin and Sunley (1996), do allow for limited regional development policy but only where strong external economies are present.)

According to Leichenko (2000), empirical testing of NITT is still undeveloped. Martin and Sunley (1996) argue that a major limit with Krugman’s interpretation is a restricted view of geography in the form of Marshallian externalities. There is a neglect of the influence of local institutional, social and cultural structures in facilitating or constraining local development and determining the trajectory of trade. Another problem is that NITT does not answer which nation’s firms will achieve increasing scale economies and in what industries (Porter 1990).

2.3.3.2 Endogenous growth theory
This recent theory has emerged in response to shortcomings of traditional neoclassical growth theory (Martin and Sunley 1998). It has similarities with NITT but has a more extensive treatment of technology (Leichenko 2000). Endogenous growth theory recognises that technological change is endogenous (Romer 1986; 1990; Grossman and Helpman 1991). Individuals and firms can earn monopoly rents on discoveries. Technological spill-overs are important as knowledge creates more knowledge, leading to a positive feedback effect (Grossman and Helpman 1991). Technology is considered a non-rival good but is partially excludable (Romer 1990). Increasing returns are geographically bounded which helps explain spatial differences in growth rates (Lucas 1988; Romer 1986; 1994). This provides a mechanism for internally driven long-run growth and an explanation for divergence in growth rates over time (Leichenko 2000). Endogenous growth theory explains regional growth as an outcome of externalities and
increasing returns to scale that are associated with the spatial clustering of firms and local specialisation in particular industries (Krugman 1995; Martin and Sunley 1998). Positive externalities that result in knowledge spill-overs can be investments in human capital (Romer 1986; 1990) or Schumpeterian endogenous innovations (Grossman and Helpman 1991). The cumulative accrual of scale economies of agglomeration and specialised skills helps the regions become growth poles in an economy of increasing international connections.

Although it is not a trade theory, the endogenous growth model argues that trade drives long-run growth (Leichenko 2000). The development and production of new goods for export has externality effects which foster economic growth. Some products have greater spill-over effects so countries or regions that specialise in such exports experience rapid economic growth (Romer 1990). The spill-over effects are most likely to occur in geographic concentrations of similar industries (Lucas 1988; Martin and Sunley 1998). These ideas provide a theoretical argument why spatial concentrations can be active centres of economic growth and trade.

Despite the persuasive theoretical arguments of endogenous growth theory, there are criticisms. One is its failure to capture the importance of the socio-institutional context and embeddedness of regional economic development (Martin and Sunley 1998). Another problem is the lack of empirical support, as studies have shown the growth of output in a country can fall even when R & D is increasing (Martin and Sunley 1998; Leichenko 2000).

2.3.4 Critique of clustering theories

There is research that challenges the assumed relationship between clusters and trade. Saxenian (1994) argues that spatial agglomeration does not necessarily create mutually beneficial interdependencies, and an industrial system may be geographically
agglomerated and yet have limited capacity for innovation. Some research suggests that a large proportion of firms have few trading links with nearby firms, even when the locality has a strong spatial clustering of a particular industry (McCann 1995; Lublinski 2003). Malmberg (1996; 1997) concludes that few empirical studies are able to show that linkages - in the sense that the output of one entity is the input of another - are predominantly local. Proximity by itself does not necessarily guarantee learning processes are initiated. Indeed, proximity can take other forms - social, cultural and organisational - that are not necessarily spatially constrained (Malmberg 1997). Work by Storper (1997) also suggests that untraded inter-dependencies - as in knowledge spill-overs and labour pools - help explain the innovative capacity of clusters even when traded linkages within the cluster appear weak.

The importance of local tacit knowledge may be overemphasised, as Amin and Cohendet (1999) suggest. Local establishments can gain knowledge from their non-local parent firms by using corporate strategies that involve intra-firm and inter-firm linkages (Caves 1989; Dicken and Lloyd 1990; Appold 1995; MacKinnon et al. 2002). Research by Simmie (2003) shows how innovative firms located within UK growth regions transfer and share knowledge from the local to international level by using these linkages.

Confused terminology also explains why contention has arisen over agglomeration. In much of the cited literature spatial clusters, spatial proximity and economies of agglomeration are used as interchangeable terms. Phelps (1992) warns that theoretical problems can arise when these terms are conflated because the types of economic linkages are not distinguished. There are two types of distinct linkages present in agglomerations (Harrison et al. 1996). Urbanisation economies reflect externalities associated with the co-presence of firms from diverse industries. The close proximity of heterogeneous industries results in positive externalities for the locality. The second type - called localisation economies - are externalities associated with the presence in the locality of many other producers in the same industry. A large concentration of similar firms will give economies of scale because of the production of shared inputs, as well as influencing the diffusion of technology (Angel 1994; Saxenian 1994; Harrison et al. 1996). The distinction between
urbanisation economies and localisation economies is important because it can explain why some spatial concentrations may not be innovative - for example, urbanisation economies where there are few internal linkages (Harrison et al. 1996). This distinction is relevant when analysing the empirical evidence (Sections 6.3; 6.4).

2.3.5 Limitations of contemporary explanations

The various theories reviewed in Section 2.3 improve on factor proportion theory because they more satisfactorily explain how and why trade occurs between industrialised nations with similar factor endowments. Limitations, however, still remain. A more developed explanation of competitive advantage is required to explain trade when technologically similar sectors from different regions or nations are competing (i.e. no technology gap exists). Furthermore, while regional clusters of economic activity are nodal points of global trade flows (e.g. Baptista and Swann 1998; Porter 2003), clustering theories are insufficient in themselves to explain trade because the knowledge required for innovation and productivity may not necessarily derive from local sources (Section 2.3.4). The processes explaining foreign direct investment (FDI) need to be incorporated into a model of trade, given that FDI is an important component of trade flows (Braunerhjelm 1998). Finally, the role of the state in explaining trade must be specified. Addressing these limitations provides direction for the rest of this chapter.

2.4 Multinational activity and trade theory

2.4.1 Why is multinational activity important?

A comprehensive review of international trade theories needs to consider the processes that explain foreign direct investment (FDI) as a result of multinational corporation (MNC) activity. As much as one third of international trade is estimated to take place within corporations (i.e. intra-firm trade) (Dicken and Thrift 1992; UN 1995 cited Braunerhjelm 1998). Annual FDI flows almost doubled between 1991 and 1996 with an increasing share of trade being channelled through foreign affiliates of multinational firms (Braunerhjelm 1998). Attempts to integrate FDI and multinational firms into general equilibrium trade models only began in earnest from the 1970s (Ekholm 1998; Markusen
Dunning’s work is a well known attempt and is detailed below. The theory of MNC activity stands at the intersection between a macro-economic theory of international trade and a micro-theory of the firm (Markusen 1998). Some researchers (e.g. Braunerhjelm 1998; Markusen 1998) argue that intra-firm trade between units located in different countries is explained by the same general determinants (e.g. factor endowments; technology gaps; scale economies) that underlie trade between countries. However, as the thesis argument develops it is shown that other explanations are required to explain trade, especially for smaller firms (Section 3.2.3).

Traditional hierarchical models of MNC organisation, as reviewed by Dicken and Lloyd (1990), imply an oversimplified deterministic pattern of growth. Also these models do not explain why firms might choose to relocate some activities to foreign locations. Product cycle theory is an early explanation of MNC activity (Dunning 2000) but its applicability to different industries is limited (Section 2.3.2.1). Dunning’s (1977; 1993b) eclectic paradigm of international production is one of the durable explanations so a précis of it follows. A large body of literature, some of which builds on Dunning’s work, has emerged that discusses numerous aspects of MNC activity, such as processes of globalisation and state responses (e.g. volumes edited by Braunerhjelm and Exholm 1998; Mudambi and Ricketts 1998; Hood and Young 2000). These insights, however, are not discussed because MNC activity is only one aspect of a comprehensive explanation of trade.

2.4.2 Dunning’s eclectic paradigm

Dunning (1977; 1993b) seeks to explain why domestic firms engage in FDI and become MNCs. While not primarily a trade theory, Dunning’s explanation does offer a reason for the spatial flow of capital (as FDI), and goods and services (as an outcome of FDI). The paradigm proposes three conditions for firms to seek to undertake direct foreign investment. These are:

1. **Ownership advantage**: the firm must have a product or a production process that gives it some advantage in foreign markets. This could be through innovations in cost, financing
or marketing – specific to ownership – which is sufficient to outweigh the disadvantages MNCs face when competing with indigenous firms in the host country. Knowledge capital is a major ownership advantage (even for resource-based MNCs). Although costly to produce, knowledge capital can be reproduced relatively cheaply in different countries (e.g. as blueprints, chemical formula, reputation capital or software design).

2. **Location advantage**: the firm must have reason to want to locate production abroad rather than concentrate in the home country. Minimising transaction cost is the main motivation identified in Dunning’s (1977) early interpretations. Firms choose international locations with the least cost for each activity they perform, allowing various modes of entry into different countries. If transport costs or other trade costs such as tariffs are high, the firm will have an incentive to locate production directly in the market where it is sold. Recent research by Ekholm (1998) still finds strong support that trade costs favour foreign production. Other explanations, however, have also emerged. For example, Archibugi and Michie (1995) argue that one reason why firms increase international operations is to acquire technological assets (intangible and tangible) which are specific to other nations.

3. **Internalisation**: the firm must have a reason to want to exploit its ownership advantage internally, rather than license or sell its product or process to a foreign firm. For example, hierarchical control over exchange results in lower transaction and administrative costs than if activities are undertaken by others. Another reason is to protect firm-specific (or proprietary) knowledge. Firms transfer knowledge internally in order to maintain the value of assets and prevent asset dissipation. Licensees can easily absorb knowledge capital and use it to their own advantage (Porter 1985; Markusen 1998). As Caves (1989) observes, most MNCs commonly undertake the majority of research and development (R & D) in their home country. This is due to scale economies in R & D, the need for proximity to the firm’s headquarters, and the desire to maintain strategic knowledge within firms.

The three conditions, especially internalisation, create an incentive for MNCs to engage in both vertically integrated production (i.e. geographically fragmenting the production
process by stages) and horizontally integrated production (i.e. producing a similar product in multiple locations). Proponents of Dunning’s theory (e.g. Buckley and Casson 1976; Clegg 1993) claim that these conditions apply to MNCs involved in resource, manufacturing and service industries. However, O’Farrell and Wood (1998) argue that the FDI of service industries is different. Branch offices for service providers often act as conduits for service transfers, without necessarily providing a base for foreign production as in the case of manufacturing FDI.

2.4.3 Limitations of the eclectic paradigm

Dunning’s (2000) recent work argues that the eclectic paradigm can accommodate contemporary theoretical developments, such as the emphasis on knowledge as a competitive asset. Yet a number of problems remain with Dunning’s interpretation. The argument that MNCs are primarily driven by seeking low cost locations receives little support. Empirical evidence shows that there is substantially more FDI between developed economies than flows from developed to developing economies (Schoenberger 1988; Dicken 1992; Markusen 1998). The concept of increasing returns to scale is used to address this particular shortcoming (Dicken 1998). The advantages of scale economies mean that a MNC can horizontally invest in another country with similar factor advantage (i.e. similar market and income) to achieve profits by selling its product in the host country without having to pay export costs (Helpman 1981; Helpman and Krugman 1985).

Other limitations still persist. While the eclectic paradigm explains why firms prefer full ownership to partnership, it does not adequately distinguish between different degrees of partnership (O’Farrell and Wood 1998). Dunning’s explanation overlooks that corporate strategies other than FDI can influence trade. In recent decades the array of corporate strategies used by MNCs has substituted for much of the equity previously obtained through FDI (Webber and Rigby 1996: 33). Strategies such as acquisitions, mergers, joint ventures, licensing, franchisee arrangements, production sharing agreements and subcontracting are also important for explaining trade. Recent work (e.g. Hood and Young 2000) acknowledges that networks are reflective of more flexible organisational structures
and the growing need to deploy a wide range of relationships with the different stakeholders in various locations. Indeed, a main limitation of the eclectic paradigm is that it neglects concepts of networks and power relationships (O’Farrell and Woods 1998). For instance, Olds and Yeung (1999) and Yeung (2000) argue that analysing social and business networks offers a better explanation of Asian MNC activity than does transaction cost analysis.

Porter (1990) argues that ideas of competitive advantage that emphasise the home market offer an improved explanation of why and how multinationals from a particular nation become dominant in their industry (see Section 2.5.1). In contrast to Dunning, Porter’s ideas do not explain, however, why a MNC might choose FDI over direct exporting.

While acknowledging these limitations, the empirical work uses some of the ideas offered by the eclectic paradigm to explain the activities of MNCs involved in the water industry in Australia. There is, however, a considerable imbalance of FDI flows for this industry, with much more inward FDI than outward FDI (Bainbridge 1997; also see Section 7.4.3). A theory of MNC activity is useful but only contributes to a partial explanation of trade.

2.5. Competitive advantage

The concept of competitive advantage offers an important insight into why competitiveness differs between nations. Porter (1985; 1990) has been one of the most influential in developing a conceptual model of competitive advantage. The concept is not directly a theory of trade, but as Porter (1990: 7) explains: “International trade allows a nation to raise its productivity by eliminating the need to produce all goods and services within the nation itself. (National productivity rises because) the nation can thereby specialize in those industries in which its firms are relatively more productive and import those goods and services where its firms are less productive than foreign rivals”. For both a firm and a national industry sector, competitive advantage is obtained by productivity, resulting in either a lower cost product (i.e. cost differentiation) or a specialised product that can command a premium price (i.e. product differentiation). Innovations lead to higher productivity.
The strength of Porter’s concept of competitive advantage is that it can accommodate some of the macro-level theories previously discussed. Factor proportions theory, product life cycle and the Linder demand model are argued by Porter (1990: 16-21) to be embraced by this interpretation. Porter also claims that the concept can accommodate a theory of multinational internationalisation because MNCs gain competitive advantage from rivalry and sophisticated demand conditions in the home market. This is a contentious point that is discussed further. The theoretical tenets of competitive advantage and NITT are, however, incompatible: the former relies on conditions of vigorous competition between rivals, whereas NITT emphasises conditions of imperfect competition.

Porter’s concept forms an important strand of the theoretical framework for this research. It is applicable at both the macro and micro-level (Section 3.2). Section 2.5.1 presents a synopsis of the macro-economic dimension of Porter’s model. The description is kept brief because it is well covered in the contemporary literature (e.g. Webber and Rigby 1996; Dicken 1998; Lindahl and Beyers 1999). A critique of the concept follows and modifications to the model are suggested (Sections 2.5.2 and 2.5.3). Section 2.5.4 concludes by indicating the limitations that remain.

2.5.1 Porter’s ‘diamond’ model

Through extensive case studies, Porter (1990) has distilled four broad determinants of national competitive advantage - referred to as the ‘diamond model’ (Table 2.2). The model’s purpose is to provide a framework to explain why firms based in a nation are able to compete successfully against foreign rivals in particular segments and industries. The complex interaction of the four determinants, influenced by the industrial history of the nation, determines the preconditions for competitive advantage. Two outside forces - government and chance - are also considered. Governments can influence and be influenced by each of the four determinants. Porter stresses that the role of government is

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3 Rigby (2004 [personal communication]) argues that competition is not the distinguishing factor in these two incompatible theories. Even in models of imperfect competition, a firm can have monopolistic control
partial. It can amplify determinants of the diamond but lacks the power to create competitive advantage itself. This is a key point of contention with some other interpretations and is discussed further. Chance is defined as events that cannot be strongly influenced by firms and governments, and accounts for the inherent element of uncertainty.

Porter (1990) argues that geographic clustering of industries within the national economy intensifies the diamond, eventually determining which sectors develop competitive advantage. Geographically concentrated domestic rivalry has positive effects on related and supporting industries and demand conditions. Similar to Baptista and Swann’s (1998) analysis of clusters, positive externalities arise from both supply and demand sides.
Table 2.2 Explanation of the determinants of competitive advantage

<table>
<thead>
<tr>
<th>Determinant</th>
<th>Explanation</th>
<th>Importance to competitive advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor conditions</td>
<td>The nation’s position in factors of production - such as skilled labour and infrastructure - necessary to compete in a given industry.</td>
<td>Quality and cost of infrastructure services &amp; labour supply need to be of a globally competitive standard. Factor endowment (e.g. cheap labour, natural resources) is a sub component of factor conditions.</td>
</tr>
<tr>
<td>Demand conditions</td>
<td>The nature of domestic demand for the industry's products &amp; services.</td>
<td>Sophisticated customers demanding world's best practice &amp; design will force suppliers to continually upgrade products.</td>
</tr>
<tr>
<td>Related and supporting industries</td>
<td>The presence or absence in the nation of supplier and related industries that are internationally competitive.</td>
<td>Supporting innovative industries with a learning/adapting culture provide a platform for constant adaptation.</td>
</tr>
<tr>
<td>Firm strategy, structure and rivalry</td>
<td>The conditions in the nation governing how companies are created, organised and managed, and the nature of domestic rivalry.</td>
<td>Successful innovation likely to occur in conditions of strong home competition &amp; demand.</td>
</tr>
</tbody>
</table>

Source: after Porter (1990: 71; 127); interpretations in column 3 from Brain (1999: 60-1).

2.5.2 A critique of Porter’s concept

Porter attempts an ambitious task and inevitably, weaknesses and omissions have been noted. Some points of criticism are the emphasis on home nation conditions and the neglect of the role of inward FDI. Although MNC activity is acknowledged, it receives only scant treatment (e.g. Porter 1990: 17-18; 678-9). Also, the diamond model’s foundations are not built on rigorous empirical evidence. These criticisms are elaborated on.

Some commentators disagree with Porter’s emphasis on home nation conditions such as the strength of domestic supporting and related industries (Rugman 1991; Dunning 1993a; van den Bulcke 1995; Moon et al. 1995). This ignores the possibility of multiple home bases where sustained value-added activity depends on access to the resources and skills available in other countries. National competitiveness in an industry may be reliant on the
characteristics of the four determinants in both foreign and domestic diamonds (Rugman
and Verbeke 1993; 1995; Rugman et al. 1995). For example, Moon et al. (1995) argue
that the international success of Korean firms is partly due to targeting cheap labour in
other Asian countries, and not solely characteristics of the national diamond. Even in the
dominant trade triad of Europe, US and Japan, firms benefit from a combination of
strengths in both domestic and foreign markets. Furthermore, in small, open, resource-
intensive economies with their own multinational enterprises based on small domestic
diamonds - Canada and Australia being examples - overseas activity helps compensate for
empirical support for a relationship between a nation’s advanced domestic users and
international competitiveness, but also stipulates that Porter’s home market hypothesis is
only one of several explanations for the development of strong export industries.

The diamond model is limited because it negates the contribution that foreign-owned
subsidiaries make to the domestic host economy. While Porter considers only outward
flows of FDI, some researchers argue that inward flows are just as important for creating
competitive advantage (e.g. Dunning 1993a; Rugman 1991; Rugman and Verbeke 1993;
1995; Waverman 1995). Rugman (1993) shows that the largest subsidiaries in Canada
export almost as much as they import, arguing that provided value-added activities created
by inward FDI are sustainable in the long run, then their value is not inferior to the output
of domestic activities. Multinational activity impacts on many sectors of the Australian
economy (Fagan and Webber 1994). The Australian water industry itself has experienced
an increase of MNC activity since industry reforms (see Section 4.3.3). An explanation of
trade for this industry needs to consider intra-firm flows of financial capital, goods and
services. Intra-firm trade out of Australia is related to inward FDI from the foreign parent
company (as discussed in Section 7.4.3). Porter’s concept of MNC activity, confined to
home market strengths and outward FDI, cannot adequately explain competitive
advantage and trade when it is based on inward FDI.

Porter makes a contentious claim that the diamond model accommodates a theory of MNC
internationalisation. Although Porter’s ideas explain what initially makes a MNC
competitive, Porter does not answer why FDI is preferred by some firms as an export method. Porter’s ideas do not supersede those of Dunning’s that explain why MNCs engage in FDI. As argued in Section 2.7, a comprehensive theory should combine ideas from both the diamond model and the eclectic paradigm.

A serious criticism of Porter’s model is that there is no theoretical basis that allows ex-ante predictions. Porter’s (1990) evidence relies on numerous accounts of different company histories and strategies, using the most appropriate example to reinforce the particular point being made. There is a lack of statistical analysis to underpin the large amount of anecdotal evidence. Waverman’s (1995: 69) contention with Porter’s work is that, “a large number of assertions are made, most untested. .... A set of assertions and impressions is not a robust theory”. Some of the assumptions that underpin Porter’s ideas are also found to be questionable when tested at the micro-economic level, as discussed in Section 3.2.2.

A pertinent question that persists is how macro-level determinants of competitive advantage relate to the firm and create exports. Ultimately, as Porter (1990: 33) stresses, it is not countries that export but firms within countries. Determinants of national competitiveness depend on the competitiveness of certain industries, which themselves consist of competitive firms. Chapter 3 pursues this micro-level analysis of competitive advantage. There is also contention with defining what the role of the state should be for creating competitive advantage and facilitating trade. This issue is tackled in the next section.

2.6 The role of the state in a theory of trade

An explanation of trade at the macro-economic level ought to consider the role of the state. There are two common ways this role is executed: strategic targeting and the creation of competitive advantage. Although the effectiveness of the state’s influence can

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4 The state is an inclusive term to include all tiers of government. Generally the lower case for ‘state’ refers to the political apparatus. The upper case ‘State’ refers to sub-national political units of federations such as Australia. The state is a set of institutions, not a coherent whole (Jessop 1990: 117-8). States consist of distinct institutions that have their own projects. These projects reflect and influence internal forces within a sovereign territory as well as external pressures from other states (Webber and Rigby 1996: 90).
be contentious, the state should still be considered in a comprehensive framework. As van den Winden (1995: 151) comments, “even if government interventions had a predominantly negative effect on productivity development, this does not justify the neglect of government policy within an explanatory analysis”.

2.6.1 Why the state is important

A cursory examination of business-related mass media - even that which is firmly rooted in the paradigm of neo-liberal economics (e.g. Business Review Weekly, The Economist or the Far Eastern Economic Review) - demonstrates that there are numerous direct and indirect ways governments influence trade. Some overt examples include world trade negotiations, agricultural tariff protection issues and environmental agreements; more subtle ones include industry policy, education and training, and regional development policy. In short, the state performs certain functions and provides conditions for the existence and accumulation of capital (Jessop 1982; 1990).

The degree of involvement by the state in economic development (including trade and export development) depends on the underlying political paradigm. Different labels are given to the two basic courses of action of intervention or non-intervention. For example, Brain (1999) compares interventionist approaches of the corporatist state (e.g. intense industry protection, nurturing and targeting) with neo-liberal or economic rationalist responses of deregulation intended to promote comparatively advantaged industries. Jessop (1990) and Webber (1997) identify similar distinctions. The policy response is determined by underlying internal fractional divisions. The purpose here is not to debate the merits of one paradigm over another but to argue that regardless of the degree of intervention, the state still needs to be considered in an explanation of macro-level trade. Even in conditions of extreme economic rationalism, the state still has a role to maintain some infrastructure and assist in factor creation.

Yet in traditional trade theory there is no theoretical role for the state. Factor endowment theory has no role for the state because conditions of perfect competition are assumed. In this model, the market is the best mechanism to efficiently allocate resources and
determine what and how much is produced. Factor endowment theory provides the ideological foundations for free trade policies (Harris 1985; Brain 1999). Tariff protection and export subsidies are argued to be economically inefficient (e.g. Harris 1985; Krugman 1986; Porter 1990). Political support for the actions of the World Trade Organisation (WTO) is based on a belief in the benefits of free trade. However, an irony persists with determining the role of the state in a regime of free trade policies - the more a minimalist role of the state is advocated, the more international governance is required to enforce this condition. Even if factor proportion was the main theory being discussed - such as a study of trade in a commodity - the role of the state would still need to be considered. In such a case, the influence of the WTO would likely be a major point of discussion.

Other explanations of trade, such as NITT and competitive advantage, can theoretically accommodate an interventionist role for the state. Because scale economies and dynamic learning economies are assumed, the state can intervene to lower entry barriers for select domestic firms and encourage externalities (Brander and Spencer 1984; 1985). The state can also simulate domestic demand, leading to more competitive industries (Porter 1990). Having argued why the influence of the state ought to be considered, the next task is to investigate what instruments of the state are used and why.

2.6.2 How the state is involved

There are numerous ways that the state exercises its influence at the macro-level and interacts with the process of trade. Trade liberalisation, as facilitated by the WTO, is a prominent example of the influence of global (or supra-national) governance. The establishment of export processing zones is another example (Dicken 1992; Grant 1994). In addition, regional development policies can bolster existing agglomeration economies and generate exports (Krugman 1993). These influences are not discussed here because their impacts are broad and are not pertinent to global water industry trade. For example, there appear to be only a handful of WTO publications that refer to trade issues for environmental industries, including water (e.g. WTO 1998). Even then, the main concern is with defining the industry rather than a detailed analysis of how the WTO interacts in this type of trade.
Two areas of state influence are chosen for further investigation: developing export industries through industry targeting and the shaping of national competitive advantage. These are chosen because targeting and the creation of competitive advantage are believed to contribute to long-term growth (e.g. Brain 1999). The growth of exports occurs as a result of long-term growth in a nation’s or a region’s productivity, whereas the liberalisation of trade and fluctuations of exchange rates are argued to only temporarily create favourable terms of trade (Porter 1990; Romer 1990; Leichenko 2000). The following sections explain how the state has an influence in these areas and critiques its effectiveness.

2.6.3 Targeting

Targeting involves policies that identify particular industries or individual firms for support and development. One form is called sheltering which is often in the form of tariff protection, direct subsidies and grants. The purpose of sheltering is to allow an infant industry time to develop competitive strength. Tariff protection is widely considered to be inefficient because it retards micro-economic efficiency and hinders competitiveness (Harris 1985; Krugman 1986; 1990; Porter 1990; Rugman and Verbeke 1993; Martens and Vandenbempt 1995). Numerous problems exist such as knowing which industries should be protected, the tariff limit and its time limit (Suranovic 1997).

Another form is strategic targeting. The policy instruments range from direct export subsidies to subsidisation of R & D, plant and equipment. The term ‘strategic’ indicates that in an oligopolistic model, policy-makers take into account a response by foreign firms or governments when calculating their best cause of action (Stegemann 1996). Work from the mid-1980s gives intellectual support for strategic targeting policies (Brander and Spencer 1983; 1984; 1985; Brander 1986; Spencer 1986). This work argues that it is possible to identify (or target) some sectors at the margin that are more valuable than others because of potential rents (i.e. payment to an input higher than what the input could earn in an alternative use) or due to externalities (e.g. knowledge spill-overs). Subsidising domestic firms in these targeted sectors is justified if the extra profits from the exports exceed the cost of the subsidy. Targeting is argued to raise national income by capturing
rent-yielding domestic industries, thereby preventing foreign competitors doing likewise. For a subsidy to be effective, the main underlying assumption is that there is imperfect competition in the targeted industry. In these conditions a small number of international competitors (oligopolies or duopolies) are present because of entry barriers and temporary learning advantages due to increasing returns to scale. Subsidies can help domestic firms overcome entry barriers and sustain increasing returns, eventually stultifying the competition of foreign rivals. This logic, however, also assumes that retaliation by the foreign government subsidising its industry will not be as effective (Brander and Spencer 1984; 1985; Spencer 1986; Stegemann 1996).

Table 2.3 details the conditions necessary for effective targeting. The various theoretical assumptions, however, create a number of practical hurdles. The unpredictable responses of foreign competitors mean that the success of targeting could be limited (Grossman 1986; Krugman 1986). Policy makers potentially face a ‘prisoner’s dilemma’ problem and the associated effects of retaliation (Brander 1986; Stegemann 1996). A problem noted by a number of commentators is that of ‘picking winners’ (Krugman 1984; Harris 1985; Stegemann 1996). The challenge is knowing what types of products and firms are likely to be successful, and the correct amount of support. The political ramifications are that targeting policies may be captive to special interest groups that are not in the national interest (Industry Commission 1996; Stegemann 1996; Productivity Commission 2002). Importantly, if targeting is not directed toward efficient industries with scale economies, it is akin to shelter policies and unlikely to be sustainable (Porter 1990; Krugman 1994a).
### Table 2.3 Industry conditions and assumptions for effective strategic trade policy

<table>
<thead>
<tr>
<th>Necessary condition for a subsidy to be efficient</th>
<th>Underlying assumptions and limits of subsidies</th>
</tr>
</thead>
<tbody>
<tr>
<td>The industry needs to earn additional returns sufficient to exceed the total cost of the subsidy.</td>
<td>Needs to be substantial barriers to entry to preserve the gains in profit. Subsidies will not benefit national welfare if trying to save an unprofitable industry.</td>
</tr>
<tr>
<td>Increases in domestic output should lead to foreign rival firms reducing output levels.</td>
<td>Does not work with domestic monopolies that do not face foreign competition. Should occur relatively early in the product cycle before foreign capacity is established. Large and inflexible capital requirements are desirable. Assumes that foreign firms reduce their R &amp; D. Reaction of foreign rivals can be unpredictable.</td>
</tr>
<tr>
<td>The domestic exporting industry should be more concentrated (few and larger firms), or at least equal, to the rival foreign industry.</td>
<td>Assumes that firms will choose optimum output level given the output level of rivals. Assumes that each firm produces the same product at the same cost of production. Too much industry concentration can violate anti-trust laws.</td>
</tr>
<tr>
<td>Factor prices should not excessively increase due to domestic targeting.</td>
<td>If the industry has a strong union and a key input is in fixed supply (e.g. highly specialised labour), then factor prices will rise because of a subsidy. Marginal costs will increase and profits decrease.</td>
</tr>
<tr>
<td>The domestic industry has a fundamental cost advantage relative to the foreign competition, or that there are substantial learning or scale economies from increased production.</td>
<td>Assumes comparative advantage of the domestic industry in conditions of imperfect competition. Assumes barriers to entry. Assumes that government intervention, as in subsidies to capital, can lower marginal cost sufficiently to create a domestic advantage.</td>
</tr>
<tr>
<td>There is minimal spill-over of new domestic technology to rival foreign firms.</td>
<td>Externalities generated by R &amp; D subsidies must be conferred on domestic firms and not foreign ones. Assumes domestic counterparts will share knowledge. Assumes that government intervention can transfer technology to domestic firms and that foreign governments are not trying to limit spill-overs.</td>
</tr>
<tr>
<td>R &amp; D support and capital costs form a significant proportion of industry costs.</td>
<td>Support is most effective in the early product cycle stage when the initial innovating firm has temporary monopoly of the product.</td>
</tr>
</tbody>
</table>

*Source: summarised from Spencer (1986).*
Another questionable assumption from Table 2.3 is that domestic producers are strictly domestically owned. In reality ownership structures are more complex as the boundaries between domestic and foreign firms are not always clear. Domestic firms can have collaborations with overseas partners, as well as large degrees of foreign equity. Thus it can be unrealistic to assume externalities from subsidising R & D activity will only be confined to the domestic economy. Alternatively, the benefits from subsidising the R & D activities of a domestic firm may be confined to only that firm because of patent protection of proprietary knowledge. Furthermore, the effectiveness of targeting policies is questionable for some industries when cost-benefit analysis studies are applied (Industry Commission 1996; Stegemann 1996).

Proponents of targeting argue that provided certain parameters are adhered to - which can be difficult in reality - then targeting can be an effective form of trade policy, especially for small open economies (Harris 1985; Brain 1999). In Harris’s (1985) view, targeting policy should be directed at small and medium size domestic firms in technologically progressive (i.e. Schumpeterian) industries, where there are potential benefits but barriers to entry. Also, support should be short-term and only used in the early phase of development and export, with programs targeted at firms or individual R & D projects rather than industries (Harris 1985; Porter 1990). In Porter’s (1990) assessment, persistent subsidies can cause an industry to lack incentive to pursue innovation.

Because of the difficulties associated with targeting policy, some current mainstream economic thinking is reasserting that the optimal trade policy is to facilitate free trade, but with international guidelines for cooperation (Cowling and Sugden 1998). This shift is evident in the context of this research. For example, a number of government publications from the mid-1990s advocated specific targeting policies for developing an exporting Australian environmental goods and services industry (e.g. EDC 1995; DIST 1996). Yet in recent years such overt support has been absent, although more indirect forms of policy support still exist such as generic export facilitation programs and R & D subsidies (see Sections 3.5.2; 4.4.2). The empirical work evaluates the effectiveness of existing
programs (Sections 10.1.1). Using Table 2.3 as a guide, Section 10.1.2 considers if the water industry would theoretically be a suitable candidate for specific industry targeting.

2.6.4 Creation of competitive advantage by the state

The state can influence national competitive advantage and hence trade. There are numerous ways this occurs: for example, the state can encourage technological development by funding research, enact legislation to protect intellectual property, and more generally maintain markets and supporting institutions using various forms of fiscal and monetary policy (Rigby 2004). This discussion, however, is confined to critiquing Porter’s interpretation because the objective throughout Section 2.6 is to integrate the state as a central determinant into a model of competitive advantage and trade.

Porter (1990) argues that the state’s role is not to directly intervene, but rather adapt a partial role as a pusher and challenger for the four determinants of the ‘diamond’. Investment in education and training is perhaps the single greatest long-term leverage for upgrading industry. State-funded research and industry collaboration can be effective, provided rival firms are involved and there is an emphasis on commercially relevant technology.

Porter asserts that the state’s response should be dynamic depending on the developmental stage of a nation. In the early stage, development is mainly factor and investment-driven. Direct influence on factor creation can be initially effective. This is achieved by using policies to encourage savings or using foreign borrowing to accumulate capital, and providing temporary protection until domestic firms establish domestic markets. Importantly, devaluing currency will only be beneficial in the early stages when a nation’s firms still depend on price competition to enter foreign markets. To move toward the innovation stage, firms themselves must become prime movers and the state should play an indirect generalist role as a facilitator. The main influence of the state at this later stage of development should be to create advanced factors and upgrade demand conditions. One common option is by facilitating and encouraging early and widespread industry adoption of high technical standards, such as implementing stringent environmental legislation.
(discussed in Section 3.5.2.2). Such policy is usually most effective when it anticipates international developments because its implementation means that a nation’s firms gain a head start over foreign rivals. This is referred to as ‘first mover’ advantage.

Due to the ambitious agenda, Porter’s discussion of the state’s role for creating competitive advantage is generalised and akin to a menu of policy options. This broad treatment has limited relevance for examining a specific industry. Also, Porter’s discussion does not suggest what the appropriate policies might be for rivals to compete equally with an industry in a nation that has achieved ‘first mover’ advantage (Brain 1999). Rugman (1991) believes that an unmodified adoption of Porter’s diamond model in smaller industrialised countries would result in the wrong policies, given the influence of foreign MNCs. Furthermore, Porter only provides a general description of what the prevailing industry conditions should be for state influence to be effective. In comparison, the work on strategic trade policy (e.g. Brander and Spencer 1984; Krugman 1986; Spencer 1986) offers an analysis of the desirable industry conditions for efficient targeting.

A common criticism of Porter’s interpretation is its relegation of governments to a secondary role (Rugman and Verbeke 1993; Moon et al. 1995; Dicken 1998; Brain 1999). Moon et al. (1995) comment that it is odd to leave out the only actor potentially interested in the pursuit of national competitiveness. Given Porter’s emphasis on home base advantages and recognition that competitive clusters have unique industrial histories, it is contradictory to diminish the legacy of governments which are integral to that history (Rugman 1991; Jegers 1995; Waverman 1995). Whereas Porter claims that newly industrialised countries (NICs) developed mainly due to vigorous domestic rivalry, Webber and Rigby (1996) argue that the industrial success of NICs was largely as a result of actions by national developmentalist governments, which created competitiveness through the domestic creation of increasing returns. Interestingly, there are also critiques of Porter’s work that question the effectiveness of the state - even in a secondary role - to create national competitive advantage because of the mobility of MNCs that have no singular connection to any one nation state (Root and Visudtibhan 1994).
2.6.5 What needs to be known about the state and trade?

Section 2.6 has considered why the state ought to be included in building a theory, and discussed how actions by the state influence macro-level trade. Strategic targeting has some theoretical basis but in practice is wrought with difficulties. With competitive advantage, the state has a number of ways where it can have an influence. The contention is to what degree should the state intervene, and how effective this will be for particular industries. Chapter 3 continues this inquiry by arguing that the state is also important for understanding trade at the level of the firm.

Another issue, not well covered in the literature, is that State and Local tiers of government also have an influence on industry and trade policy. Porter (1990: 622) alludes to this: “(because of industry clusters) the role of regional state and local policies is potentially as great or greater (in impact than overarching national policies)”. However, this important point is not developed in his work. The empirical investigation of the Australian water industry (Section 10.3.4) considers the influence of these lower tiers of government.
2.7 Conclusion: the usefulness and limitations of macro-economic trade explanations

Chapter 2 has reviewed theories and explanations of trade at the macro-economic level. There are a number of useful ideas that offer insight into how and why international trade occurs. Table 2.4 summarises what has been found and the limitations. The concept of competitive advantage emerges as the most useful explanation (although as noted, its original intention is not primarily a trade explanation). Competitive advantage helps to explain why trade occurs between nations with similar factor endowments. There is also the recognition that productivity, achieved by innovation, is a key driver. Other explanations are not as comprehensive. While product cycle and technology gap ideas recognise innovation, they do not give an adequate account of how innovation is created for different industries. Further, an explanation such as NITT is based on assumptions of increasing returns to scale and monopolistic barriers to entry, but these conditions may not apply to all industries. The simplicity of Porter’s (1990) ‘diamond’ model makes it a malleable concept of competitive advantage that can be applied to different industries. For instance, factor conditions might be emphasised to explain the internationalisation of a resource-intensive industry, whereas related and supporting industry could be the more salient determinant for a high-technology industry characterised by clusters.
Table 2.4 Summary of trade explanations reviewed in Chapter 2

<table>
<thead>
<tr>
<th>Name of theory or explanation</th>
<th>Main features of the theory</th>
<th>Type of product market assumed</th>
<th>Role of technology</th>
<th>Role of state</th>
<th>Type of competitive market assumed</th>
<th>Main limitations</th>
<th>Possible applicability to the Australian water industry1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor proportions theory</strong> (includes comparative advantage; Heckscher-Ohlin; NIDL)</td>
<td>Differences in geographically- specific factor endowments. Comparative costs between trading partners.</td>
<td>Commodities; basic manufactured goods.</td>
<td>Static</td>
<td>Nil</td>
<td>Perfect</td>
<td>Does not explain trade between countries with similar factor endowments.</td>
<td>No. However, comparative ‘disadvantage’ might have a limited explanatory value.</td>
</tr>
<tr>
<td><strong>Linder demand</strong></td>
<td>Overlapping demand between trading partners.</td>
<td>Mass market consumer goods.</td>
<td>Generally static but there is recognition of converging technology between trading partners.</td>
<td>Nil</td>
<td>Imperfect (because market information suffers from distance decay).</td>
<td>Neglects services. Market information is spatially restrained.</td>
<td>No</td>
</tr>
<tr>
<td><strong>Technology explanations: Product cycle theory &amp; technology gap theories</strong> (includes path dependency &amp; evolutionary theories)</td>
<td>Technological evolution; technology gaps between nations.</td>
<td>Mainly mass market consumer goods; some recognition of intermediate goods.</td>
<td>Evolving technological capacity is essential.</td>
<td>Nil</td>
<td>Imperfect (because of barriers to entry, also monopolistic rents are recognised).</td>
<td>Cannot explain demand or product evolution for multiple countries.</td>
<td>Limited relevance for some manufactured goods.</td>
</tr>
<tr>
<td><strong>‘Clustering’ explanations: New international trade theories; endogenous growth theory;</strong></td>
<td>More realistic assumptions about observed patterns. Agglomeration as a driver. Recognition of increasing returns to scale/ imperfect competition. Also recognises technology.</td>
<td>Consumer &amp; intermediate goods.</td>
<td>Crucial</td>
<td>Some role for ‘engineering’ comparative advantage. Barriers to entry provide justification for state intervention.</td>
<td>Imperfect</td>
<td>Too much emphasis on agglomeration. Does not distinguish between urban and localised linkages.</td>
<td>Potentially relevant if increasing returns to scale are found.</td>
</tr>
<tr>
<td><strong>Multinational FDI theory</strong> (mainly Dunning’s eclectic paradigm)</td>
<td>Accounts for intra- firm trade. Advantages to firm by re-locating production (e.g. lower labour costs, raw material access). Advantages through internalisation.</td>
<td>Usually manufactured goods &amp; commodities.</td>
<td>Not specified.</td>
<td>Not specified</td>
<td>Imperfect (because of barriers to entry).</td>
<td>Does not explain what makes MNCs competitive. Does not explain intra-firm trade between countries with similar factor endowments.</td>
<td>Potentially relevant if multinational activity is significant in this industry.</td>
</tr>
<tr>
<td><strong>Competitive advantage</strong></td>
<td>Innovation recognised as crucial because it creates productivity. Home nation competition and demand conditions crucial for creating competitive environment.</td>
<td>As above. Also producer services recognised for some interpretations.</td>
<td>Crucial. Also recognises innovation is created from technological R &amp; D, market intelligence, and environment external to the firm.</td>
<td>Recognised but in a partial/ secondary role.</td>
<td>Imperfect/ perfect.</td>
<td>Role of state is not fully articulated. Too much emphasis on importance of home nation’s competitive conditions. Does not explain FDI, although double diamond seeks to remedy this. Does not explain processes at the firm-level.</td>
<td>Relevant. Will be used as a core explanation. Possible modification, subject to empirical tests.</td>
</tr>
</tbody>
</table>

1. These assessments are made using information from Chapter 2. Various explanations are appraised in Section 11.2 after analysing the empirical evidence.

Source: various references reviewed in Chapter 2.
Limitations, however, remain with the concept of competitive advantage. Dunning’s (1977; 1993b) eclectic paradigm is still useful for explaining the motives of intra-firm trade, offering a more comprehensive treatment of this aspect than Porter (1985; 1990). Another shortcoming of Porter’s concept is the relegation of the state to a secondary role. An argument, prevailing in this chapter and the next, is that the state should be an endogenous determinant in an explanatory framework of trade. To complement Table 2.4, the contentious and unknown issues identified from the review in this chapter are listed in Table 2.5. This provides a direction for the discussion in Chapter 3, as well as introducing some of the sub-questions that bolster the main research question.

**Table 2.5 Contentious and unknown issues from macro-economic trade explanations**

<table>
<thead>
<tr>
<th>Relevant theme from review</th>
<th>What needs to be known in the context of the Australian water technology and management industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor proportions</td>
<td>Does factor disadvantage contribute to an explanation of trade for this industry?</td>
</tr>
<tr>
<td>Technology gap theory/ innovation creation</td>
<td>How does the national innovation system of Australia influence this industry? (e.g. influences of R &amp; D expenditure, research institutions and general institutional capacity)</td>
</tr>
<tr>
<td>Geographic clusters</td>
<td>Are clusters evident for this industry? How strong are the linkages between related and supporting industry for this industry?</td>
</tr>
<tr>
<td>Multinational activity/ FDI theory</td>
<td>What is the relationship between inward FDI and domestic industry exports? How might Porter’s model be modified to include ideas on MNC activity, influences of the state, and trade? (This question is addressed in Figure 2.2.)</td>
</tr>
<tr>
<td>Competitive advantage</td>
<td>How does Porter’s ‘diamond’ model relate to this industry?</td>
</tr>
<tr>
<td>Role of the state</td>
<td>Is targeting feasible for this industry? How do different tiers of government create competitive advantage and influence trade?</td>
</tr>
<tr>
<td>Overall</td>
<td>How do macro-level determinants of competitive advantage relate to the firm and create exports?</td>
</tr>
</tbody>
</table>

*Source:* summarised from review in Chapter 2.

Figure 2.2 models how trade is generated between two nations, based upon a modified concept of competitive advantage. The diamond model, with the addition of the state, represents determinants that generate competitive advantage in a nation. The concept of innovation has been made explicit in the diagram. Competitive producers, suppliers and
buyers in geographic proximity can lead to strong linkages within the diamond. Such conditions are conducive to positive externalities and knowledge spill-over effects. The state also has a role in amplifying linkages.

The diamond representing international determinants builds on Rugman and Verbeke’s (1993) argument that the national diamond is interdependent with global determinants. These global determinants are competitive conditions in other nations, including the importing nation. Note that the state is also included as an international determinant. This encompasses the influences of global governance (e.g. WTO and various regional trading blocs), as well as governments in other nations that create opportunities for trade (e.g. demand conditions) and constraints (e.g. trade barriers). Inflows of FDI into the exporting nation also emanate from the international diamond. This addition addresses one of the issues in Table 2.5, that of integrating Dunning’s ideas with Porter’s concept. The complex relationships within and between domestic and international determinants are shaped by the nations that are involved and the particular industries. Although the addition of extra features to Porter’s original concept may seem detrimental to the ideals of the model to be simplistic, the modifications shown in Figure 2.2 are argued to better reflect reality, as determinants within a nation will inevitably be influenced by international determinants when trade occurs.

Yet because Figure 2.2 is a generalised representation at the macro-economic level, its explanatory power of exactly how trade occurs is limited. Ultimately, it is the firms within national industries that actually export goods, services or financial capital. The argument underpinning the development of a theoretical framework in Part One is that rethinking trade requires combining macro and micro-level perspectives. This is analogous to understanding processes or phenomena of the physical and natural sciences by combining a holistic understanding of the system under investigation with a detailed understanding of the processes that occur at the molecular or cellular level. In a similar fashion, Dicken and Malmberg (2001) argue that understanding the workings of industrial systems requires consideration of structures at the macro scale, as well as understanding firms as networks
of relationships within these structures. Chapter 3 addresses the challenge by developing an explanation of trade at the level of the firm.

Figure 2.2 Diagrammatic representation of trade at the macro-economic level

Source: adapted from concepts by Porter (1990); Dunning (1993b); Rugman and Verbeke (1993).
Chapter 3
Explaining trade at the level of the firm

This chapter develops an explanation of how trade occurs at the level of the firm. The framework developed in Chapter 2, based on a modified conception of competitive advantage, is useful for explaining international or regional trade. Yet as a comprehensive explanation, a macro-level approach is limited. A micro-level perspective is also required because it is firms that actually trade. Explaining trade requires an understanding of how firms acquire innovations, gain competitive advantage, connect with markets and interact with the state. This chapter draws on several strands from the literature to construct a comprehensive explanation that is applied to the empirical analysis of the Australian water industry. An eclectic approach to the theorisation of trade is pursued because no one strand can adequately explain trade, especially in industries comprising diversified manufacturers and service providers. Bagchi-Sen and Sen (1997) also support an integrative approach to explain the process of internationalisation, particularly given the complexity of the service sector.

Chapter 3 is organised as follows. Section 3.1 defines what is meant by ‘the firm’ and what its function is, and then explains why the micro-economic level is important in a study of trade. The next four sections correspond to the separate strands that have been identified as important for explaining trade at the level of the firm: competitive advantage and corporate strategies, innovation creation, the function of networks, and the role of the state and institutional support. Each section discusses what is known from the literature relevant to the particular strand. The critique highlights the limitations and contentious issues, and what needs to be known. To conclude, Section 3.6 connects these strands to create an explanation for trade at the micro-level. The different ideas reviewed in this chapter generate a number of questions that are addressed in the empirical work.

The choice of strands is guided by two influences. First, the previous chapter indicates that competitive advantage is an important avenue of investigation. This provides a starting point. Ideas about innovation creation and the role of the state also provide general guidelines of what to discuss. However, these explanations need to be integrated
and directed at the level of the firm. The second influence on the choices is that as the chapter progresses, some of the limitations identified in previous sections are addressed by exploring a new strand. This approach builds a framework and directs the types of research questions asked.

3.1 Defining the firm and its importance in a study of trade

In rethinking explanations of trade, a fundamental assertion is that the firm should be the centre of analysis. To clarify and justify assumptions underpinning this assertion, Section 3.1 reviews current definitions of what is meant by ‘the firm’. The motives that explain why firms enter international markets are then outlined. Finally, some reasons are considered that justify why a micro-level analysis is important for understanding trade.

3.1.1 What is ‘the firm’?

Early studies of how firms operate emphasise how firms are contractual entities, shaped by the costs of using the price mechanism (Coase 1937; Williamson 1975). The firm seeks to minimise transaction costs by either internalisation within the firm or externalisation to the market. Penrose (1959) introduces the resource-based view of the firm that highlights the firm’s endogenous factors, rather than exogenous factors. A firm’s competitive advantage derives from combining resources into firm-specific competencies (Taylor and Asheim 2001).

These foundational studies, however, are limited by a simplistic concept of the firm as a self-contained entity comprising partnerships of owners of proprietary assets. Recent work in economic geography has redefined the firm as having permeable and blurred boundaries. The boundaries between functions performed within a firm (‘in-house’) and those which are externalised to other firms (‘out-sourced’) are in a continuous state of flux, especially among large firms (Murdoch 1995; Markusen 1998; Dicken and Malmberg 2001; Maskell 2001). The firm blends into its surrounding environment, with the boundary ending where the firm exercises neither power nor influence. The boundaries between a firm and its external environment are arbitrary and dependent on
the perspectives, intentions and interpretations of the decision-makers (Hakansson and Johanson 1992). These ideas are in contrast to earlier concepts (e.g. Dicken and Lloyd 1990) that define the boundary as the point where internal transactions of the firm are replaced by external transactions of the market.

Re-conceptualising the boundaries of a firm as a transitional zone has implications for a study involving the firm as the unit of analysis. Dicken and Malmberg (2001) acknowledge that the firm is a starting point for the economic activity of a system, adding that a comprehensive analysis needs to explore the interconnections between firms, industrial systems, territories, and the overall macro dimension of governance systems (e.g. institutions, rules and conventions). Furthermore, the firm is a “dense network at the centre of a web of relationships” (Badaracco [1991: 314] cited Dicken and Malmberg 2001: 351). These networks themselves form power structures. Such insights suggest that explaining trade needs to consider networks and interconnections between micro and macro-level influences. Approaches that rely on an atomistic and simplistic reductionist view of the firm are not adequate (e.g. Eckert and Leftwich 1988).

The concept of ‘the industry’ is derived from that of the firm (Dicken and Malmberg 2001). The interconnections between firms involved in similar and related activities create industries. An industry is usually defined as having certain similarities in production technology, product characteristics and service content, or combinations of these. The relationships between firms in an industry are horizontal: they produce similar outputs and are mainly related through competition. There can also be vertical interrelationships by firms that are involved in related up-stream and down-stream activities.

### 3.1.2 Assumptions about the motives and behaviour of firms

Clearly, “all firms in a capitalist system are driven by a profit motive” (Dicken and Lloyd 1990: 269). Yet within the constraints of basic survival, firms pursue a variety of specific goals. Not all firms are profit maximisers or seek market leadership (Nelson and Winter 1982; Dicken and Lloyd 1990; Wakelin 1997). This assertion is in contrast to the
traditional neo-classical view of the firm (e.g. Eckert and Leftwich 1988; Varian 1992). As Dicken and Lloyd (1990: 269) suggest, “some firms are satisficers with a fairly low level of aspiration above sheer survival”. Uncertainty - for example, with market trends or recent innovations - is another reason why profit maximisation is not always pursued. Moreover, the actors that comprise the firm are not governed by a singular logic of profit maximisation but rather are subject to multiple discourses dominated by power relations and changing identities (Yeung 2001). The firm is not necessarily a rational, autonomous economic subject, as different interest groups (e.g. shareholders or management) within the organisation attempt to impose their particular viewpoints and aspirations (Dicken and Lloyd 1990; Thrift and Olds 1996; Schoenberger 1997; Dicken and Malmberg 2001).

The profit motive also underpins trade. Yet there are other motives for trade that are not always strictly economically rational. Meyer (1996) categorises motives for internationalisation as proactive (e.g. economies of scale and scope, and managerial urge) and reactive (e.g. risk spreading). Managerial urge, for instance, is motivated by ambitions for career advancement and the personal satisfaction obtained by managers by proving oneself to peers. Such motives at the micro-level can explain why individuals within the firm seek to internationalise the firm’s activities, even though risk or uncertainty might increase. Table 3.1 outlines some reasons why firms seek international markets and hence trade.

Table 3.1 Motives for internationalisation by firms

<table>
<thead>
<tr>
<th>Supply side drivers</th>
<th>Demand side drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main reason:</strong> Profit seeking to meet shareholder’s expectations/firm survival.</td>
<td><strong>Main reason:</strong> Profit seeking</td>
</tr>
<tr>
<td>Parent company initiatives/strategies for long-term growth and sustainability.</td>
<td>Saturated domestic market so foreign markets are pursued.</td>
</tr>
<tr>
<td>Additional revenue for further growth. Expansion to recoup an investment, such as for developing new innovative goods/services.</td>
<td>Emergence of a new or changing foreign market (e.g. because of shifts in consumer taste; demand for new products/processes by industry; demand created by new technologies; demand created by government procurement; demand created by legislation such as stricter environmental and public health regulations).</td>
</tr>
<tr>
<td>To spread risk and as a barrier against uncertainty.</td>
<td></td>
</tr>
<tr>
<td>Intangible reasons (e.g. managerial urge, personal satisfaction for decision-makers by achieving a goal).</td>
<td></td>
</tr>
</tbody>
</table>


3.1.3 Why the level of the firm is important
Most of the early studies of trade theory, as noted by McConnell (1986), treat international trade as interactions between countries rather than as transactions between firms. An exception is Posner’s (1961) work that argues technology gaps arise from economies of scale because of learning at the level of the firm. More recent work does consider the importance of firms in an analysis of trade and more generally, in the organisation of production (Nelson and Winter 1982; Dicken and Thrift 1992; Grant 1994; Wakelin 1997; Dicken 1998; Yeung 2000). Because of the focus on manufacturing multinational firms in earlier work (e.g. Dunning 1977), contemporary studies of internationalisation and trade have advocated shifting the emphasis to small and medium size firms in the service sector (Schoenberger 1997; O’Farrell and Wood 1998; Rialp and Rialp 2001).

Analysis of trade at the micro-level is useful because it is firms - not nations - that compete in international markets (Porter 1990: 33; Krugman 1994a; Thompson 1998). National trade is the aggregate of trade by individual firms. In addition, the firm is where interactions occur between macro and micro-level processes that lead to trade. As Taylor (1984: 8) eloquently comments: “the business organisation is the basic unit of the economy, the point of production, the crucible within which both macro- and micro-forces meet and are played out”. Wakelin (1997: 116) observes that it is at the level of the firm that the commitment of resources is made and the benefits of innovation most accrue in terms of increased productivity.

Building on the insights discussed in Section 3.1, the thrust of this chapter and subsequent empirical analysis is that explaining trade recognises that firms are composed of individual decision-makers operating within the influences of a wide structural framework. When firms export, it is due to an interaction of macro- and micro-level determinants. Competitive advantage is created both within firms, and at the macro-level such as within agglomerations and networks. An analysis of determinants of trade should emphasise micro-level determinants and the interconnections with the macro-level, rather than focusing only on macro-level processes.
3.2 Competitive advantage and the firm

Competitive advantage is a foundational concept in a theory of trade. It can be applied at different scales, from the national and regional, through to the individual production unit. Based on a similar logic applied at the macro-level (Section 2.5), the assumption is that like nations, firms possessing competitive advantage are more productive and so create goods and services that are cheaper and/or of higher quality than less competitive rivals (Porter 1985; 1990; Webber and Rigby 1996; Wakelin 1997; Maskell 2001). Being more productive - and hence more competitive - extends the spatial extent of the market and thus the propensity to trade. Productivity or competitiveness is achieved by innovations (Section 3.3). The interrelationship between competitive advantage, productivity, innovation and trade is a central theme that underpins the theory.

This section discusses how competitive advantage is created at the level of the firm. Section 3.2.1 reviews what is known about this. Porter’s (1985; 1990) ideas relevant to the firm are useful but have limitations. Section 3.2.2 provides a critique, with alternative concepts of competitive advantage suggested. Corporate strategies are described in Section 3.2.3. Firms use these strategies to gain competitiveness over rivals and extend influence over space. Section 3.2.4 concludes that several issues need to be addressed to further understand how competitive advantage leads to trade.

3.2.1 The creation of competitive advantage for the firm: concepts of competitive strategies

A firm’s performance is tied to its ability to construct competitive advantage by pursuing particular competitive strategies. Porter’s (1985) central theme is an analysis of how a firm can create and sustain competitive advantage in its industry. Put simply: “Competitive advantage itself grows fundamentally out of value a firm is able to create for its buyers that exceeds the firm’s cost of creating it” (Porter 1985:3). A firm’s competitive advantage comprises internal determinants called the value chain. External determinants (or competitive forces) influence the value chain.
3.2.1.1 Internal determinants

Firms create value for their customers by establishing a value chain within the organisation. The value chain consists of discreet activities that are linked (e.g. R & D, design, production, marketing). At each stage, value is added to the output of the previous stage. The value chain comprises primary activities (e.g. production, marketing, after-sales service) and support activities (e.g. raw material procurement, R & D, human resource management). These activities are interdependent and connected by linkages. Linkages occur when the way in which one activity is performed affects the cost or effectiveness of other activities. This contributes to competitive advantage by optimisation and co-ordination of specific activities such as procuring raw materials and after-sales service. There are internal linkages for activities within the firm. There are also external linkages between the firm’s value chain and the value chains of suppliers and buyers. In a vertically integrated firm, the majority of primary activities are internally linked. Alternatively, a horizontally integrated firm usually specialises in one activity in the value chain, or establishes another production facility in a related industry that is at the same stage of the value chain (Porter 1985; Dicken and Lloyd 1990; Jepma and Rhoen 1996).

Through the value chain, there are two ways firms can deliver value: a lower cost, achieved by knowing the costs and assets of value chains and producing a cheaper product than competitors; and differentiation, by which the firm creates superior value in the form of quality products or services by knowing value chains of buyers and identifying existing sources of uniqueness. The low cost firm produces a given output using fewer inputs than its competitors require; the differentiated firm achieves higher revenues per unit than competitors. Competitive advantage, arising from either type of strategy, is related to the productivity of a firm. Productivity is a result of innovation, as explained in Section 3.3. The low-cost firm produces a given output using less input than competitors require. The differentiated firm achieves higher revenues per unit than competitors (Porter 1990: 37-38).
Against the broad strategies of cost and differentiation, Porter (1985; 1990) adds another dimension - competitive scope (i.e. the type of market aimed for). Scope can be divided into two sub-categories: a broad target (diverse clients) and narrow target (specialisation). Combining competitive strategies and scope results in four ‘generic categories’ (Table 3.2). There is also a fifth outcome when a firm pursues multiple strategies aiming for both low cost and product differentiation. Porter (1985) argues that this approach (referred to as ‘stuck in the middle’) is rarely satisfactory because the firm compromise the advantages inherent in pursuing a single strategy. These ideas are critiqued in Section 3.2.2.

**Table 3.2 Summary of Porter’s concept of competitive strategies**

<table>
<thead>
<tr>
<th>Competitive scope of the firm</th>
<th>Value creation by lower cost</th>
<th>Value creation by differentiation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Broad target</strong>: firm seeks competitive advantage within a broad range of industry segments.</td>
<td><strong>1. Cost leadership</strong>: firm has a broad target while emphasising efficiency and low cost production in value chain creation.</td>
<td><strong>2. Differentiation</strong>: emphasis on quality oriented aspects in the value chain with a broad target.</td>
</tr>
<tr>
<td><strong>Narrow target</strong>: firm seeks to achieve competitive advantage in its target segments.</td>
<td><strong>3. Cost focus</strong>: strategy of low cost production and a narrow scope of offerings for targeted markets.</td>
<td><strong>4. Differentiation focus</strong>: emphasis on quality for a specialised offering for specific markets.</td>
</tr>
</tbody>
</table>

*Source: adapted from Porter (1985: 1-30).*

Porter’s (1985; 1990) case studies suggest that provided a firm is more productive than its rivals, then either cost or differentiation strategies result in exports. Other researchers, using examples from producer service industries, argue that differentiation strategies are strongly linked with trade. This is because specialisation gives firms competitive advantage over a wider geographic area when compared with routine service providers pursuing a cost strategy (Monnoyer and Philippe 1991; Bryson et al. 1993; O'Farrell et al. 1992; 1993; Cornish 1995; Beyers and Lindahl 1996; Lindahl and Beyers 1999; Goe et al. 2000). Furthermore, firms with a differentiation focus, such as producer services and manufacturers of specialised industrial goods, often search beyond their local market to generate sufficient business (Monnoyer and Philippe 1991; Hart 1994). The empirical
work investigates what strategies are common for firms in the water industry (Sections 7.2.2; 7.2.5).

3.2.1.2 External determinants

Figure 3.1 illustrates the external determinants of the firm’s competitive position. These five competitive forces determine industry profitability because they influence the prices, costs and required investment of firms in an industry (Porter 1985).

**Figure 3.1 The five external determinants of industry profitability**

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<table>
<thead>
<tr>
<th>Determinant</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threat of new entrants</td>
<td>Shapes investment required to deter entrants; limits prices.</td>
</tr>
<tr>
<td>Bargaining power of suppliers</td>
<td>Determines cost of raw materials; intermediaries.</td>
</tr>
<tr>
<td>Industry Competitors</td>
<td>Rivalry among existing firms.</td>
</tr>
<tr>
<td>Bargaining power of buyers</td>
<td>Influences price firms can charge; demand can spur investment.</td>
</tr>
<tr>
<td>Threat of substitute products</td>
<td>Influences quality and price.</td>
</tr>
</tbody>
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Figure 3.2 conceptualises how these external determinants relate to the firm, as well as to the macro-level determinants of national competitiveness (i.e. the ‘diamond’ model). Macro-level determinants influence external determinants of firm-profitability, which in turn influence the firm. This addresses a limitation noted in Section 2.5.2, as Porter’s (1990) work does not make clear the relationships between macro and micro-level concepts. Competitive advantage results from an effective combination of determinants at different spatial levels. For example, the strength of related and supporting industries for a sector of the national economy influences the bargaining power of a firm’s suppliers.
This in turn influences the internal value chain because the firm can purchase inputs from internationally competitive domestic suppliers. Another case is where high quality inputs, due to favourable factor conditions, enable the firm to modify its value chain and pursue a differentiation focus. In both micro and macro-level concepts, an intense competitive environment results in firms and industries developing competitive advantage.

**Figure 3.2 Relationships between Porter’s macro and micro-level determinants**


### 3.2.2 A critique of Porter’s approach: contentions and alternative interpretations

Porter’s micro-level model, like the macro-level (or diamond) model, is an insightful conceptualisation of the creation of competitive advantage that can be a useful component of a theoretical framework. However, the micro-level interpretation draws
similar criticisms to its macro-level counterpart (see Section 2.5.2). The evidence Porter uses is descriptive and not statistical (Waverman 1995). While Porter’s (1990) study of national competitive advantage recognises government, albeit it in a secondary role (see Section 2.6.4), earlier work at the micro-level does not consider the role of the state (Porter 1985). Also, no explanation is offered of how firms might signal their competitive advantage and connect with other players in the market. The integration of innovation and competitive advantage is assumed but never developed, an issue redressed in Section 3.3.

Several empirical studies have applied Porter’s micro-level framework to producer (or business) service industries (O’Farrell et al. 1992; 1993; Lindahl and Beyers 1999). The results challenge the robustness of some of the main ideas of firm-level competitive advantage. Contrary to Porter (1985), Lindahl and Beyers’s (1999) evidence finds that ‘stuck in the middle’ firms do not necessarily have sub-par performance when measured as growth in sales per employee. This suggests that in the case of producer services, it is an oversimplification to explain strategy simply as a tension between low cost and high quality, given that few producer service firms pursue a competitive strategy based exclusively on low cost. For such firms, the non-routine, unstandardised work is part of the reason why multiple factors are at play. Lindahl and Beyers (1999) identify several factors as contributing to competitive advantage for producer services firms: creativity, geographic proximity and speed of delivery, R & D capability, attention paid to clients’ needs, established reputation, specialised expertise, and quality of the service. However, Lindahl and Beyers (1999) fail to provide a convincing reason why these factors should be considered outside Porter’s differentiation strategy.

The age and size of firms can also influence competitive strategy (O’Farrell et al. 1993; Tordoir 1994; Lindahl and Beyers 1999). Porter’s work neglects this aspect. Some researchers use a life cycle concept to argue that the type of strategy a firm pursues is not static. O’Farrell et al. (1993) claim that specialisation and product differentiation are more likely in older producer services firms. This is because for firms in producer services industries, ‘word-of-mouth’ and reputation are of prime importance and take
time to acquire. New firms must compete on cost factors more than established reputable firms, despite relatively low capital barriers to entry. Similarly, Lindahl and Beyers (1999) examine competitive strategy in relation to the age of producer service firms and find that young establishments tend to pursue a cost focused strategy to a greater extent than older establishments, which are more likely to be following a differentiated strategy. Older firms have a greater propensity to trade because offering a specialised service extends their market.

In relation to the size of firms, small specialist firms can compete effectively by pursuing a focused differentiation strategy (O’Farrell et al. 1992; 1993; Keeble and Bryson 1996). The success of small producer services firms depends on informal person-to-person networks, word-of-mouth and repeat business (Bryson et al. 1993). What these studies lack, however, is a longitudinal approach to confirm whether individual firms change their competitive strategy - both over time and as firm-size changes. Time series data can be difficult to obtain for small individual firms. Also, there is a failure to acknowledge that while some firms may be recently established, they might comprise key individuals with long experience in a particular industry. Referring to firms as ‘young’ and ‘old’ may be misplaced. In flexible labour markets, it is likely that experienced individuals, especially specialist contractors, frequently transfer between firms in an industry (Angel 1994; Saxenian 1994).

3.2.3 Corporate strategies

As discussed in Section 2.4, intra-firm linkages - typified by the vertical integration strategies of multinational corporations and flows of foreign direct investment (FDI) - are one explanation of trade. Yet there are also other ways firms internationalise without using FDI or direct exports. These involve various corporate strategies in the form of inter-firm alliances and acquisitions (i.e. horizontal linkages) that contribute to the creation of competitive advantage and trade (Dicken 1998; O’Farrell and Wood 1998). Whereas competitive strategies explain how firms compete in a particular market, corporate strategies are defined as decision-making about what activities the firm decides to be involved in, including which elements of the value chain are to be performed.
Understanding the motives underlying corporate strategies helps explain trade for different sizes of firms.

There are some features of corporate strategies worth noting. The fluid boundaries that characterise firms (Section 3.1.1) are extended by corporate strategies. For example, an alliance between firms extends the influence of each partner. Corporate strategies are a means of managing external determinants by creating flexible organisational structures of inter-firm relationships, allowing the firm to remain competitive. Another feature is that power structures underlie different strategies (Dicken and Thrift 1992; Anderson 1995; Murdoch 1995). There is an asymmetrical dominance by larger firms when they acquire smaller firms. Alternatively, strategic alliances between similar size firms represent more symmetrical power relationships. A final point is that a decision by a firm to embark on a corporate strategy is not always rational or strategic. Decisions are sometimes made impulsively or modified as events unfold (McGrath-Champ 1999).

Firms pursue various corporate strategies to attempt to maintain or increase competitive advantage. Trade can result but this might not be the prime motive for a firm. As outlined below, there are advantages and disadvantages with common inter-firm strategies.

### 3.2.3.1 Alliances

Alliances are defined as the collaboration between otherwise independent firms to achieve specific ends, but falling short of outright merger with a rival (Porter 1985). The linkages between firms in an alliance tend to be horizontal because of the co-ordination of value chains at similar stages of production. Coalitions, joint ventures and research collaborations are forms of alliances. This strategy represents one of the major developments in the global economy of recent decades (Dicken and Thrift 1992; Dicken 1998; O’Farrell and Wood 1998) and is common in many industries, including the international water industry (see Section 4.2). Alliances in international competition are prominent because they allow partners to utilise economies of scale, gain access to technology or markets, challenge an industry leader, or spread risk, without giving up corporate independence or requiring expensive merger. Alliances are also a means of gaining the cost or differentiation advantages of vertical linkages without actual
integration, and for firms in competing and related industries to co-ordinate value chains (Porter 1985). Furthermore, market intelligence can be acquired from such horizontal collaborative partnerships (Cornish 1997a). Dicken and Thrift (1992) describe alliance relationships as ‘increasingly polygamous’ in that few firms only have a single alliance. The international water industry is an example where firms that are fierce rivals in one geographic area form alliances in another location to seize local market opportunities (see Section 4.2.1).

Porter (1990) notes that alliances are often transitional rather than stable arrangements. This is because of the significant cost in terms of co-ordination. Similarly, Sleuwaegen (1995) warns that alliances require partners to divide decision-making processes, sometimes resulting in disputes about objectives. Alliances can help firms penetrate foreign markets, but also run the risk of deterring the individual firm’s efforts at upgrading because of complacent management that relies on the other firm’s efforts (Porter 1990). In this view, the best alliances are temporary and highly selective, involving particular activities in the value chain. Alliances can only reinforce an existing competitive advantage as ultimately, the firm itself must develop its own internal capacity to create it (Porter 1990; Anderson 1995).

3.2.3.2 Subcontracting
Subcontracting networks are a common form of strategy (Holmes 1986; Dicken and Thrift 1992), and an integral part of the process that drives flexible specialisation in particular industrial districts (Piore and Sabel 1984; Scott and Storper 1987). With subcontracting arrangements, the linkages are vertical in that a firm engages a subordinate firm to carry out one or more activities in the value chain. The strategy can range from the lead firm contracting out various business services (e.g. accounting and advertising), to an extremely disaggregated form where almost all functions of the production chain, other than those of central control and co-ordination, are contracted to independent firms (e.g. as in the clothing and footwear industries) (Dicken and Thrift 1992). Like horizontal alliances, subcontracting sometimes suffer from co-ordination
problems by the lead firm, resulting in such configurations being less profitable than expected (Porter 1985).

3.2.3.3 Acquisitions and mergers

Acquisitions of foreign firms serve two general purposes. One is to gain access to a foreign market or obtain selective skills. The second purpose for a foreign acquisition is to gain access to a highly favourable national ‘diamond’ (Porter 1990). The foreign acquisition can become the new global home base for the firm, or the newly acquired firm can concentrate on particular areas that contribute to competitive advantage. However, Porter (1990) warns that extensive integration of an acquired firm into a diversified global strategy can result in a loss of focus that compromises the firm’s initial competitive advantage.

Mergers are similar but occur when two firms converge to create a new entity (e.g. BHP-Billiton). They are an especially prominent strategy. Sleuwaegen (1995) argues that this strategy creates synergies of scale and scope, while reducing the risk, time and uncertainty associated with creating a new firm. The disadvantages are the creation of a more inflexible organisational structure compared with alliances and subcontracting, and the risk of encouraging anti-competitive behaviour through the creation of monopolies and oligopolies.

Using Dunning’s eclectic theory, Yaprak and Shaheen (1994) explain that a firm, possessing an ownership-specific asset in technology or information, will choose merger or acquisition to safeguard proprietary knowledge, rather than engage in collaborations. In addition, an acquisition usually yields a quicker return compared with developing a new venture.

3.2.3.4 Diversification

Diversification, which can involve acquisitions, is a strategy intended to spread risks or to use the same skills in different activities (Porter 1990; Yaprak and Shaheen 1994). One form is diversification into a closely related area and relies on facilitating the transfer of skills and resources into related areas. Some argue (e.g. Porter 1990; O’Farrell and Wood
1998) that this strategy can be more successful for creating competitive advantage than unrelated or widespread diversification, such as acquiring an independent company with its own history and way of operating. In Porter’s (1990) assessment, unrelated diversification detracts from focus, commitment and sustained investment in core industries - in short, making no contribution to innovation. Yaprak and Shaheen (1994) also believe that widespread diversification usually means that co-ordination becomes increasingly difficult, with marginal benefits likely to decrease. There are some cases to support this assertion. For example, the core industry of the giant French conglomerate, Vivendi, is as a global water service provider. However, in recent years Vivendi has diversified into media and communication concerns, and by 2001 it reported a loss that business analysts believe is due to its lack of focus (The Economist 9 March 2002; 4 May 2002). Yet related diversification does not necessarily guarantee success: witness the dismal share prices during 2002 of the Australian financial services firm AMP after pursuing related diversification into the UK financial services market (AMP 2003).

3.2.4 Conclusion

Competitive advantage is a central concept of a trade theory for the firm. Porter’s (1985; 1990) ideas are a useful foundation. There remain, however, several contentious and unknown issues with this concept. It is contentious whether the competitive strategies used by firms to gain competitive advantage are simply a dichotomy of price or quality as suggested by Porter, or multiple strategies (at least for producer services) as argued by Lindahl and Beyers (1999). Another issue is how the size and age of firms influence the strategies pursued, and how these change over time. In addition, more needs to be known about how and why particular corporate strategies contribute to competitive advantage in particular industries. There appears to be scant empirical evidence about relative successes when similar firms choose different corporate strategies.

The empirical work - within the limits of a single industry study - addresses some of these issues. It investigates how competitive advantage is created for water industry firms and tests whether it can be explained by a simple cost or differentiation strategy or whether the concept needs to be extended. It also tests if size and age influence the
competitiveness of firms. The empirical work considers what corporate strategies water
industry firms in Australia use to access export markets. Using the information discussed
in Section 3.2.3, the analysis addresses why particular corporate strategies are chosen,
and considers the influence of underlying power structures.

It is acknowledged that innovation leads to competitive advantage (Section 2.3.1; Section
3.2). Yet the processes involved in the creation and diffusion of innovation at the level of
the firm have not been articulated. Competitive advantage is crucially influenced by the
ability of firms to mobilise and integrate fragmented and diversified forms of knowledge
(e.g. tacit and codified, formal and informal), rather than specialise in one form (Nelson
and Winter 1982; Wakelin 1997; Amin and Cohendet 1999). What also needs to be
known is how innovative firms extend their competitive advantage over space. These are
the tasks of Sections 3.3 and 3.4 respectively.

3.3 Innovation and the firm

There is widespread agreement that innovations1 embedded in processes, products and
services are fundamental to the success of firms in a competitive market place (e.g. Porter
1985; 1990; Department of Industry, Science and Resources 1998; 1999; Industry
Research and Development Board 1998; Wakelin 1997; 1998). The interrelation of
innovation with productivity, competitive advantage and trade is explained at the macro-
level in Section 2.3.1. A similar explanation applies at the level of the firm. Innovation
by a firm leads to increased productivity (i.e. larger quantities or higher quality goods and
services are produced per unit of factor input [or cost] that leads to an increase in the
firm’s revenue). Innovation can involve virtually any activity in the value chain (Porter
1990). Innovations allow a firm to pursue a cost strategy because of more output per unit
of labour or capital (referred to as process change), or a differentiation strategy because
new or higher quality goods or services can be produced, leading to an increase in the
price of the output per unit of factor input (referred to as product innovation) (Porter
1990:37-8; Webber and Rigby 1996: 182-3). Firms that achieve higher (or greater)
productivity relative to the average of their industry gain a competitive advantage over less productive rivals, and have a better chance of accessing spatially larger markets.

Section 3.3.1 begins by outlining the basic characteristics of innovation. The sources of innovation are described in Section 3.3.2. External sources of innovation are arguably as important to the firm as internal sources such as R & D activities. Section 3.3.3 considers innovation diffusion. The contention with this strand, as discussed in Section 3.3.4, is finding a suitable proxy to measure innovation and empirically test relationships.

3.3.1 Characteristics of innovation and the relationship with technology

In much of the literature, innovation and technological (or technical) change are treated as interchangeable terms (e.g. Porter 1990; Webber and Rigby 1996; Wakelin 1997). However, while the concept of innovation often implicitly implies a technological component, other factors are involved. The use of market intelligence and networks can also be inputs into innovation (Cornish 1997a; 1997b; Berry and Taggart 1998; Kirby 1998). This thesis considers innovation as a broad concept that includes technological change, as well as information from suppliers and buyers that improves production and delivery process.

Technological change itself does not have to be dramatic (i.e. radical or breakthrough) for innovation to occur. Much innovation in practice is incremental and consists of small, almost mundane improvements to a product or process. Long-term product success often requires the continuous incorporation of incremental improvements (Kleinknecht 1981; Angel 1994; Cornish 1997a). Particularly among small and medium size enterprises, innovation is likely to be incremental and encompass broad aspects such as service delivery (Smallbone and North 1999). Innovations related to the water industry are often based upon incremental improvement. One reason is that most major developments occurred due to radical innovations earlier in the 20th century (Smith 1998). This feature of the industry has implications for the validity of common innovation proxies, as discussed in Section 8.1.2.

1 The singular ‘innovation’ refers to the concept. The plural ‘innovations’ refer to the innovative products,
Another characteristic of innovation is that the industry the firm is in influences how it approaches innovation creation and acquisition. Different technological paradigms require that some firms be more reliant on basic scientific research, whereas others are based more on cumulative experience (Pavitt 1984; Dosi et al. 1988). Learning and knowledge are not just restricted to ‘high-tech’ industries, but also essential to ‘low-tech’ industries (Porter 1985; Malmberg 1996; 1997). Products have different types of innovation embedded in them that may be specific to the firm or based on general diffusion in the industry (Wakelin 1997).

The process of innovation is also surrounded by uncertainty of what is technologically possible and the uncertainty over the economic significance of innovations (Wakelin 1997). This helps explain why not all firms are prepared to be innovative, even when the competitive benefits are acknowledged.

3.3.2 Innovation creation and acquisition

The creation and acquisition of innovation by firms involves heterogeneous internal and external sources (Oerlemans et al. 1998). Internal sources are embodied in transformation functions (i.e. R & D, and production) and in transaction functions of the firm (i.e. supply purchases, marketing and sales). External sources include public knowledge infrastructure (e.g. universities), private knowledge infrastructure (e.g. trade organisations and consultants), the business environment (e.g. suppliers, buyers, competitors), and intermediaries (e.g. chambers of commerce, government business centres). This provides a useful categorisation when examining sources of innovation for water industry firms (e.g. Table 8.8).

The following sections discuss some of the main internal and external sources identified from the literature. These are not competing explanations but rather, different insights into a complex process. A contentious issue is how much can be generalised from the various explanations, given that different firms and industries follow unique trajectories.
The empirical work draws on this discussion to explain why some innovation sources are more common than others among water industry firms.

### 3.3.2.1 Schumpeter’s ideas and the issue of firm-size and innovation

Schumpeter’s (1934; 1939) ideas are pioneering attempts to recast innovations as endogenous to economic growth, offering a perspective of how innovation is created. Schumpeter suggests that innovations cluster in distinct historical periods. A major innovation triggers other innovations in related products and industrial processes. Previous technologies are rendered obsolete - hence the term ‘creative destruction’.

Although Schumpeter’s ideas are mainly macro-level perspectives, there are some insights relevant to the micro-level. Creative destruction allows the entry of new firms (Malerba and Orsenigo 1996). Some firms have the financial resources to be more technologically progressive and can capture some of the rents from innovation. Unique innovations give the innovator monopoly power because of entry barriers in some sectors. As long as innovations are not diffused abroad, they can have a positive impact on a firm’s export performance. If the temporary monopoly advantage is supplemented by economies of scale, then a single firm may have a long-term superiority in export markets (Wakelin 1997). The firm’s innovations follow a product life cycle, attaining dominance until market maturity is reached.

Schumpeter’s work generally assumes innovation creation is by monopolistic large firms because such firms can maintain entry barriers. Yet this tidy explanation becomes unravelled with empirical testing of the relationship between firm-size and innovation. Harris (1985) claims that medium size firms are prone to spend relatively more on R & D and are more productive than other firms. Pavitt et al. (1987) find a U-shaped relationship between innovation and firm-size, with both small specialised firms and very large firms active in innovation. Yet other studies suggest smaller enterprises do not show a proportionally high share of innovations (e.g. Tether et al. 1997; Tether 1998). Wakelin’s (1997; 1998) research suggests that there is an increasing relationship between firm-size

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2 There are some inconsistencies in Schumpeter’s explanations relating to firm-size and innovation. Harris (1985) notes that Schumpeter's early work (1934) suggests that small new firms are the primary source of
and innovation because of entry barriers and economies of scale. Another flaw with Schumpeterian explanations is that only innovations interpreted as ‘radical breakthroughs’ are considered. Many industries progress without the need for ‘gales of creative destruction’ sweeping the industry; the water industry is an example of largely incremental innovations (Bainbridge 1997; Smith 1998). The issue of firm-size and innovation is discussed further when examining the empirical evidence from the Australian water industry. However, because the evidence is confined to a relatively small sector in a small economy, the results do not shed much light on contentions raised by Pavit et al. and Wakelin.

**3.3.2.2 Demand-pull and technology-push explanations**

Factors generated from the demand-side, such as shifts in buyer’s tastes and preferences, can motivate firms to innovate. Government regulations, for instance as restrictions on monopolistic entry and stricter environmental standards, also stimulate demand (as discussed further in Section 3.5.2.2). Often, innovation comes from not avoiding, but embracing pressure and challenge (Porter 1990). There can also be internal demand within firms for technological change. This is referred to as ‘induced innovation’ and is due to firms searching for techniques that save on the relatively expensive inputs of production. The relative costs of labour and capital inputs influence production costs and the direction of technical change (Webber and Rigby 1996: 194-196).

Firms can also be innovative by ‘technology-push’ that can make new products feasible and result in new industries (Porter 1990). Technical change often arises from a firm’s internal efforts at current R & D, as well as cumulative learning from past experience. This is also referred to as ‘learning by doing’ (Nelson 1981; Dosi et al. 1988). Commonly, external sources are also harnessed.

**3.3.2.3 External sources of innovation**

The macro-level external environment to the firm can be as crucial to innovation creation as internal factors (Porter 1990; Nelson 1993a; 1993b; Fagerberg 1988; 1992; 1994; Patel 1999). New innovations, because they challenge the established order. Yet in later studies, Schumpeter (1939) emphasises large monopolistic firms as innovation creators.
and Pavitt 1994; MacKinnon et al. 2002). The previous chapter discussed how concepts such as path dependency and evolutionary models, and national innovation systems create technology gaps that persist between nations (Section 2.3.2). These influences also allow some firms to acquire innovation and maintain a technology gap, compared with competing firms in another nation or region. Nelson and Winter (1982) describe how firms scan their external environment looking for alternatives to present routines and practices, and to reduce the uncertainty and cost involved in the development of innovations.

Market intelligence - the acquisition of information from markets about products, service delivery and buyer’s attitudes and needs - is another external source of innovation (Cornish 1997a; 1997b). It can indirectly lead to exports as producers use the information to improve the product or service. The concept is related to demand-induced creation of innovation. Some commentators believe that market intelligence is as critical for product innovation as is R & D (Copper and Kleinschmidt 1988; Porter 1990; Teubal et al. 1991; Cornish 1997a; 1997b; Berry and Taggart 1998; O’Farrell and Wood 1998). The stronger the linkages between demanding buyers and producers, the better the quality of market intelligence to further improve products and services. Cornish (1997a; 1997b) suggests that spatial proximity between producers and users is not a critical factor for market intelligence, with knowledge often obtainable from a distance. This questions the prevailing view that cultural barriers increase with distance, resulting in a deterioration of the quality of tacit knowledge needed for innovation (e.g. Lundvall 1988; 1992; Gertler 1993; 1995; van Bergeijk 1996).

There is contention over the relationship between the type of innovation source and the type of firm. Maillat (1991) claims that firms with radical innovations depend on external sources because the limits of their internal competencies are reached more quickly than incremental innovators, where the necessary resources are found inside the firm. However, Oerlemans et al. (1998) argue that radical innovators are more confined to internal sources because newness is required. Incremental innovators have more
flexibility to use existing technical products and systems inside and outside the firm. The empirical work investigates the validity of these differing viewpoints.

3.3.3 Innovation diffusion

Innovation diffusion (also referred to as technological transfer) is a process where knowledge from the external environment permeates within the boundaries of the firm. Whereas innovation creates differences between competing firms, diffusion can be defined as a “process of imitation whereby the differences between firms are progressively removed” (Webber and Rigby 1996: 196). Lundvall (1988) also differentiates diffusion as the external mobilisation of resources and learning by interacting (i.e. using the knowledge and experience of other economic actors), in contrast to internal learning by using or doing. Primary channels for diffusion include direct foreign investment, international strategic alliances, vertically integrated value chains, licensing, and embodied transfers through the import of technology-intensive goods (Mowery and Oxley 1994).

Diffusion rates are temporally and spatially uneven, allowing some firms to maintain technological superiority. The reasons are similar to macro-level explanations of persistent technology gaps between countries. Technology is socially constructed; the characteristics of innovation and learning are dependent on social and political factors and the institutional structures of different regions. Some firms are better adapted and in the ‘right’ location to take advantage of structures such as national innovation systems (Gertler 1993; Nelson 1993a; Wakelin 1997). The diffusion process is ‘sticky’ in that technology is partly non-codified (i.e. tacit) and firm-specific; this makes the transfer of technology costly, uneven and complex. Another reason for uneven diffusion is the influence of the state, such as legislation to protect patents. However, there is some evidence that patents are not always effective at limiting knowledge spill-overs (Mansfield 1981; Folster 1995).

Diffusion of technical knowledge, such as by licensing agreements, can help recipient firms develop innovations that lead to competitive advantage and trade. Yet other
commentators (e.g. Porter 1990) are dubious if diffusion and technology transfer do create the long-term conditions for a competitive domestic sector in the recipient country. This is because of the importance of having a vigorous home market. On the other hand, there can be advantages for firms that grant a licence because access is gained to regulated markets. The empirical work cites some examples of firms exporting products by granting a licensing agreement (Section 9.1.1). The disadvantage is that the benefits of technology gaps can be eroded because proprietary knowledge flows to competitors (McGaughey et al. 2000).

3.3.4 Problematic measurements of innovation

There is consensus that innovation, including technical change, is an important process for explaining macro and micro-level trade (e.g. Fagerberg 1995; Wakelin 1997). Yet contention remains over what is the most accurate method of measuring innovation in order to test theories (Nelson and Winter 1982; Webber and Rigby 1996; Wakelin 1997). Different quantifiable approaches only capture certain aspects of the innovation process and can lead to conflicting results in empirical studies (Wakelin 1997). Research and development (R & D) expenditure is a common proxy that is used. This is an input measure with the assumption that an increase in formalised research expenditure supposedly leads to a proportional increase in innovation (Hirsch and Bijaoui 1985; Fagerberg 1994). A measure of input, however, does not indicate the success of efforts to produce an innovative output. Other researchers argue that patents are more accurate, being an output measure of the number of innovations actually realised (Soete 1981; Dosi and Soete 1983; Pavitt 1985; Ceh 1996; Wakelin 1997). Yet Feldman (1994) disagrees with the accuracy of this proxy because some patented inventions are not always commercially viable innovations. Conversely, many successful innovations are never patented.

Another proxy measuring output involves determining the actual number of new innovations (as defined by a panel of experts) within a nation over a period of time (Greenhalgh et al. 1994; Wakelin 1997). This method avoids the size bias of R & D expenditure. An alternative approach is to combine two proxies, as in Fagerberg’s (1988)
study using patents and R & D expenditure. One study of Australian industry assigns a mathematical weight to R & D expenditure and patent counts, done by determining the market value of the firm and dividing it by the total assets (Industry Research and Development Board 1998). This approach is only suitable for publicly listed firms. Another approach is to introduce a productivity measure, as in Verspagen’s (1993) research that includes labour productivity along with the patent index.

Problems persist with using quantifiable proxies to measure innovative activity. Expenditure on R & D and patent registrations could reflect technical change within the firm but fail to capture more subtle manifestations of innovation. Innovation creation that is not ‘breakthrough’, such as learning by doing and incremental innovation, can be overlooked. Firms in some industries are more likely to experience technical change, and so have a higher propensity to patent or have more formalised R & D expenditure than firms in other industries. For instance, ‘high-tech’ manufacturing firms likely have greater technical change in product and process development than service firms. Yet service firms can still be innovative, such as improving the way services are delivered to customers.

Other problems include the practical difficulties in disentangling the direct impact of innovation from other effects on a firm’s productivity (e.g. capital improvement, upgrading the skills of the labour force, or improved marketing). Quantifying innovation proxies can underestimate the contribution of innovative smaller firms that may have no formalised research budget (Wakelin 1997). In addition, innovation proxies measure flows into the stock of a firm’s or nation’s technological capabilities, rather than the stock of knowledge itself. A firm with no recent R & D expenditure nor patent registrations could still be considered innovative because of a stock of skills and knowledge embodied in past experience (Wakelin 1997). Patent counts also do not capture the diffusion of innovation from its original sector to other sectors. For example, developments in microelectronics impact on many other sectors - including the water industry - but recipient sectors may not show a proportional increase in patents. Finally, international comparisons of innovative activity can be unreliable because countries have
different definitions of R & D and different legal and bureaucratic arrangements for the
granting of patents (Wakelin 1997; Department of Industry, Science and Resources
1998).

Combining proxies is one way of overcoming limitations in measuring innovation. Some
research suggests that R & D expenditure and patent counts are positively correlated
(Scherer 1983; Acs and Audretsch 1989). Yet other work finds no relation because one is
an output measure and the other input (Wakelin 1997; Arundel and Kabala 1998). Some
research relies on sophisticated techniques to make these proxies a more reliable
indicator of innovation. To account for stock variables, one approach is to use a
mathematical weight according to the age of the patent, with recent patents given a
greater weight (Cotsomitis et al. 1991). Similarly, Buxton et al. (1991) use different
depreciation rates to account for R & D stock variables. Another method is to determine
the market success of different innovations by firms (Greenhalgh 1994 et al.; Wakelin
1997; 1998).

The empirical research on the Australian water industry lacks the data to use these more
complex econometric methods. To investigate the relationship with innovation and
export proportion, the approach in Section 8.1 is to use both R & D expenditure and
patent counts, bearing in mind the limitations of these proxies as measures of innovation.

3.3.5 Conclusion

Section 3.3 has defined innovation and explained how the concept relates to trade.
Explanations for the creation and diffusion of innovation at the level of the firm have
been reviewed. The empirical work investigates which sources - both internal and
external to the firm - are important in the water industry (Section 8.2). The relationship
between corporate strategies and innovation creation is also investigated.

Section 3.3 has also reviewed contentions about the validity of innovation proxies. This
knowledge can help interpret the empirical findings and recognise inherent limitations.
What is not known at this stage of the theoretical development is how firms obtain
innovation from external sources. Intra- and inter-firm linkages (i.e. corporate strategies)
are part of an explanation. However, a comprehensive discussion needs to consider networks and the role of the state in shaping the external environment to the firm that leads to competitive advantage. These are the objectives of subsequent sections.

3.4 The function of networks

An explanation of how networks function is essential for a comprehensive framework. Networks help explain how competitiveness embodied in goods, services and capital is extended across space. To illustrate this, consider the following scenario that reflects examples from the empirical work. A water-engineering firm based in Melbourne has particular expertise in industrial wastewater management. The group of individuals employed by this firm collectively possess skills and experience that creates tradable expertise. Meanwhile, in Chiang Mai, Thailand, a municipal government - again a group of individuals bounded by working for a common entity - requires particular expertise for managing industrial wastewater from a new industrial development. Without the establishment of prior linkages from previous projects, it is unlikely that individuals from either the supply and demand points - separated by a considerable spatial and cultural divide - directly contact each other. Rather, the establishment of contact between this space is most likely to be through a number of other third parties (e.g. aid agencies, national governments, other firms) - in essence, from a network of business (and possibly social) contacts. Once a contract is negotiated, the transfer of expertise from Melbourne to Chiang Mai can be through individuals from the Australian firm travelling there. At later stages of the project once specific requirements are clear, the transfer of expertise could be through electronic methods such as E-mails and faxing blueprints and consultancy reports. In addition, local people may be recruited or possibly an alliance formed with a local firm. However, in the pre-contact stage, signalling expertise in the market place for complex intermediate goods and services - that is, industrial marketing - is different from the marketing of consumer products where mass media advertising predominates (Lynch 1994). Trade is likely if relationships and trust have been established through extensive networks of decision-making individuals (Bryson et al. 1993; O’Farrell and Wood 1998). Firms do not simply develop and then trade a product
in isolation to information from the market, or devoid of the social contacts made by decision-makers. Networks affect trade by extending the spatial reach of the firms, whether large or small, to connect with diverse sources of information and international markets.

Section 3.4 is organised as follows. Section 3.4.1 defines networks and explains why network analysis is a useful concept for understanding economic relationships. Section 3.4.2 discusses how actor network theory can provide an analytical insight into how networks initiate and sustain trade. This theory considers the influence of non-human resources. Ideas about power relations are also important. These ideas explain how networks retain influence over space. The concept of the ‘strength in weak ties’ is explained in Section 3.4.3. This provides an explanation of why some individuals and firms can exploit networks more effectively than others can. Section 3.4.4 investigates three ways that networks impact on trade: bringing sellers and buyers together, as facilitating linkages between internal and external determinants of the firm, and acting as conduits of trust. Section 3.4.5 concludes by acknowledging the limitations of the network approach and the need to include wider structural influences in a theory of trade.

3.4.1 Explaining network theory and its relevance

Networks are defined as interconnected structures of economic and social relationships that function in reciprocal and mutually supportive ways to link sets of persons, objects, or events (Cooke and Morgan 1993; Murdoch 1995; de Burca and McLoughlin 1996). In Yeung’s (2000) interpretation, networks are a process of socialisation through which disparate actors and organisations are connected in a coherent manner for mutual benefit and synergies.

Network theory seeks to analyse the function of networks in economic activity, having been adapted from the sociological literature (see Emirbayer and Goodwin [1994] for a review). The core of the theory is that co-ordination of economic activity takes place due to the interaction of firms in a network, rather than being solely dependent on the price mechanism as in traditional market models (de Burca and McLoughlin 1996). In network
theory, the actions of individuals aggregated together produce institutions, rather than atomised individuals disconnected from relations with others and the history of these relations (Bryson and Daniels 1998). In this respect, the theory differs from earlier behavioural or humanistic approaches of geography because the centre of analysis is the connections between individuals, not merely individual choices.

Studies by Haggett and Chorley (1969) of locational analysis and transport are early examples of network theory applied to economic geography. Later developments build on work such as Granovetter’s (1973; 1985), arguing that embedded structures of social relations are fundamental to economic action. There is considerable discussion of the relevance of networks as social processes that are instrumental to flexible specialisation and the growth of particular industrial districts (e.g. Piore and Sabel 1984; Cooke and Morgan 1993; O hUallachain 1991; 1992; 1993; Murdoch 1995; Malmberg 1994; 1996; 1997; Storper 1992; 1997; Yeung 1994; 2000). Relevant to understanding trade, other commentators argue that networks are essential to the internationalisation of small and medium size producer services firms. Developing networks reduces the firm’s reliance on its own internal resources (Grabher 1993; O’Farrell and Wood 1998; Rialp and Rialp 2001).

Johanson and Mattsson (1984) and Hakansson (1987; 1989) describe the fundamentals of the economic network model. This work is useful because it provides insight into the function of networks at the level of the firm. Individuals - referred to as actors - possess or control resources. Actors represent particular firms and organisations, and possess (or have access to) particular expertise and resources. Resources can be physical, financial or human. The main activity is to transform and exchange (i.e. transact) resources by using other resources. The individual firm is dependent on resources controlled by other firms, with the use of an asset in one firm being dependent on the use of the other firm’s assets (Hakansson and Johanson 1992; O’Farrell and Wood 1998; Vatne and Taylor 2000). Firms access resources not only through suppliers and customers but also through banks, shareholding institutions, government and consultants (Easton 1992). Economic value depends on the combination of resources because efficient production requires knowing
how to use these combinations within limits of uncertainty. With this model, the boundaries between a firm and its external environment are blurred. Network relationships allow the firm to gain access to external resources, acting as channels by which the internal and external processes of the firm interact (Section 3.1).

What needs to be known with this model is how the relationships that mobilise resources come into existence and operate over space. Some ideas that elucidate this explanation are discussed in the following sections. By understanding the processes that create and sustain networks, this knowledge can be integrated into a theory of trade at the micro-level.

3.4.2 Using actor network theory for analysis

In the actor network theory - which is an interpretation of the economic network model - networks are built from relations or associations. The ties between entities confer agency, rather than any essential (i.e. natural or social) characteristics held by a particular subject or object (Latour 1999; Murdoch et al. 2000). Action is dependent on relations between agencies. For actor-network theorists (Law 1994; Callon 1991; 1998), agency is understood as the collective capacity of heterogeneous networks, in which the activities of non-humans and humans, and material and non-material resources, are equally relevant. The recognition of non-human agency (or artefacts) provides insights into how the cultural, the social, the economic, and the technical combine to create networks that can reach over global space. Concepts of power help explain how networks bind together and what constitutes successful or strong networks. The following subsections detail these foundational ideas of actor network theory.

3.4.2.1 Non-human agency

The scenario that opened Section 3.4 implicitly referred to non-human objects - such as electronic communication technologies and modes of transport - as instruments that bring networks into existence. In actor-network theory, such objects are conferred with the power of non-human agency. In Callon’s (1991: 133-134) interpretation, texts and technical artefacts (e.g. machines and power supplies) are not passive tools, as they help
define the role played by humans (acting as producers and consumers) in the network. Texts, technical artefacts and money, as well as humans, are known as intermediaries. These allow networks to come into being, giving shape, existence and consistency to social linkages. Callon (1991: 135) stresses that, “actors define one another in interaction - in the intermediaries they put into circulation”. Law (1994: 24) offers a further insight: “Left to their own devices human actions and words do not spread very far at all” (emphasis in original). In interpretations by Callon and Law, intermediaries such as text and technologies form a crucial part of a network.

Non-human agency also helps explain how local actors are linked to non-local actors and how actors influence control at a distance. Latour (1987) believes that rendering events, places and people mobile allows influence across distance. Technology allows mobility, whether it is in physical terms (e.g. transporting a person or a commodity) or in an abstract sense such as transferring information by electronic means to transform or transact resources. Murdoch (1995) gives the example of international accounting firms that reduce the variety of activities in one place to a set of figures that are transported to another place to be acted upon.

3.4.2.2 Power

Power relations between actors determine the ability of actors to influence the decisions and actions of others within the network. This is a fundamental idea in network analysis (Dicken and Thrift 1992; Murdoch 1995; de Burca and Mc Loughlin 1996). For example, Dicken and Thrift (1992) argue that the organisation of production chains is a complex set of networks of inter-relationships between firms that have differing degrees of power and influence. Murdoch (1995: 748) refers to power relations as the “glue that binds the network”. The concept of power complements the ideas about non-human agency because to stabilise the networks after they come into existence, the actor enrols entities - human and non-human - within the network. The stronger the network the more tightly the various entities are tied in (Latour 1986). In Murdoch’s (1995) interpretation, this will entail redefining the roles of actors and entities as they come into alignment, such that they gain new identities or attributes within the network. However, stability is only
temporary. As de Burca and McLoughlin (1996) note, network structures are not static and evolve gradually in response to changes that are external and internal to the network.

Importantly, most of the relationships within networks are asymmetrical with respect to power. The power structures dictate how different firms influence the action of other firms, which ultimately affects the development of the network (de Burca and McLoughlin 1996). Power is relational because those who are powerful do not hold power in isolation, but instead extend influence by engaging others into networks (Latour 1986; Murdoch 1995).

3.4.3 ‘Strength through weak ties’ hypothesis

Granovetter’s (1973) ‘strength through weak ties’ hypothesis is another insight that explains how networks might be initiated and reach over a distance. It also explains why some firms are more apt than others at connecting with their external environment to source innovation. The argument is that economic actors receive more relevant information by having numerous weak ties with other groups of people, rather than by just having a few strong ties. While individuals possess a number of close friends and acquaintances through being embedded in a closely-knit social and cultural structure, any two friends will, however, possess different friends and acquaintances, with friendships representing a crucial bridge between two different groups of individuals. To Granovetter, individuals with many weak ties are “best placed to …. diffuse innovations, since some of these ties will be local bridges” (1973: 1367). Alternatively, strong ties breed local cohesion and overall fragmentation as individuals have limited contact with parts of the social system, due to the intensity and time needed to maintain strong networks (Granovetter 1973). Weak ties provide individuals and firms access to new forms of tacit and non-codified knowledge, thereby extending reach and power within the network.

Applying Granovetter’s hypothesis to economic analysis, Hakansson (1987), Bryson and Daniels (1998), and Oerlemans et al. (1998) argue that although networks are important for both small and large firms, the difference is that large organisations - particularly
multinationals - have access to a complex network of geographically dispersed weak ties. The movement of managers between firms and nations is an example of network access. These weak ties provide large firms with opportunities to obtain knowledge created in different cultural, social and political environments. There are well-established networks that the branch plant can rely on. Conversely, smaller firms are more constrained because of an over-reliance on a few strong local ties. Smaller firms are arguably unable to break dependence on local tacit knowledge and less likely to access new information and international innovation networks than are large firms (Malemberg 1996; Bryson and Daniels 1998). Similarly, Park’s (1996) research suggests that both strong and weak ties are necessary for sustaining exporting industrial regions.

3.4.4 Networks and trade

Having explained how networks come into existence and have influence over space, the next step is to discuss how networks facilitate trade. Fundamentally, networks enable producers to signal their competitive advantage to the market and connect with buyers. Producer-buyer interaction, often instigated through third parties, is an essential process in the international trade of producer services and industrial goods because of the complexity and cost of these products (Hakansson 1982; Easton 1992; Lynch 1994; Bryson 1997).

In addition to connecting producers and buyers in the market, networks contribute to two other processes integral to trade. One process is by networks acting as a bridge between internal and external determinants of the firm, thereby facilitating the innovation process - and indirectly trade (von Hippel 1988; Freeman 1991; Veugelers 1997; Peters et al. 1998). As Oerlemans et al. (1998) argue, networks are part of a firm’s external link for gaining innovative and competitive advantage, and are as important as internal R & D expenditure. Networks between firms and public institutions form the linkages that constitute national innovation systems (Nelson 1993a). Importantly, networks help firms - especially small and medium size - access external knowledge (Section 3.3.2.3). Often, networks are initiated in informal settings (such as at trade shows, conferences, staff tearooms and ‘after work’ social venues). Spatial proximity is believed to facilitate
informal networks, hence the emphasis in some literature on geographic clusters for innovation creation (see Section 2.3.3). In contrast, formalised networks often require legal agreements, and include corporate strategies and research collaborations (Anderson 1995). (Rosenfeld (1996) refers to informal and formal networks as soft and hard networks.)

Networks also facilitate trade by acting as conduits of trust. Trust sustains networks because once contacts are made, there needs to be confidence among decision-makers that others in the network can be relied upon to meet obligations and ensure that sensitive information is not misused. Abundant research emphasises the importance of trust in economic interactions, often realised through networks of personal contact (e.g. Granovetter 1985; Platteau 1994; Smart 1995; Vatne 1995; Park 1996; O’Farrell and Wood 1998). Social relations evolve slowly as trust is developed and institutionalised through negotiation and practice, continual contracting, joint collaboration and experience. A number of commentators (e.g. Amin and Thrift 1992; Boden 1994; Schoenberger 1997; Storper 1997) have re-described economies as networks of everyday talk which transmit specific, morally attuned stories concerning the worth of particular business practices and reputations. Thrift and Olds (1996: 323) eloquently describe this role of networks as, “generators of talk, as the intersubjective means by which stories are cobbled together and transmitted in ways which constitute passions and forge identities”.

Trust implicitly influences trade. In O’Farrell and Wood’s (1998) assessment, the internationalisation of business service firms primarily reflects opportunities arising from external resources of contacts for the firm, based on social exchange and trust established with domestic and foreign collaborators and clients. Trust is difficult to establish, nurture and sustain in foreign markets, especially where there are significant cultural and linguistic differences. Yet such conditions often make collaboration necessary. Despite narratives of time-space compression by Castells (1989) and Harvey (1989) that emphasise the de-coupling of spatial constraint on the organisation of production, face-to-face contact and interaction are still required to nurture trust and establish networks (Shapin 1994; Park 1996; Thrift and Olds 1996). The empirical work investigates
whether network formation and the influence of trust have a spatial constraint (Section 9.2).

3.4.5 Critique of network theory

As argued in Section 3.4, networks are important for initiating and sustaining trade. Networks are also integral to processes that underpin industrial marketing, corporate strategies and innovation creation (e.g. Hakansson 1987; Axelsson and Easton 1992; Easton 1992; Oerlemans et al. 1998). There are, however, some contentious issues and limitations with this strand. Easton (1992) notes the dialectical processes of competition and co-operation in networks. While the network perspective emphasises co-operation, in every exchange relationship there is the potential for conflict between actors. Yet the theory appears to be underdeveloped for accommodating this inherent contradiction. Another controversy is the emphasis that actor-network theory places on non-human agency. Arguably, these entities are not actors but inanimate objects that, in themselves, have no power or influence. These objects are not part of the network, merely tools that allow interaction between humans in the network. These contentions, however, are not addressed because this research is not intended to be an exposition of network theory.

What is addressed is to integrate this explanatory strand with the other strands to create a comprehensive explanation of trade. A major limit with network theory is that it is exalted to the neglect of other processes that also explain innovation creation and trade (see Bryson et al. 1993; O’Farrell and Wood 1998). This thesis argues that one strand alone is not enough to explain the complexities of how trade occurs. It is important to consider what makes firms in a network initially competitive and what creates innovation. The sources of the initial power a firm holds in a network need to be explained.

Furthermore, the literature does not articulate that individuals within networks also interact with wider structural influences. The state, as an example of a structural influence, is recognised as a resource in network theory but it is subsumed with other resources. Although researchers such as Granovetter (1985), Hakansson (1987) and
Oerlemans et al. (1998) admit that the neglect of structural influences is a theoretical weakness in analysing networks, their work does not tackle this problem. A reason for this general neglect, suggested by Murdoch (1995), is that network theorists are averse to resorting to structuralist macro theories.

The eclectic approach used in Part One of integrating different strands to develop an explanation deflects this type of criticism. Without resorting to overarching theories, it is argued that including the state as a complementary strand can add a useful dimension to network analysis. The empirical work reports how initiatives by governments can result in networks between people representing firms in the Australian water industry and Asian research institutions. Yet networks can also develop between individuals without an overt structural influence (see Section 9.2). Individual networks possess certain fluidity and flexibility that are caused by chance events (e.g. serendipitous meetings), but are also influenced by prevailing structures. A useful analogy that Axelsson and Easton (1992) use to illustrate this ‘middle approach’ describes networks as a liquid system where the movement of individual bodies is partly constrained by the forces emanating from other bodies close to them. The ‘liquid’ network behaves very differently from either ‘solid’ institutional structures where entities are fixed in place, or a ‘gas’ of free-moving atomised individuals unconstrained by other bodies. The next section explores the strand of the state as a structural influence that can influence networks, and ultimately trade for firms.

3.5 State and institutional influence on micro-level trade

This section argues that the state is important for understanding trade at the level of the firm. It builds on Section 2.6 that argued an explanation of trade at the macro-level ought to consider the role of the state. Similarly, at the micro-level exporting firms do not just create innovations or forge networks devoid of state or institutional influence. Section 3.5 begins with the assertion that a convincing theory is lacking to justify why the state is an important influence on trade. In Priest’s (1999) assessment, few descriptions of the operations of government policy offer a theoretical background. Because of this
limitation, practical examples are used in Section 3.5.2 to demonstrate how the state can have an influence on the propensity of firms to trade. Section 3.5.3 describes how institutional support assists exporting firms.

### 3.5.1 The paucity of theoretical explanation

Although there is an impressive body of work on state theory as applied to political structures and class conflict (see Dear [1994] for a review), a theoretical development of the role of the state in the facilitation of trade is comparatively sparse. As Webber and Rigby (1996: 90) point out, in an abstract capitalist economic system there is no role for a state: “There are no inevitable or logical economic functions which the state comes into existence to serve: all states are not necessarily solely instruments of class oppression; the role of the state is not simply one of facilitating capitalist interests”. Jessop (1982) notes that no single theory is adequate to explain the functions of the state, due to the complexity of the interaction of causal chains.

While a strong general theory is lacking, there are attempts to categorise the myriad of state actions. This can help analyse the interaction between the state and the firm. Dear’s (1994) review notes that there is a distinction between state form (i.e. how a structure evolves within a given social formation), state function (i.e. what the state actually does) and state apparatus (i.e. the set of institutions and organisations - educational, legal, political, treasury - through which state power is exercised). The following discussion about influence involves the category of state function, as the concern here is what the state does in relation to the exporting firm.

### 3.5.2 Influence of the state on trade at the micro-level

Debates concerning the effectiveness of industry targeting policies were discussed in Section 2.6.3. Instruments such as export subsidies and R & D support are some of the more direct ways the state can influence trade for both regions and individual firms. There is also an array of indirect ways that the state influences trade. Indirect ways are often preferable to direct facilitation by a national government, as they are less susceptible to being perceived by the international community as creating unfair trade
advantages (Harris 1985; Porter 1990). Boundaries need to be defined when discussing influences, as there are numerous avenues of action that encompass state function and apparatus. Among the more prominent not discussed here are roles such as the production and reproduction of the labour force (e.g. through education and health services). These instruments indirectly influence the exporting prospects for individual firms; however, they are too generalised to warrant further discussion. The following sub-sections outline the more relevant indirect influences on the propensity of firms to trade. Some of these influences were alluded to in Section 2.6.4 when discussing creation of competitive advantage at the macro-level by the state. The review below provides more detail and highlights contentions over effectiveness.

3.5.2.1 Facilitating innovation creation

Because innovations are generated, acquired and used at the level of the firm, policy directed at the firm to promote innovation can considerably improve export performance (Wakelin 1997). In addition to targeting instruments such as R & D subsidies, governments also influence innovation creation and diffusion by facilitating the formation of dense networks of contacts (Nelson 1993a; Peters et al. 1998). One common way is to sponsor research ties between public-funded institutions and the private sector. This type of cooperation arguably increases awareness of the demands of the market and stimulates public sector institutions to direct knowledge development toward underpinning technological innovation (Peters et al. 1998). Cooperative Research Centres (CRCs) in Australia (with several that focus on water research) are prime examples of university, government and industry collaboration (discussed in Section 4.4.2). These initiatives are important for creating national innovation systems. Yet there are challenges with collaborations. Firms that compete fiercely to bring their own proprietary technologies to market usually only collaborate on and reveal research that is not proprietary (Porter 1990). In addition, collaborations are susceptible to the ‘free-rider’ problem.

3.5.2.2 Impacts of environmental and health regulations on competitiveness
It is argued that stringent environmental regulations and public health standards can promote innovations in many sectors (Porter 1990; Porter and van der Linde 1995). This can indirectly influence the propensity of some firms to export. Stringent regulations and standards encourage early, sophisticated demand conditions, often leading to firms in nations that adopt early standards to gain competitive advantage as other countries follow with similar standards. Stricter environmental regulations can also save on production costs for some firms because of reduced energy and materials (e.g. through ‘cleaner production’ techniques). In addition, producers of environmental goods and services benefit due to increased demand for their products (OECD 1992; 1996).

There are lively debates over whether this is what actually happens or whether stricter standards hinder competitiveness (Stevens 1993; Jubb 1995; OECD 1997; Uimonen and Whalley 1997; Barker and Kohler 1998; Braun 1998; Ekins and Speck 1998). The general conclusion is ambiguous. For example, Jaffe et al. (1995: 157-8) review concludes: “Studies attempting to measure the effect of environmental regulation on net exports, overall trade flows, and plant location decisions have produced estimates that are either small, statistically insignificant or not robust to tests of model specification”.

However, the impact of environmental regulations on competitiveness very much depends on the sector and the firm (Sprenger 1998). Those firms involved in producing environmental goods and service would be expected to benefit (Moore and Miller 1994; OECD 1992; 1996). The empirical work considers whether Australian environmental and health regulations have likewise driven innovation in water industry goods and services, leading to competitive advantage and exports (Section 10.3.2). The tier of government that is involved is of interest because environmental and health legislation can emanate from the Local or State level. This is an example where the lower tiers of government can still have an indirect influence on trade (although unlike Federal Governments they lack constitutional powers to directly control exports).

### 3.5.2.3 Procurement by governments

Procurement by governments and related agencies can influence domestic demand conditions (Porter 1990). This influences the competitiveness of some firms. Public
sector procurement policies can have a direct impact on innovation processes, products and producers (Cornish 1995). One example, explored by Polese and Verreault (1989), was the decision of the Quebec provincial hydroelectric utility to outsource engineering work in the 1960s, rather than build an internal department. This led to the growth of an exporting consulting engineering sector. Yet certain conditions are required for procurement to create a competitive environment. Governments need to be sophisticated and demanding buyers in order to stimulate innovation. A strong element of domestic, and even foreign, competition should be present to ensure domestic firms are able to offer internationally competitive products and services (Porter 1990).

Foreign aid tied to the purchase of the donor nation’s goods and services is one form of government procurement that influences trade. Yet in Porter’s (1990: 653) assessment, this may not be the best avenue toward global competitiveness. Because the 'captive' markets created by foreign aid are rarely advanced or demanding, the donor nation’s firms may not develop capabilities to meet the more stringent needs of other advanced countries. In the past, tied foreign aid has been an important vehicle for Australian water industry exports. Recent government revisions have emphasised the untied aid approach where domestic firms do not receive automatic preference for contracts. The issue of foreign aid as an avenue of export for Australian water industry firms is discussed further (Sections 4.3.1; 10.3.3).

3.5.2.4 State responses to wider scale influences
The restructuring of water utilities in Australia since the early 1990s, because of the Hilmer reforms and competition policy (see Section 4.3.3), is an example of a response by the state - both Federal and State tiers - to wider scale influences. The restructuring of the industry has influenced the exporting prospects of some firms. Water utilities have out-sourced some functions, creating opportunities for smaller firms. On the other hand, there has been an influx of international competitors. The empirical work considers how restructuring and the internationalisation of the industry have resulted in trade opportunities and constraints for local firms (Section 10.3.1).
Restructuring is the outcome of complex and larger economic, political and social processes of the previous three decades. For public utilities such as water, spiralling levels of public debt and the need for massive infrastructure upgrading were some of the reasons behind restructuring (Hilmer 1993; Smith 1998). The reasons for economic restructuring in the broader Australian context are analysed in numerous works (e.g. Daly and Logan 1989; Fagan and Webber 1994; Webber and Rigby 1996; Ravenhill 1997; Webber 1997; Stubbs and Underhill 2000). This thesis, with its focus on explaining trade, does not expand on the economic theory behind the restructuring of the Australian water industry. Rather, it is acknowledged that action by the state, such as restructuring public utilities, can indirectly influence the propensity of some firms to trade.

### 3.5.3 Institutional support for exporting firms

There are various forms of institutional support for exporting firms that are not directly related to functions of the state. Industry associations, chambers of commerce, professional associations, and financial services - while not usually directly funded by government - are still part of the institutional support (also referred to as capacity or thickness) of regions that influences economic development and trade (Murdoch 1995; Yeung 2000). Institutional support contributes to the strength of factor conditions in a region. Developing a region’s institutional support is argued to be important to secure globally mobile economic activities (Amin and Thrift 1992; 1995; Phelps and Tewdwr-Jones 2000). The function of institutional support is quasi-governmental, often fulfilling industry needs in the absence of direct action by the state. As Jessop (1990) notes, distinctive forms of sub-national governance (such as institutional support) appear to be a by-product of the decomposition and devolution of powers and responsibilities from central government. Interestingly, in some Asian regions where the state is usually interventionist in export facilitation, Yeung (1997a) argues that ethnic networks of personal relations provide the necessary institutional thickness rather than the state.

Business and industry associations facilitate exports at the micro-level by the promotion of networks and contacts (Martens and Vandenbempt 1995; Bryson and Daniels 1998; Bennett 1999a; 1999b). Associations function as intermediaries between business and
government, such as by developing networks between managers and bureaucrats (Bennett 1998). In the process, the effectiveness of the state is improved in its wider regulatory and institutional contribution to the economy.

There are, however, some contentious issues concerning industry associations. While strong local institutions can help embedded firms in specific locations, too much institutional ‘thickness’ can be a hindrance to growth in places where inflexible attitudes and habits are firmly locked into the economic system (Scott 1998). Another problem is that the government’s relationship with such associations may sometimes cause a conflict of interest between industry and public goals (Bennett 1998). Also, the extent of geographic coverage where associations can retain effectiveness is uncertain. Bennett's (1998) research suggests that voluntary local business associations in Britain are most effective if their spatial reach is confined to small geographic areas. Yet it is common for industry associations to take a national perspective. The Australian Water Association (AWA), for instance, is a voluntary industry association that attempts to act as a unified voice for the nation’s water industry. The spatial influence of industry associations is evaluated in Section 10.2.3.

3.6 Conclusion: what is known and what still needs to be known

Chapter 3 has reviewed explanations of how trade occurs at the level of the firm. Four strands are identified: competitive advantage and corporate strategies, the creation and diffusion of innovation, market function and networks, and the role of the state and institutional support. Each strand taken alone is deficient as a comprehensive explanation of trade, despite claims that usually support one particular strand. The approach has been to integrate the useful elements of each strand into a framework. This provides a powerful analysis of how and why trade occurs for firms in a particular industry. The framework can accommodate different size firms, and encompasses manufacturers and services providers. In addition, the interaction of human agency (e.g. networks between decision-makers) with structural influences (e.g. the state and national innovation systems) provides depth to an analysis.
The fact that the Australian water technology and management industry has been chosen for study, as justified in Chapter 1, has not been central in Part One for developing the theoretical explanation. Characteristics of the water industry did help guide some of the avenues for explanation in Chapter 2, but the approach taken in Chapter 3 could apply to a vast range of manufacturing and service industries where comparative factor advantage and sensitivity to transport costs do not prevail.

To tie together the ideas discussed in Part One, Figure 3.3 is a conceptualisation of the processes that explain how trade occurs among firms. These interacting processes are based on the four strands. Trade is an outcome of processes inside and outside the firm. Both the internal resources of the firm and external determinants influence innovation creation and acquisition. Innovation drives productivity (either by a lower price per ‘unit’ or a higher quality) at any point in the value chain. Competitive advantage results. The arrows represent interconnections and flows of capital, goods, services, and importantly, knowledge and information. Arrows also represent the networks that permeate all parts of the process. Although the arrows are shown as flows in one direction to explain the sequence, a virtuous cycle can also occur as information, such as from other firms, suppliers and the market, feeds back into the innovation process. Note that Figure 3.3 is intentionally simplified as a linear sequence. In reality, there are multiple interconnections and non-sequential processes that are not shown. For example, competitive advantage can be created by an injection of capital from a merger, without necessarily being preceded by innovation creation. In addition, the state’s influence is more complex than suggested by the diagram. The formation by the state of multi-lateral trade agreements affects the international market that in turn, influences the firm.

A question raised in Chapter 2 (Table 2.5) is how do macro-level determinants of competitive advantage relate to the firm and create exports. Recall that Figure 3.2 shows how Porter’s five external determinants of industry profitability interact with the larger ‘diamond’. Likewise, Figure 3.3 further clarifies this issue because it shows the relationship between processes that are internal and external to the firm. As an important step in the theoretical development of combining macro and micro-level approaches to
explain trade for an industry, Figure 3.3 complements Figure 2.2 (Section 2.7) by providing detail that is lacking with a macro-level approach. Figure 3.3 conceptualises that is the interaction of internal and external determinants that influence the propensity and ability of firms to trade.

The state of knowledge at this point of the research is summarised in Table 3.3. The limitations and contentions identified in the literature generate a number of issues that need to be known, thereby providing direction for the empirical work. Column 3 details the research questions addressed in the empirical investigation. The cumulative knowledge provides detail about the main research question: how does trade develop among firms in this industry. The table also acts as a bridge between the previous chapter by incorporating questions from Table 2.5. The number of disparate explanations covered in Chapters 2 and 3 is reduced to four central strands that encompass both macro and micro-level explanations of trade. The usefulness of this approach is appraised in Section 11.2. Although there is not a dominant strand in the theoretical framework, it is possible that some elements are more important than others are when subject to empirical testing.
Figure 3.3 Diagrammatic representation of determinants of trade at the level of the firm

**Innovation creation / acquisition**

- **Productivity** (by lower cost or higher quality output)
- **Creation of competitive advantage** by strategies of cost or quality.

**FIRM**

- **Internal environment**
- **External environment**

**STATE**

- **Domestic demand**
- **Suppliers (related & supporting industries)**
- **Factor conditions**
- **Other firms (threat of new entrants or collaborators through corporate strategies)**

**TRADE**

- **Feedback of market information/ network formation**

**International market**

**Importing firm/ organisation**

*Source*: constructed from the literature reviewed in Chapter 3.
## Table 3.3 Summary from Part One of what is known about trade theory and what needs to be known

<table>
<thead>
<tr>
<th>Theoretical strand</th>
<th>What is assumed/ known from the literature</th>
<th>What is not known or contentious about a particular strand</th>
<th>What needs to be known (i.e. what is this thesis about)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional explanations</td>
<td>Conventional trade theory is inadequate for explaining much contemporary trade.</td>
<td>What explains trade between countries with similar factor endowments? What explains trade in services?</td>
<td>1. (From Table 2.5) Does factor disadvantage contribute to an explanation of trade for this industry?</td>
</tr>
<tr>
<td>Competitive advantage and corporate strategies</td>
<td>The concept of competitive advantage has improved explanatory powers as a trade explanation. MNE activity and FDI are an important part of a trade explanation.</td>
<td>Do Porter’s ideas overemphasise the importance of the home market in creating competitive strength? Can inward FDI compensate for a small domestic sector as suggested by Rugman (1993)? What should the role of government be in creating competitive advantage?</td>
<td>2. What is the relationship between competitiveness and export performance? 3. Does the size and age of firms have an influence on firm-performance? 4. (From Table 2.5) What is the relationship between inward FDI and domestic industry exports? 5. (From Table 2.5) How might Porter’s model be modified to include ideas on MNC activity, influences of the state, and trade? (This issue is addressed in Sections 2.5.3 and 2.7.)</td>
</tr>
<tr>
<td>Firms with higher productivity and hence competitive advantage should be more likely to trade.</td>
<td>How correct is the assertion that higher productivity leads to exports? Is competitive strategy by firms a simple dichotomy of cost and differentiation as Porter suggests? How is competitive advantage constructed for producer service industries? How do competitive strategies differ according to firm size and age?</td>
<td>6. How is competitive advantage created for firms in this industry? 7. Are particular competitive strategies related to the performance of firms? Why or why not? 8. (From Table 2.5) How does Porter’s ‘diamond’ model relate to this industry?</td>
<td></td>
</tr>
<tr>
<td>Clusters or spatial agglomerations of similar industries can create competitiveness and innovation that result in trade.</td>
<td>Are innovation and competitiveness a result of localisation economies (i.e. links between similar industries or urbanisation economies (i.e. general agglomeration economies)? What are the reasons why not all geographic clusters are generators of trade? What explains trade for industries that are not found in clusters of strong local linkages?</td>
<td>9. What are the characteristics and industrial organisation of the industry (i.e. in terms of firm-size, age, type, locations, ownership and supplier linkages)? 10. (From Table 2.5) Are clusters evident for this industry? Why or why not? 11. (From Table 2.5) How strong are linkages between related and supporting industries for firms?</td>
<td></td>
</tr>
<tr>
<td>Firms use different corporate strategies to gain competitive advantage over their rivals.</td>
<td>What intra and inter-firm strategies are more likely to lead to competitive advantage and international trade? Which are least likely? Why? How much is the choice of strategy determined by asymmetrical power relationships between decision-makers?</td>
<td>12. What types of corporate strategies (e.g. alliances, licensing, acquisitions, merger, FDI) are used and why?</td>
<td></td>
</tr>
</tbody>
</table>
### Table 3.3 (continued)

<table>
<thead>
<tr>
<th>Theoretical strand</th>
<th>What is assumed/ known from the literature</th>
<th>What is not known or contentious</th>
<th>What needs to be known (i.e. what is this thesis about)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation creation and acquisition</td>
<td>Innovation, competitive advantage and trade are linked. Innovation derives from numerous sources, internal and external to firms. Proxies that quantify innovation have limitations. Sources of innovation (R &amp; D, market intelligence) need not be spatially confined. The relevance of knowledge needed for innovation does not experience distance decay.</td>
<td>What are the limitations with the proxies used to measure innovative activity? Do incremental innovators have different sources of innovation compared with radical innovators? Why do some forms of knowledge remain spatially ‘sticky’ or embedded in particular organisations and locations?</td>
<td>13. Is there a relationship between innovation proxies and firm-performance? Why or why not? 14. What are the internal and external sources of innovation for firms? 15. Are innovation sources spatially constrained? Why or why not? 16. (From Table 2.5) How does the national innovation system influence this industry?</td>
</tr>
<tr>
<td>Function of networks</td>
<td>According to network analysis, firms (including individual decision-makers) with diversified networks should be well placed to develop trade linkages.</td>
<td>What is better for trade contacts: a few strong ties or many weak ties? How is the influence of networks maintained over large distances? How do structural influences such as the state influence the formation of networks between decision-makers involved in trade?</td>
<td>17. How are export markets accessed? 18. Why are particular methods used? 19. Does the size and type of firm influence the method used? 20. Is there a dominant theory explaining export access, or are several explanations required? 21. How are networks formed? 22. Are there spatial barriers to forming networks and trust? 23. How do networks reach over space? 24. How can network theory inform an analysis of trade?</td>
</tr>
<tr>
<td>State and institutional influence</td>
<td>The state can influence trade directly and indirectly. However, short-term gains by some policy instruments (e.g. sheltering and tariff protection) can be detrimental to long-term competitiveness.</td>
<td>Do environmental and public health policies positively or adversely influence competitiveness and trade for some sectors? To what extent should the state be involved in the creation of competitive advantage and the facilitation of trade? Is industry targeting feasible given the number of theoretical assumptions? Should the state be an active initiator of trade, or a passive facilitator?</td>
<td>25. How does the state directly and indirectly influence trade for firms in this industry (e.g. export facilitation and innovation programs, water industry reforms, foreign aid procurement practices, environmental legislation)? 26. How effective are direct initiatives and why? 27. (Table 2.5) Is targeting feasible for this industry? 28. How effective are industry associations in facilitating trade? 29. Is institutional capacity sufficient? 30. (Table 2.5) How do different tiers of government create competitive advantage and influence trade? 31. Why is the state a necessary theoretical strand to explain trade? (This issue is partly addressed in Sections 2.6.1; 3.5.2.)</td>
</tr>
</tbody>
</table>
Table 3.3 (continued)

<table>
<thead>
<tr>
<th>Theoretical strand</th>
<th>What is assumed/ known from the literature</th>
<th>What is not known or contentious</th>
<th>What needs to be known (i.e. what is this thesis about)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>No one theoretical strand offers a comprehensive explanation of trade.</td>
<td>To what extent should generalist explanations be modified when applied to empirical testing?</td>
<td>32. (From Table 2.5) How do macro-level determinants of competitive advantage relate to the firm and create exports? (This is addressed in Section 3.2.2 and Figure 3.2.) 33. How can disparate explanations be linked into a comprehensive theoretical framework to explain trade for an industry? (See Chapters 2 &amp; 3 and Figures 2.3 &amp; 3.3.) 34. What elements and ideas need to be included in a theoretical explanation at the level of the firm? (See Section 3.6 and Figure 3.3.) 35. For this industry, how do exporting and non-exporting firms differ in terms of structure, size, competitive strategy, and the use of institutional support? 36. How can the theoretical framework and the empirical findings be reconciled and limitations redressed? 37. Can the explanation be applied to other industries?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can theoretical frameworks be applied to different types of industries?</td>
<td></td>
</tr>
</tbody>
</table>

*Source:* derived from the literature reviewed in Chapters 2 and 3.
Chapter 4
The water technology and management industry: definitions, the global and national context

Part One developed an explanation of trade. It refined macro-level trade theories to develop an explanation applicable to the level of the firm. The water management and technology industry has, until now, been broadly defined (Section 1.1). Part Two (Chapters 4 and 5) of this thesis provides the necessary background to bridge the theoretical and empirical work. Chapter 4 defines the industry and describes the global and Australian context. Chapter 5 discusses the development of the methods used to collect information about the Australian industry.

Chapter 4 serves several purposes. Section 4.1 establishes an organisational framework for an industry that is not officially defined and consists of diverse but related activities. The remaining sections place the industry in a global and national context as this background is required to appreciate the competitive challenges confronting Australian firms. Section 4.2 explains why the global water industry is dominated by firms from Britain and France. Section 4.3 describes the development of Australian water management exports, initially closely associated with foreign aid projects. Water industry reforms during the 1990s have influenced recent developments, namely the entry of foreign water multinationals. The state of knowledge about how exports develop for the Australian water industry is dealt with in Section 4.4. The section also overviews the types of state and institutional support relevant to the Australian industry. Section 4.5 concludes by reinforcing how the material discussed contributes to the empirical investigation.

4.1 Defining the water technology and management industry

The water technology and management industry encompasses a diverse collection of activities, ranging from simple to elaborately transformed manufactured products, and specialised producer services. The boundaries that define this industry are not obvious. The lack of definitions and industrial classification codes means that accurate statistical
information on the industry - both for Australia and internationally - is also lacking. This has been noted in a number of publications (e.g. EDC [Economic Development Committee] 1995; OECD 1992; 1996; McRae 1999; AWA [Australian Water Association] 2000). Section 4.1.1 reviews the limitations of standard definitions and estimates. Defining the water industry as a sub-sector of the environmental goods and services industry is argued to be unsatisfactory. Section 4.1.2 develops a framework to categorise the different activities.

4.1.1 Limitations of published definitions and estimates

The water industry is not officially defined and published estimates of its economic value are unreliable. Because of this, inter-industry and international comparisons are restricted. Australian Bureau of Statistics (ABS) publications are too generalised to be of use classifying activities within the water industry. For example, aggregate annual turnover of water utilities is listed (e.g. ABS 1999 #8226.0). However, suppliers to the water industry are not separately listed. Water treatment manufacturing does receive a standard industrial classification code (SIC) (ABS 1994 #1293.0). Manufacturers of pumps, pipes and water filters are assigned SICs (ABS 1994 #1293.0) and receive Australian Harmonised Export Commodity Classification Codes (ABS 1999 #1233.0). Yet these classifications are rather general, as products are not usually differentiated by specific use (with the exception of filters). Pumps, for example, are supply inputs to many different industries. For services relevant to the water industry, there are classifications and data for construction services and consulting engineering (e.g. ABS 1997 #8693). These activities, however, are not just confined to the water industry.

Because there is no standardised definition, economic estimates of the water industry are not compatible. Table 4.1 summarises what is known. Only a sketch of the industry is provided; the reliability of some of the figures is dubious.

Table 4.1 Estimates of the magnitude of the Australian water industry
<table>
<thead>
<tr>
<th>Activity</th>
<th>Quantitative estimates</th>
<th>Comments on limitations of data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water utilities, corporations 1; 2; 3</td>
<td>Estimated turnover (1999): $5 000 M (million); for urban utilities $4 475 M Employment (1998) 16, 500 employees</td>
<td>Does not include supplier industries or contractors.</td>
</tr>
<tr>
<td>Capital investment by industry 2</td>
<td>$899 M (1996-97) compared with $1,220 M 1992-93</td>
<td>Only includes urban water industry, does not distinguish foreign investment.</td>
</tr>
<tr>
<td>Expenditure on wastewater management and water protection (final and intermediate consumption plus gross capital formation) 5</td>
<td>$3 018 M (1996-97) (includes household expenditure, government and industry)</td>
<td>ABS environmental expenditure figures are criticised for only measuring input expenditure and not successful outcomes. 6</td>
</tr>
</tbody>
</table>

Note: All monetary values are in Australian dollars relevant to the cited year.

Sources:
1. AWA (Australian Water Association) 2000: 11
2. WSAA (Water Services Association of Australia) 1998
3. ABS 1999 #8226.0
4. ABS 1997 #8693.0
5. ABS 1999 #4603.0
6. Warby et al. (1997)
7. ABS and industry estimates (cited Asian Intelligence Wire 2000)

The literature lacks comprehensive information on the magnitude of exports of water-related goods and services. Various government reports from the past decade, which extol the potential of this export industry (see Section 1.1), are scant on such data (e.g. EDC 1995). The South Australian government has attempted to develop water industry exports (see Section 4.3), hence does publish some data. The estimated export revenue between 1994 and 1999 was $120 million (SA Water 1999; WIA [Water Industry Alliance] 2000). However, this figure is questionable for two reasons: first, it includes exports to other Australian states, not just overseas; second, the definition of the water industry used for accounting purposes is broad, including up-stream supply activities.
such as plastic fittings and electrical wiring (SA Water 1999; p.c. [personal communication] Interview Codes #114). The problem is that the term ‘water industry’ becomes nebulous and removed from goods and services directly involved in water treatment. It is possible there is some political advantage for maintaining a loose definition.

A number of publications have included the water industry as a subsector of the broader environmental technology and management industry (also referred to as the environmental goods and services industry) (EDC 1995; OECD 1992; OECD 1996; Sousane 1996). Despite considerable effort, these publications are unsuccessful in developing a standardised definition of the ‘environment industry’ (including water). The OECD (1996) has attempted quantitative comparisons between countries of the water industry; however, different definitions are used. For example, some countries include water storage infrastructure and others do not. There have been moves toward formulating international standards for classifying subsectors of the environment industry, the most well known being the European System for Economic Information on the Environment (known as SERIEE) (OECD 1996). However, these efforts still await widespread adoption.

The inclusion of the water industry as an environmental industry is appealing to policy makers for a number of reasons. One justification is that including water bolsters the relative economic importance of the environment industry - usually in the order of 40 to 60 percent - because of the large capital expenditure on water treatment (OECD 1996: 14). Also, referring to the water industry as part of the environmental industry recasts its image as a new and exciting growth industry. This can be favourable for attracting government support. Additionally, the use of the term ‘environmental’ conveys more satisfactorily the interconnection that such activities have with the biophysical environment, rather than if classified simply as ‘engineering’ activities. Yet this inclusion has produced no benefit to date because the different definitions used produce unreliable estimates.

4.1.2 Developing a definition
The lack of an official definition requires that considered choices are made to define the ‘water technology and management’ industry. For this research, the industry is defined as encompassing products and services directly related to the treatment and management of water and wastewater. The activities involved are detailed in Figure 4.1.

These listings have been obtained from industry association directories (Aquatech 1996; AWWA [Australian Water and Wastewater Association - former name of the AWA] 1999; AWA [Australian Water Association] 2000). A directory typically contains about 180 separate product and service listings - too many to be practical. Listings have been summarised into about 30 activities, as described in Appendix A (Table A.1). This has been achieved, for example, by not having subcategories for different types of filters or pumps.

In Figure 4.1 these diverse activities are represented as an integrated cycle to show the interrelation between the industry and the biophysical environment. Water provision and wastewater activities directly utilise the source and sink functions of the biosphere. This interconnection is overlooked when categories are organised alphabetically as in AWA listings. In addition, the concept of a cycle reflects the shift in water management from the domain of civil engineering, to encompass wider concerns of environmental management (e.g. Smith 1998).
Figure 4.1 Activities that define the water technology and management industry

**Services**

- Research & management of water resource
  - Catchment management
  - Groundwater management
  - Freshwater ecology management
  - Testing & analytical services
  - Drinking water quality research

- Consultancy and design services for water supply and treatment

- Management & operation services for water treatment

- Construction of water delivery infrastructure

- Wastewater management and pollution control research

- Wastewater treatment, consultancy & design (including reuse systems)

- Management & operation services for wastewater plants

- Construction of treatment and disposal infrastructure

- Effluent reuse management (e.g. agricultural/horticultural greywater reuse; vermiculture; microbial treatment)

- Stormwater treatment management (e.g. runoff catchment; artificial wetland design & construction)

**Goods**

- Monitoring and testing equipment

- Water treatment equipment
  - Filters & filtration media
  - Treatment chemicals & gases
  - Desalination equipment
  - Pumps, valves, power equip.
  - Disinfection equipment (UV)
  - Automation & computer control systems
  - Packaged plant units

- Wastewater Treatment Equipment
  - Filters & filtration media
  - Treatment chemicals
  - Screens
  - Aerator, blowers, centrifuges, decanters, mixers
  - Sludge dewatering & drying equipment
  - Monitoring & testing equipment
  - Automated and computerised control systems
  - Packaged plants

- Industrial wastewater treatment equipment (e.g. oil/water separation; heavy metal removal; cyanide removal)

- Stormwater treatment equipment (e.g. litter-traps; catchment tanks)

**Key**

- Supply input
  - Water source
  - Wastewater

Several water-related activities are excluded from the definition presented here. These include domestic distribution and disposal systems (e.g. water and sewer pipes, drainage systems); plumbing hardware such as taps, toilets and basins; services involving final consumers (e.g. billing, water meter reading, domestic repairs); and domestic bottled water products. These are omitted because the definition of the ‘water technology and management industry’ is intended to encompass activities directly related to the treatment and management of water and wastewater. However, it is acknowledged that the boundaries chosen for this research are arbitrary. Realistic research boundaries need to be imposed for definitional and logistic reasons. (Appendix A [Discussion A.1] explains why certain water-related activities are excluded from the definition used to select the empirical sample.)

The work in Section 4.1 has been necessary because of the lack of a standardised definition. The activities shown in Figure 4.1 indicate what is meant throughout this thesis by the term ‘the water technology and management industry’. The definition provides the basis for choosing the types of firms and organisations to be investigated in the empirical work (Part Three). With a useable definition in place, a background to the industry and its trade can proceed.

4.2 The emergence of a global industry

Trade in water related goods and services likely had its origin with the colonial expansion of European powers in the 19th century. The growing awareness of water borne disease and the development of new technologies - such as motorised pumps - probably resulted in some transfer of technology to protect the health of compatriots in the colonies of Asia and Africa. The establishment of urban water utilities in Australia in the late 19th century also relied on equipment imported from Europe (Beasley 1988). Yet it is only in recent decades that there has been recognition of a global water industry trade (Karp 1995; Finger and Lobina 1999; Tolhurst 1999). The trend toward public service privatisation by many national governments is a major driving force for trade in the global water industry (Finger and Lobina 1999). The global market for municipal and
industrial water and sewerage goods and services is estimated to be US $ 200-320 billion per annum (Masons 2000). A handful of French and British firms dominate international trade in the water industry (Table 4.2). Sections 4.2.1 and 4.2.2 explain that this dominance is largely because of particular historic circumstances in those countries. The global pattern is also shaped by other minor players, as described in Section 4.2.3.

Table 4.2 The main firms in the international water industry

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Compagnie Generale des Eaux (part of Vivendi)</td>
<td>US $ 12 billion¹</td>
<td>235 000 (includes all of Vivendi)</td>
</tr>
<tr>
<td>Suez Lyonnaise des Eaux</td>
<td>US $ 7.4 billion (Euro 6.3 billion)²</td>
<td>n/a</td>
</tr>
<tr>
<td>United Utilities PLC</td>
<td>£ 2.5 billion</td>
<td>13 000</td>
</tr>
<tr>
<td>Thames</td>
<td>£ 1.4 billion³</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Notes:
1. This figure is for water-related sales for the Vivendi group. For the entire conglomerate turnover was US $ 32.5 billion.
2. This figure is turnover for water-related sales of Suez Lyonnaise des Eaux. For the entire conglomerate, turnover was US $ 40 billion.
3. International operations for Thames were £ 172 million in 1998; £ 58 million in 1999.


4.2.1 French dominance through franchising

The franchising ownership model has evolved over the past two centuries in France where municipal governments generally own the assets that are contracted to private sector tenders. In total, there are some 50 private companies offering such services in France but, over time, two major companies have captured 75% of the market (Smith 1998; Finger and Lobina 1999). The oligopolistic structure of the domestic market and the absence of significant competition abroad have allowed these two major companies, each with a long history of experience with contractual arrangements in water management, to establish a global presence (Finger and Lobina 1999). By 2000 the two companies controlled approximately 60% of public-private partnerships in water services in developing countries (Financial Times Newsletter 31 March 2000).
The two major firms - Vivendi and Suez Lyonnaise des Eaux - have very different corporate styles. Vivendi is a conglomerate with wide ranging activities including communications, whereas Suez Lyonnaise des Eaux concentrates on utilities (Financial Times Newsletter 2000; Vivendi 2000). Vivendi is an aggressive player that views the convergence of multimedia and telecommunications as a major long-term growth opportunity (Ogier 1999). By 1999 approximately 40% of Vivendi’s turnover was outside France, up from 25% a decade earlier (Vivendi 2000). Vivendi acquired US Filter in March 1999 for US $ 6.2 billion, adding to its vertical integration chain (Chang 1999; Faircloth 1999; Ogier 1999). The acquisition meant that over two-thirds of Vivendi’s turnover came from the US market (Ogier 1999). Vivendi also has 10% of the British water services market (The Economist 4 May 2002: 9). In recent years Vivendi’s global empire has been under stress from over investment in its media interests (The Economist 9 March 2002: 9).

The rival - Suez Lyonnaise des Eaux - was formed in 1997 by the merging of finance company Suez and the long-established water company, Lyonnaisee des Eaux. Suez Lyonnaise des Eaux is considered more circumspect in style than Vivendi, with core interests in water, energy and waste management, supplemented by minor interests in communications (Ogier 1999). It is the world’s biggest private constructor of water treatment works, as well as the third largest energy producer in the world. Lyonnaise des Eaux entered Asia in 1985 when it bought a majority stake in the Macao Water Supply Company and won a 25-year concession to run the utility. By 1995, its subsidiaries were solidly established, selling water treatment equipment to China and operating franchising arrangements in Hong Kong (Karp 1995). Seventy percent of Lyonnaise des Eaux’s core business is outside France, with the US an important destination for investment (Institutional Investor 1998; Jones 1998). Suez Lyonnaise des Eaux acquired Nalco Chemical Company for US $ 4.5 billion in late 1999, creating the world’s leading water treatment services business (Chang 1999; Financial Times Newsletter 2000). The vertically integrated strategies are a form of competitive advantage, providing integrated and comprehensive solutions to clients.
Although Vivendi and Suez Lyonnaise des Eaux remain fierce rivals, they collude on international projects if they have a common interest. For example, in 1993 the two French firms combined to outbid the other competitor, Thames Water, for projects in Argentina (Chang 1999; Financial Times Newsletter 2000). More recently, Vivendi and Lyonnaise bid jointly for a majority interest in the privatisation of water services in Rio de Janeiro (International Trade Finance 1998; Jones 1998). The aggressive behaviour of French-based multinationals has received criticism. Finger and Lobina (1999) argue that these oligopolies often practise collusive, anti-competitive behaviour to achieve such results. Gleick et al. (2002) voice concern with the privatisation and globalisation of fresh water becoming the domain of a few global corporations. The French dominance looks set to continue. With only about 15% of American municipal water systems privatised by 1998 (Jones 1998), large European multinationals see ripe pickings.

The legacy of the French presence is the development of a franchising model that has become a global standard for utility management. There are several forms of franchising due to differences in the degree of state-private operation. One form is where the public sector constructs the infrastructure and the contractor operates and maintains it. South Australia’s SA Water Corporation adopted this arrangement when it tendered its water services in 1995 (see Section 4.3.3). Another form is called BOOT (build, own, operate and transfer) where the contractor constructs and operates the infrastructure, and transfers ownership after 15-30 years. Australian Water Services, a consortium including Suez Lyonnaise des Eaux, manages and operates a Sydney treatment plant under a BOOT scheme (Nosworthy 1995; Hassan 1998; Smith 1998: 265; Finger and Lobina 1999).

4.2.2 The British experience with privatisation

British water utilities have also become prominent international players, although far more recently and with a different ownership structure than that of the French. Indeed, the privatisation in 1989 of water utilities in England and Wales (but not in other parts of the UK) in 1989 is considered the most extreme example of global water industry privatisation (Haarmeyer and Mody 1997; Hassan 1998; Smith 1998). When the utilities were listed on the stock exchange, the British water industry was crippled by debt.
Because it was a mature industry with limited potential for domestic growth, share issues were dependent on considerable ‘sweeteners’ such as cancelling water industry debt (Hassan 1998).

Several commentators have speculated why privatisation was chosen over franchising, given the success of the French model. Hassan (1998) believes that in the mid-1980s the viability of franchising was less evident than it was by the late 1990s. Water industry leaders in England believed privatisation would provide new managerial freedoms from treasury controls and government interference (Hassan 1998). A major reason for privatisation was to attract the £ 25 billion required for new investment into aging infrastructure, partly to meet the new and stringent environmental requirements of the European community (Nosworthy, 1995; Haarmeyer and Mody 1997: 149; Hassan 1998: 167). Undoubtedly, a major impetus was the privatisation agenda of the Thatcher government that had an ideological opposition to any public sector role in the water industry (Hassan 1998). (The debates over UK water industry reform and the often adverse social impacts are detailed in Johnson and Rix 1993; Saunders 1995; Hassan 1998.)

The privatisation of the British Water industry has resulted in the internationalisation of water services. Because of strict merger laws in the UK, coupled with shareholder’s expectations, overseas markets have been developed. For example, the utility Thames Water built on experience and reputation gained in the previous decade from managing pollution affecting the River Thames to undertake geographic expansion of its core skills (Masons 2000: 430-431).

However, internationalisation has forced some water industry firms to diversify too much beyond core activities (Haarmeyer and Mody 1997; Hassan 1998). It has only been since 1997 that international operations of Thames Water have shown a profit (Thames Water 1998; Masons 2000: 432-3). Smaller British utilities, such as Southern and Yorkshire Water, have exited from the international market (Haarmeyer and Mody 1997). Non-core business - as international operations are sometimes referred to - can take up a
disproportionate amount of management time and often produces losses or (at best) small profits (Bannister 1995 cited Hassan 1998: 189).

Although having established a global presence, British firms are still outmanoeuvred by the strategies of French rivals. The major shareholders of several of the British water authorities are French water companies, able to take advantage of compulsory competitive tendering (Smith 1998: 268; Finger and Lobina 1999). Paradoxically, Thames Water argues that the UK Monopolies and Mergers Commission - that restricts British water firms merging - has hampered Thames Water’s ability to compete against rival French firms (Mail on Sunday 6 December 1998). In sum, the French giants have the upper hand in the global water industry, as a result of access to capital and long experience with contractual franchising agreements. Franchising is often more appealing to recipient governments than outright privatisation. Critics such as Finger and Lobina (1999: 182) argue that anti-competitive behaviour is the main strategy used, evident by rivals “colluding in foreign markets for specific projects in ad hoc transversal consortia”.

4.2.3 Other global players

Compared with the dominant French-Anglo players, firms from other OECD countries have a lower profile in the global water industry. A major reason for the lack of an American global presence in water is that the US industry is still largely in public ownership, with only about 15% of the American population served by private water companies (Masons 2000: 29-30). The United States also has the burden, as Tolhurst (1999) claims, of unnecessarily stringent public health regulations that are costly to met and provide no added health benefit. To encourage its domestic water industry to be more export focused, the US Department of Commerce (1996; 1997) has issued a series of reports identifying market opportunities in China, India and Eastern Europe. The large US aid program provides a suitable entry point for many firms (US Department of Commerce 1996; 1997). Some large American engineering consultancies are becoming more internationally active, especially in the Asian water services market (ABC Radio National 2003).
At present German water management companies are still minor compared to those from the UK and French. By 2000 the German utility company RWE had become a major player, with its purchase of a major stake of Thames Water and its takeover of American Water Works (The Economist 22 September 2001: 59-60). A number of German manufacturing companies are recognised exporters of innovative water treatment equipment (US Department of Commerce 1996; 1997). Germany has a tradition of having precision engineering industries. In addition, domestic demand for such products is partly because of the German government being a first mover in implementing stricter environmental legislation (Moore and Miller 1994; OECD 1996). Specialist water technology firms from Denmark and Netherlands have been identified as particularly aggressive in the Chinese market (US Department of Commerce 1996: 16). Some Italian companies are also seeking to internationalise their activities (Masons 2000: 29). The Spanish firm Aguas de Barcelona has global ambitions and is active in South America (Financial Times Newsletter 2000).

In the past decade, competition has emerged from Asian firms. Two Malaysian firms were active in Vietnam in the mid-1990s, building a plant to supply the government owned water company (Karp 1995). Singaporean firms are also active in the region, backed by a well coordinated government strategy (The Economist 1 February 1992: 82). Japanese firms have a low profile in water services because of strengths in manufacturing, rather than consultancy service exports (EDC 1995; OECD 1992; 1996). Japan was an early mover in pollution control and with MITI, the government-industry linkages were in place to establish a global presence. Japan has thus far concentrated more on air pollution control (Moore and Miller 1994; Broadbent 1998). The Southern Jiangsu Province in China has been identified as an emerging manufacturing centre for environmental technologies, although substantial exports are yet to develop (US Department of Commerce 1996: 15-16).
4.3 The development of Australian water industry exports

In the face of French-Anglo dominance of the global water industry, it might seem that Australian utilities, consultancy and supplier firms face an insurmountable task in trying to compete internationally. Nevertheless, Australia does have some exportable expertise in water technology and management. These include project management skills and manufacturing monitoring equipment (Davis 1996; Garman and Borton 1997). The challenge of water management in arid climates has fostered some expertise (EDC 1995; Smith 1998). By international comparisons the Australian water industry is small; yet this has not deterred some publications touting water expertise as a potential export industry (EDC 1995; Sheehan et al. 1995; SA Water 1996; EIDN 1996; 1999). This section presents a historical context of the development of Australian water industry exports. Government foreign aid projects provided early opportunities for private sector involvement. More recently, environmental regulations and institutional reform of the Australian water industry have indirectly influenced trade.

4.3.1 Beginnings: private sector involvement in foreign aid projects

Aid projects in developing countries continue to be an important source of demand for Australian water expertise (EDC 1995; AusAID 1996; Australian Overseas Aid Program 1997; Perkins 1997). The beginnings of water technology and management exports from Australia had roots in Australian foreign aid projects. The main official aid agency is AusAID (Australian Agency for International Development), until 1995 known as ADAB (Australian Development Assistance Bureau). AusAID is an autonomous bureau within the Commonwealth Department of Foreign Affairs and Trade, and is frequently referred to throughout this research.

While isolated events occurred in the 1960s, the use of Australian expertise for overseas water projects began on a regular basis during the 1970s. After the long period of national development during the post war years, the domestic market for civil engineering services was maturing (Smith 1998). Consequently, some of the larger consultancies and public works organisations began looking for overseas opportunities.
In the mid 1970s ADAB and the Snowy Mountains Engineering Corporation - an independent consulting firm established in 1970 to retain the engineering skills developed during the Snowy Mountains scheme - were jointly involved in African aid projects, for example, constructing wells in Tanzanian rural communities (Snowy Mountains Engineering Corporation 1986). By the mid 1980s prominent civil engineering firms, such as Coffey and Partners and Scott Furphy Pty Ltd, were working regularly with ADAB on water development projects (Bishop 1986; Goldfinch 1986). Technology transfer was emerging, with consulting firms engaging local counterparts (Bishop 1986).

Interestingly, aid programs involving Australian firms have historically had a good reputation for administrative and engineering competence, being noted for having an awareness of the moral and cultural sensitivities of the local community in the recipient country (Goldfinch 1986). The empirical work finds that this attribute is still relevant for creating competitive advantage (Section 7.2.3). Appropriate technology also continues to be an important attribute in technology transfer (Metcalf 1997). A problem identified with some early projects was inappropriate technology for developing countries because proposed solutions were capital intensive rather than labour intensive (Bishop 1986).

A chronological summary of some of the main projects undertaken jointly by ADAB and Australian consulting engineering companies during the 1980s is shown in Table 4.3. Part of the motive was initiated by the United Nations International Drinking Water Supply and Sanitation Decade (1981-1990) (Bishop 1986). One feature is the early development of collaborations between Australian firms and Asian counterparts. The use of a local partner to access opportunities in the recipient country remains an important method of export access (Gilchrist 1994; Garman and Borton 1997).
Table 4.3 Examples of early export development in the Australian water industry

<table>
<thead>
<tr>
<th>Description of project and time scale</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined sewer implementation project in Shanghai, China (part of a major Shanghai urban studies project) (1983 onwards).</td>
<td>ADAB, World Bank, Chinese government representatives, plus an Australian private sector firm.</td>
</tr>
<tr>
<td>Sewerage and urban drainage feasibility study (1981) in Malacca, Malaysia.</td>
<td>ADAB, Economic Planning Unit (Malaysia), Angkasa-GHD (Australian firm GHD’s Malaysian subsidiary).</td>
</tr>
<tr>
<td>Sanitation project, Mandalay, Burma (before 1986).</td>
<td>ADAB, plus Australian consortium lead by Coffey and Partners, also Scott and Furphy Engineers.</td>
</tr>
</tbody>
</table>

Source: Water March 1986: 24-44. Articles by Crockett et al. (1986); Edwards and Hazell (1986); Eggington (1986); Hanrahan and Oddie (1986).

Until the mid 1990s the Australian official aid program had a triple mandate of humanitarian, strategic and commercial goals, as recommended by the Jackson review (1984). The belief was that a multiple objective - perceived to be in the national interest - would make aid more palatable to taxpayers. However, an Australian Overseas Aid Program (1997) report (also known as the Simons review) argued that a triple mandate lacked focus and could create confusion about the exact purpose of aid. The report stipulated that AusAID should only have one objective: the reduction of poverty.

Previously, developmental assistance was often in the form of ‘tied’ aid (i.e. the recipient country receives aid on condition it uses goods and services from the donor country). The Simmons review argued that tied aid restricts the choice for the best use of limited funds, increasing cost and encouraging donor-driven supply that can be amiss of what the developing country really needs. The restructuring of the official aid program has been a controversial recent development for the water industry, given the history of private sector exports arising from aid programs.
4.3.2 Emerging manufacturers

The export history of Australian water technology equipment has had a lower profile than the export of consultancy services. Nevertheless, there have been some early successes. In 1983, a consortium of the CSIRO, ICI Australia and Austep developed an improved desalination system using thermally regenerated resins. Some export orders to Japan resulted (Department of Resources and Energy 1983:100). A significant development was the emergence of an Australian manufacturer - Memtec - which began in the early 1980s as a specialist in micro-filtration technology for medical uses. By the mid 1980s the firm decided to apply its expertise to water purification technology as stringent laws in the US had created a demand (Hanley 1999). Memtec become an international success and opened plants in the US, Europe and Japan. Since 1998 Memtec has been owned by Vivendi, although a manufacturing and R & D plant is still maintained at Windsor, NSW.

During the 1990s a number of other Australian manufacturing firms of water treatment equipment began to establish a global presence. These firms include Greenspan (water monitoring equipment) (QLD); CDS Technology (stormwater litter traps) (VIC); and Environment Solutions International (sludge digesters) (WA). (Note the diverse locations of these firms - the significance of this is analysed in Sections 6.3 and 6.4.) An important reason for the emergence of these firms has been changing domestic demand conditions because of stricter environmental and public health regulations. Recall that Section 3.5.2.2 discussed how such regulations can create demand. The empirical work explores how environmental and health regulations have influenced innovation in the water industry (Section 10.3.2). Until the 1990s, environmental regulation in Australia was often poorly enforced by water authorities. This has arguably discouraged innovation among local water technology manufacturers (Bainbridge 1997; ABC Radio National 1998).

4.3.3 Water industry reforms and the impact on trade

The development of the Australian water management and technology industry needs to be placed in the context of extensive water industry reforms during the 1990s. These reforms have dramatically restructured the industry. Water utilities have been
corporatised - that is, still owned by the state but accountable to the performance measures of the private sector. (Johnson and Rix [1993], for example, provide a critique of corporatisation.) Corporatisation has impacted on supplier firms and exposed the domestic industry to more international competition, including the entry of the French-Anglo giants (Bainbridge 1997; Tolhurst 1999).

The motive for reforms was the belief that public ownership models were economically unsustainable (Industry Commission 1992). Before reforms, Australian water utilities were state owned monopolies - usually conservative in their choice of technology and retaining design and construction of facilities in-house (Jackson 1996; Bainbridge 1997; Smith 1998). Reform of urban and rural water utilities was necessary as it was realised that capital improvement and technological upgrading would be hindered under a growing burden of debt. For example, by the early 1980s, Sydney Water Board was then costing A $ 560 million per annum (Beasley 1988: 210).

The Federal Government’s National Competition Policy in 1993 formed the blueprint for water industry reforms. This policy promoted microeconomic reform across a range of activities, with the assumption that greater economic efficiency enhances both the welfare of the community as a whole and the management of natural resources (Pigram et al. 1994; Nosworthy 1995; Jackson 1996; Smith 1998). The recommendations led to the Hilmer (1993) report, the conclusion being that government businesses (including water and energy utilities) should operate under the same competitive conditions as other commercial businesses. The implementation of recommendations was the task of various working groups of senior levels of Australian governments – known as COAG (Council of Australian Governments) (Smith 1998). Some COAG reports were specifically devoted to the reform of water resources policy (e.g. COAG 1995a). Among the reforms discussed were pricing reform, including removal of cross subsidies; allocation of water to the environment; water trading; clarification of property rights; and asset refurbishment. This cumulated in a 1995 agreement to substantially reduce the reliance on command and control methods of water management and rely more on market mechanisms.
The purpose of water industry reforms was to encourage domestic competition and to promote ecological sustainability (COAG 1992; 1995a; 1995b). Creating an export water industry was not an intention of the reforms. However, the expectation is that increased competition of utilities contributes toward competitive advantage and innovation (Industry Commission 1992). The second COAG report (1995b) considered the possibility of water service exports but did not elaborate: “It has been suggested that Austrade should work more closely with the industry in an endeavour to secure contracts in overseas markets for Australian water expertise. The Working Group considers the suggestion to be a worthwhile one” (COAG 1995b: 20: paragraph 10.2).

Yet in the intervening period, the evidence of success has been patchy. Bainbridge (1997: 17) believes that opportunities for domestic operators are more restricted since the reforms: “Australia’s key water authorities, internally focused on their own problems, have made Australia a customer for established technology from foreign suppliers (rather than procuring services from smaller domestic operators)”. Conversely, some commentators claim that the involvement of dominant global firms in the domestic industry is an opportunity. Specialist local firms can collaborate with the major firms to gain access to Asian water infrastructure projects (Wain cited Tolhurst 1999). Others see multinational dominance as a constraint on local firms, which lack the economies of scale and cannot compete (Griffiths cited Tolhurst 1999). The empirical work evaluates the impact of COAG reforms on the exporting industry (Section 10.3.1).

Since corporatisation, four Australian urban utilities have embarked on export development as an adjunct to their core business. ACTEW (Australian Capital Territory Electricity and Water Corporation) continues to actively pursue overseas contracts (ACTEW 1999). Sydney Water has an exporting unit - Australian Water Technologies - but it forms a minor part of Sydney Water’s overall revenue (Sydney Water 1999). Melbourne Water was initially involved in exporting consultancy services to Hong Kong. By 1996 the corporation decided not pursue exports, instead preferring to concentrate on its core responsibility as an urban water service provider (Sheehan et al. 1995: 156; Melbourne Water 1998).
SA (South Australia) Water is the only utility to actively pursue water industry exports as part of the objectives of reform. The South Australian government’s reason for targeting this industry is partly because the state’s arid climate has resulted in innovations in water management (p.c. Interview Codes #114; #115). SA Water’s charter, issued after corporatisation in 1995, stipulates as a major objective: “to facilitate, participate in and profit from the development of a viable, export-focused, vigorous water industry in South Australia” (Objective 3.1, cited SA Water 1999: 69). Examples of the utility’s exports include direct government-to-government support implementing water management strategies in West Java (SA Water 1999).

SA Water has attempted to develop exports by conditional contracts with multinational water firms (SA Water 1996). Two consortiums separately manage urban and rural water supplies, although SA Water retains ownership of the water infrastructure assets. This is a franchising style common to water management in France (Smith 1998). The United Water consortium, which manages Adelaide’s water services, comprises European rivals Compagnie Generale des Eaux (part of Vivendi) and Thames Water. An alliance has been formed between the rivals for this particular project. The consortium for rural water services - Riverland Water - consists of a British utility (United Utilities) in partnership with an American engineering firm (Smith 1998). An important condition of the contracts is that the concessionaires must export a certain proportion of their expertise and involve South Australian firms, such as contractors and equipment suppliers. SA Water (1999: 2) reports that exports of $122.4 million were generated between 1996 and 1999. Yet the term ‘export’ also applies to transfers of goods and services to interstate destinations (WIA 2000). Net overseas export revenues are not available in the account summary of SA Water’s annual report. The evaluation of the South Australian water industry export program is still preliminary. For example, Smith (1998: 276) concludes that more time is needed to evaluate the progress of export generation as a result of reforms in South Australia. Other commentators argue that the opportunities for local firms to ‘piggy-back’ on international consortiums to secure work in Asia are not as widespread as first believed (e.g. Macleay 1996; Wright, T. 1996; Coombes 2001).
4.4 What is known about Australian export development and institutional support

Providing a background in which to frame the empirical work requires reviewing what is known about export development in the domestic water industry. Section 4.4.1 undertakes this task. Section 4.4.2 describes some of the state and institutional bodies established to facilitate exports. (The descriptions are useful because the success of these institutions is empirically evaluated in Section 10.2.)

4.4.1 What the literature reports

Only a few articles describe how exports develop for Australian firms involved in environmental technologies, including the water sector. Moreover, because these reports are intended for a general readership, there is no analysis of how and why certain methods prevail. What is known is that exporting water management expertise requires extended contact between the negotiating parties. Gilchrist (1994) recommends a maximum interval of 5 to 6 weeks between visits, as it is necessary to maintain momentum. Having access to a local marketing manager is also considered indispensable. Particularly in Asia, it is paramount to establish business relationships that are underpinned by trust and commitment (Swinton 1994; EDC 1995; Metcalfe 1997; Perkins 1997). For the water industry, the main methods noted for export access are networks and strategic alliances such as research collaborations (Bergman 1996; 1997; Perkins 1997; Howlett 1998; EIDN 1999). Strategic alliances involve joint ventures or licensing agreements between organisations with complimentary skills or products. Alliances are common because they minimise the investment risk to individual partners (Section 3.2.3). However, choosing the right partner can be a challenge (Perkins 1997).

The cited literature also identifies competitive advantage and impediments to exports. Australian firms are internationally competitive in certain areas: project management, the treatment of wastewater, and manufacturing monitoring equipment (Davis 1996; Metcalfe 1997). In addition, favourable exchange rates and relatively low professional costs in Australia contribute to the ability of firms to submit attractive bids (Gebbie
The impediments to growing an export industry include a fragmented industry structure due to small domestic suppliers and undeveloped domestic supply chains. Coupled with these factors are short-term political agendas and ad hoc government programs (EDC 1995; Wright, T. 1996; Bergman 1997; Environment Australia 1998; Howlett 1997; 1998; EIDN 1996; 1999).

The industry is fragmented because Australian water industry firms tend not to develop alliances or networks (Garman and Borton 1997; EIDN 1999). Australian firms do not as readily form consortiums as the European firms do (Howlett 1998). Large Australian consulting groups lack the necessary market intelligence and relationships with the World Bank and other international aid and loan agencies, compared with North American and European counterparts. Another obstacle is that Australia is not generally perceived in Asian markets as a leading high technology provider (Garman and Borton 1997). A further problem is that the marketing culture for this industry is undeveloped (EDC 1995). Harvey (1983) reports that for Australian engineering consultancies, business development until the 1970s was expected to occur even with restrictions on competitive bidding and advertising; the belief was that marketing debased the value of the profession.

A strategy for export development, based upon the experiences of the Cooperative Research Centre for Waste Management and Pollution Control (CRCWMPC), is described in Table 4.4. The strategy has no theoretical underpinning, instead serving as a sequential method for securing export contracts. The method has proved successful in several cases, with the CRCWMPC active in research and commercial collaborations overseas (CRCWMPC 1999). A catalyst for collaboration is often due to a visiting scientific delegation. Knowledge transfer and possible commercial contracts can result (Garman and Borton 1997). This, however, is not a recent realisation. For example, in 1979 a delegation of Chinese scientists visited Victoria and South Australia to investigate the use of reclaimed water for irrigation (Smith 1979). Yet it is only in recent years that organisations such as Cooperative Research Centres have been formally established to
nurture the collaborations that can eventually lead to commercial agreements and
technology transfer.

### Table 4.4 A strategy for developing market access

| 1. Use of government-to-government agreements (e.g. signing Memorandums of Understanding). |
| 2. Use of seminars, workshops and demonstration projects in the recipient country to present leading edge technologies in selective market niches. |
| 3. Development of exchange programs (6-12 months) with academic and industry participants in areas of common interest. |
| 4. Use of business facilitators to match Australian providers with potential partners. |
| 5. Development of commercial links through mechanisms such as joint ventures and licensing. |

*Source:* summarised from Garman and Borton (1997).

#### 4.4.2 Types of institutional support

A number of public and private sector institutions facilitate industry development and exports. Institutions form part of the external determinants that influence the firm (Section 3.5.3). This section describes the relevant government programs and organisations that contribute to export development for the Australian water industry.

Arguments over the benefits or costs of institutional support are usually determined by ideology - whether the commentator supports a neo-liberal or corporatist state model (e.g. compare Mortimer 1997 with Brain 1999). The empirical work assesses the usefulness of these programs and organisations, relevant to export development in the water industry (Section 10.2).

Table 4.5 summarises the main Federal Government programs. Australian State Governments also have programs, administered mainly by economic development agencies. The questionnaires used for this research list the relevant programs for different States (Appendix B Display B.1). Note that government programs are subject to rapid change and can be quickly superseded. Table 4.5 is not comprehensive - it serves as an overview of the programs available to exporting water industry firms during the 1990s. A number of programs had been discontinued by 2000. The Howard Coalition Government has terminated or streamlined several programs (Table 4.5). The reduction of the R & D tax concession in 1997 from 150% to 125% has been criticised as detrimental to
international competitiveness (e.g. Larkins 1997; Lowe 1997). A controversial move has been the termination of DIFF (Development Import Finance Facility) - a soft loans export scheme of tied aid. The defenders of the scheme argued that DIFF had a fourfold multiplier effect for every dollar spent, enabling some companies to break into new overseas markets (EDC 1995; AusAID 1996; Yu 1997). Other reports asserted that DIFF was unsuccessfully juggling competing objectives of developmental assistance in recipient countries with the commercial interests of Australian firms (Australian Overseas Aid Program 1997: 201-202). Regardless of domestic developments, Australia’s OECD competitors have a legacy of active government programs to promote exports of environmental technologies (Moore and Miller 1994; United States Department of Commerce and Trade 1996; 1997; United States Environmental Protection Agency 1998).
<table>
<thead>
<tr>
<th>Name of organisation administering program</th>
<th>Name of program</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AusIndustry (branch within Department of Industry, Tourism and Resources [DITR])</td>
<td>R &amp; D tax concession programs</td>
<td>* 125% tax concession for investment in R &amp; D. Reduced from 150% in 1997.</td>
</tr>
<tr>
<td></td>
<td>Innovative Investment Fund Program</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enterprise Development Program (discontinued 1998)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Business Networks Program (discontinued 1998)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Australia-China Collaborative Program in Environmental Technologies (discontinued 1997)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Provides grants for R &amp; D projects up to 50% of eligible project costs. Provides access to equity capital for small new technology firms.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Research and educational exchange programs.</td>
</tr>
<tr>
<td>AusTrade (independent commission associated with Department of Foreign Affairs and Trade [DFAT])</td>
<td>Export Access Program</td>
<td>* Provides training, market research and practical assistance to small and medium enterprises (SMEs). Includes grants for costs associated with exports such as promotions.</td>
</tr>
<tr>
<td></td>
<td>Export Market Development Assistance</td>
<td>* Loans and insurance to protect inexperienced exporters against payment defaults by overseas clients.</td>
</tr>
<tr>
<td></td>
<td>Export Finance and Insurance Corporation (EFIC) assistance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Export Facilitation Loans Program</td>
<td></td>
</tr>
<tr>
<td>Environment Industries Focus Unit (EIFU) (branch within Environment Australia)</td>
<td>Environet database</td>
<td>* Identify, develop and expand commercial opportunities, both internationally and domestically.</td>
</tr>
<tr>
<td>Administered by Commonwealth EPA (predecessor to Environment Australia) and AusAID</td>
<td>Environmental Cooperation with Asia Program</td>
<td>* Reports include identifying export opportunities for Australian environmental technologies and services in Central Europe and China.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Database to promote Australia's environmental management and technology expertise by providing information to potential clients.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Aim to increase awareness in Asia of Australian environmental expertise. Grants for short-term projects (demonstration plants, workshops and seminars) (discontinued in 1997).</td>
</tr>
<tr>
<td>AusAID (autonomous branch of DFAT)</td>
<td>Development Import Finance Facility (DIFF) (Discontinued in 1996)</td>
<td>* ‘Soft’ loans program to assist developing countries undertake high priority public sector projects. Tied to provision of capital equipment and services imported mainly from Australia. Discontinued because it was costing 15% of aid budget.</td>
</tr>
<tr>
<td></td>
<td>Private Sector Linkages Program</td>
<td>* Grants to encourage participation between Australian and Asian firms such as training and demonstration sessions.</td>
</tr>
</tbody>
</table>

Table 4.6 lists organisations that contribute to the institutional support of the industry. The list is confined to the organisations relevant to the water technology and management industry. Generic institutions such as regional chambers of commerce, business associations and financial institutions are not included, although they contribute to the institutional capacity of regions and indirectly influence the exporting prospects of firms. Note that most the organisations listed have been established during the past decade. This reflects the growing awareness of the potential economic importance of the environmental industry. Part of the purpose of these organisations is to help small Australian firms overcome obstacles to internationalisation, such as lack of market information, lack of contacts, a small domestic market, and fragmentation between domestic firms. The organisations are mainly funded by memberships, although AUSTEMEX and WIA do receive some government assistance.
Table 4.6 Organisations relevant to export development of the Australian water technology and management industry

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Objectives and tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIDN (Environment Industries Development Network) (established 1994)</td>
<td>Set up as an independent proprietary limited company but under contract to the Commonwealth Department of Industry, Tourism and Resources. EIDN disseminates environmental industry market information, and assists the international marketing of Australian environmental products/ services by networking, attending and hosting delegations. It facilitates collaborative research projects with Australian and overseas institutions.</td>
</tr>
<tr>
<td>AWA (Australian Water Association) (was the Australian Water &amp; Wastewater Association [AWWA] until 1999) (established 1962)</td>
<td>Traditionally mainly concerned with water engineering issues, AWA’s agenda has expanded to include public health, environmental and business concerns of the water industry, and to act as a knowledge disseminator.</td>
</tr>
<tr>
<td>EMIAA (Environment Management Industry Association of Australia (established 1991)</td>
<td>EMIAA task is to identify business opportunities domestically and overseas, and to integrate environmental goods and services into commercial supply chains. EMIAA provides national and international intelligence on strategies and opportunities, and organises and participates in international trade fairs and conferences.</td>
</tr>
<tr>
<td>AUSTEMEX (Australian Environmental Management Export Corporation) (established 1992)</td>
<td>As a joint venture between EMIAA and Austrade, AUSTEMEX is intended to specifically promote the Australian environment industry overseas, having access to Austrade resources. AUSTEMEX has not been active since about 1997.</td>
</tr>
<tr>
<td>OPCV (Overseas Project Corporation of Victoria) (established 1985)</td>
<td>Set up by Victorian Government but run as a private corporation, OPCV’s charter is to facilitate participation in overseas development projects with the private and Government sectors. As well as water resource expertise, OPCV also arranges project financing, management expertise, education and training. Part of OPVC’s function is to assist in negotiating finances with local and overseas agencies.</td>
</tr>
<tr>
<td>WIA (Water Industry Alliance) (established 1998)</td>
<td>Established by the South Australian Government after SA water contracted out water services to largely foreign consortia, WIA is funded by members and the SA government and is intended to specifically promote water industry exports for SA firms. WIA disseminates information and attempts to create a node for networks to form within the industry by partnering local firms with complimentary skills.</td>
</tr>
</tbody>
</table>

Cooperative Research Centres (CRCs) are also important organisations that act as a linkage between research organisations and the private sector. CRCs are over a decade old, with approximately 60 CRCs involved in a wide range of interests (CRCWMPC 1999). A strong reason for their establishment was Australia’s low levels of industry-funded research, poor linkages between R & D and business development, and a disappointing legacy of promising research often transferred overseas to be developed (Fegus 1996; Cullen 1997; Button 1998; Brain 1999). The funding of CRCs is a hybrid of government and private enterprise support, involving university partners, the CSIRO, publicly funded laboratories and firms. Five CRCs specialise in water technology and management, involving firms that are prominent players in the Australian industry. The CRCWMPC is particularly active with overseas research collaborations, and is strongly commercially oriented as it operates as an incorporated company owned by its members (Fegus 1996). Several of its products and areas of expertise, such as monitoring devices and wetland construction, have gained export markets.

The consensus is that CRCs act as important linkages in an economy where venture capital for innovative start-up firms is not well developed (Fegus 1996; Brain 1999). However, CRC programs have been threatened with termination by, arguably, myopic reports such as the Mortimer Report (1997) that suggests diverting funds from research into direct industry and business support (Australian R & D Review 1997b). Cullen (1997) and Larkins (1997) warn that this would be disastrous for long-term research and commercialisation.

### 4.5 Conclusion

Chapter 4 has provided a background to the water industry. It has defined the water technology and management industry, necessary because of the lack of official definitions. International comparisons are not possible; this is one factor why the research of this thesis is confined to the Australian industry. Another purpose of Chapter 4 has been to describe the global setting and provide a historical account of export
development for the Australian water industry. Establishing the context helps in understanding some of the reasons for, and implications of, the empirical findings.

A third purpose of Chapter 4 has been to provide a description of the types of state and institutional support relevant to the industry. This has revealed some of the elements of institutional support and the national innovation system that form part of the external environment to the firm. The information in Tables 4.4 and 4.5 is used in the questionnaire designs discussed in Chapter 5.
Chapter 5
Research methods: the philosophy, development and application

The purpose of this chapter is to discuss the research methods that are used for the empirical investigation of the Australian water industry. Because of the paucity of published information about how trade develops in this industry, it is necessary to develop methods to collect information directly from the relevant firms and organisations. The methods comprise postal questionnaires and interviews that act as tools designed to extract the information required to answer the research questions (Table 3.3). The chapter begins with a discussion of philosophical ideas that underpin the research. This is an important foundation because the assumptions that frame knowledge should be made explicit. As Yeung (1997b: 55) states: “Methods are surely important, but their importance cannot be exercised unless they are supported by strong philosophical claims at the ontological and epistemological levels”. Critical realism is outlined as a suitable framework and its application is justified. Its limits are also acknowledged. Section 5.1 is not a detailed exposition of the philosophy but serves to sketch how critical realism provides useful insights for this research. Section 5.2 describes how the research was developed. It explains choices about the use of surveys and interviews, and which firms and organisations to include in the sample. The rationale for the questionnaire design is also discussed. Critical realism’s tenet of reconceptualisation is evident in the evolution of the research. The practicalities of applying the methods are discussed in Section 5.3. Evidence is also presented to demonstrate that the sample is representative of the Australian water industry. The conclusion - Section 5.4 - discusses how this chapter contributes to the work in other chapters.
5.1 Philosophical underpinnings: using critical realism to inform the research

Since the demise of quantitative dominance in geographic research, the past three decades have seen a body of work exploring the philosophical underpinnings of geographic knowledge. Critical realism is one such interpretation. A succinct definition of the philosophy is offered by Gregory (1994b: 499, emphasis in original): “Realism is a philosophy of science based on the use of abstraction to identify the (necessary) causal powers and liabilities of specific structures which are realised under specific (contingent) conditions”. The development of critical realism is discussed in a number of influential publications (Urry 1981; 1983; Bhaskar 1975; 1979; 1986; Harre 1986; Outhwaite 1987; Sayer 1982; 1985; 1992; Collier 1989; 1994). The original intention of the philosophy was to offer an alternative to positivism and Marxist approaches. The purpose here is not to revisit these familiar debates (Johnston [1986] and Cloke et al. [1991] provide comprehensive overviews), but instead outline the essence of the critical realist approach and justify why its insights are useful for this research.

5.1.1 Critical realism outlined

The philosophy of realism has its origins in Platonic-Socratic thought that maintains a real world exists, independently of our perception and cognition of it (Cloke et al. 1991). The contemporary interpretation - critical realism - is an acknowledgement of a real world outside human cognition but that there is a multi-layered interpretation (known as the realist ontology). Reality comprises not only events (i.e. empirical particulars as in the world that we experience), but also mechanisms and structures (i.e. sets of internally related objects or practices) that generate phenomena which are intransitive in the sense that such objects exist and act independently of their identification (Cloke et al. 1991; Gregory 1994b; Sayer 1992). While some things are ‘real’, they are only knowable through our concepts of them (known as the realist epistemology). Causal powers exist by virtue of the nature of the objects which posses them; however, it is contingent whether they are activated or exercised. An example relevant to this research is that networks can facilitate trade but this is contingent on the desire of the actors involved. It
is not a ‘necessary’ or internal relationship as there can still be networks without trade. With different contingent conditions, the same mechanism might invoke different events, or the same kind of event may have different causes (e.g. the export of water management expertise might be through an informal network relationship, a government aid program, or combination of both). “The realist task is to tease out the causal chains that situate particular events within deep-seated mechanisms and powers” (Cloke et al. 1991: 148). Social objects (e.g. political parties, government institutions and MNCs) are conceptualised and abstracted at multiple levels, including geographic scale, and have powers and liabilities capable of generating events at different levels of reality. Concomitant with the concept of multiple realities is the recognition that it is within these levels that the dialectics of agency and structure operate (Sayer 1992; McGrath-Champ 1993: 69-70). Actors do not operate as atomistic individuals; rather they operate within the constraints of a larger structural framework that include political influences, social conventions, legal frameworks and capital flows. This point is elaborated below.

5.1.2 Justification for a critical realist philosophy

Critical realism is chosen as suitable for this research for four reasons. First, reviews of philosophical approaches in human geography (e.g. Cloke et al. 1991; Johnston 1986; Sayer 1982; 1985; 1992) highlight how realism searches for causality in an event or process, rather than regularity, generality, or extent of phenomena. As Sayer (1985; 1992) stresses, what causes something to happen has nothing to do with the number of times it happens. Applied to this research, just uncovering regularities in the development of trade for an industry - for instance, by finding a correlation between exports and R & D expenditure - does not explain what causes a firm to export. Explaining the mechanisms that cause trade needs to go beyond identifying quantitative regularities.

Second, realism treads the ‘middle ground’ of the agency-structure process. It attempts to combine structuralism (e.g. interpretations of Marxism) with humanism (e.g. aspects of behavioural geography) (Johnston 1986; Sayer 1992; Gregory 1994b). The recognition of a dialectical interaction between structure and agency is useful for understanding some aspects of an explanatory framework of trade. The networks that facilitate inter-firm trade
are an example that illustrates this concept. Recall that Section 3.4.5 described networks as behaving as a ‘liquid’, in that agency interacts within structural determinants.

Third, realism is useful as a philosophy that can guide a research method, although as Yeung (1997b) stipulates, realism it is not a research method (or methodology) itself. The acquisition and interpretation of knowledge depends on existing frames of reference. In practice, the accumulation of new information influences subsequent questions and the rethinking of concepts. Method and theory are dialectically related - both inform the other (Urry 1981; Sayer 1985; 1992; Pratt 1995). Research is a process of re-conceptualisation. Importantly, the quest for causal processes means that realism is suited to open systems - particularly social systems where there are continually changing mechanisms and events. Conversely, closed systems are more suited to positivism where it is assumed that there are constant mechanisms for causing regularities.

A fourth justification for the philosophy’s suitability is that there continue to be vibrant discussions of critical realism in contemporary geography, despite being widely covered in the literature from the 1980s. The resolution of philosophy and method still generates research. Recent examples are Pratt’s (1995) discourse on the problems of applying critical realist philosophy in practical research instances; Yeung’s (1997b) discussion of methodological guidelines grounded in the philosophy; and critiques by Gandy (1996) and Proctor (1998) of post modernist engagement with environmental issues, arguing that critical realism is a more suitable framework. Likewise, the philosophy can be useful for a contemporary study of trade. This claim is appraised in Section 11.3.1.

### 5.1.3 Critical realism applied

The philosophy of critical realism influences the methods used for empirical work in three ways:

1. The philosophy states that empirical work is necessary, not simply to apply theory or test it, but as an essential input into the development of theory. The research is assessed and re-conceptualised as it proceeds, always open to revision and reformulation of what is real as different properties of a situation or process come to light (Sayer 1985; Cloke et
al. 1991). The empirical work helps crystallise different strands of theoretical knowledge. Applied to this research, concepts that are initially unclear (to the researcher) are gradually clarified as empirical material is processed and analysed. This influences subsequent survey and interview stages, which in turn, influence the literature reviewed and incorporated into an existing and evolving framework of understanding. Applied to this research, the strands considered important for understanding trade have evolved from an interaction of theoretical development with empirical interpretation. While a theoretical framework has been established in Part One, it is revised in Chapter 11 after the empirical analysis in Part Three. Although the research is organised and written as a linear development, in practice its development has been one of interaction between theory and evidence.

2. Different methods are acceptable: quantitative and qualitative approaches that embrace extensive methods (i.e. discovering common properties, empirical regularities and generalisations) and intensive methods (i.e. concern with reconstructing the causal chains that connect social structures, social practices and individual agents in particular contexts). Each approach has limitations that can diminish explanatory power. For intensive methods the actual concrete patterns and contingent relations are unlikely to be ‘representative’, ‘average’ or generalisable. The limitations of extensive methods are that they are not always generalisable to other populations at different times and places (Cloke et al. 1991; Sayer 1992). Yet when combined, these approaches can be complementary rather than rival. Layder (1993) asserts that a realist approach offers a more flexible and multidimensional approach, accommodating both macro and micro level analysis. “A multi-strategy approach actively encourages the use of quantitative data and forms of measurement in order to complement the central core of qualitative analysis” (Layder 1993: 127). The empirical work of this research (Part Three [Chapters 6 – 10]) uses both extensive methods (by surveys) and intensive methods (by interviews). The analysis involves both quantitative and qualitative data that function in a complementary way. Yeung (1997b) stresses that it is necessary to compare and contrast different sources of findings if they are addressing the same phenomenon. Material from different methods is used as illustrations of the ‘facts’ or as an explanation.
3. The philosophy stipulates that the researcher is aware that knowledge is filtered through culturally constructed belief systems and integrated with the researcher’s own interpretation of reality (Outhwaite 1987). In Proctor’s (1998) interpretation, the nature of knowledge involves partial truths with some social explanations being more adequate representations of reality than others. The researcher is embedded within a particular intellectual and institutional context, thus he or she needs to recognise their own representation. There are separate realities, whether the observer/researcher exists or not, but interpretation of these realities depends on the researcher’s frame of reference or meaning. For example, trade occurs between firms but the interpretation of the causation depends on my frame of reference as the researcher. At a practical level, this implies that the researcher can never be detached but lies somewhere between the extremes of observer and participant. In conducting this research I was an outsider to the industry studied. This had a bearing on the information received - some interviewees would have been more open, conversely some would have been more guarded. Also, the methods I applied changed as my understanding of the industry increased. Thus some early questions became quickly redundant; conversely, other questions that could have been useful were not asked - either early on or at all - because the knowledge to formulate those questions was lacking.

5.1.4 Limitations

The application of critical realism has attracted several criticisms. There is the question regarding how to determine what are necessary and what are contingent relations. The philosophy’s eclectic nature has brought the charge that its epistemology is set at such a generalised level that theoretical contradictions are likely to occur as soon as it is applied to concrete situations (Cloke et al. 1991). There are other claims that critical realism is not new, as some of its assumptions have already been internalised with prior approaches, notably humanism and structuration theory (Cloke et al. 1991). One inherent contradiction is that realism allows the ‘real’ to become the ultimate judge of theory, meaning traces of empiricism can be found within what is supposedly itself a critique of empiricism (Cloke et al. 1991). Furthermore, Pratt (1995) sees the interrelation between
theory and method as undeveloped. In his view critical realism needs to achieve a
dialectical mediation between philosophy (concerning ontology and epistemology) and
the social sciences (concerning theory and methodology).

This discussion does not attempt a philosophical dissection to address these limitations.
Rather, the usefulness of the philosophy is appraised in Section 11.3.1. This chapter turns
to the development of the research, with the understanding that critical realism provides
an ontological and epistemological foundation for the methods.

5.2 The development of the research

This section describes how the research was designed and developed. It begins by
justifying why surveys and interviews are chosen as suitable methods for extracting
information. It then describes how the sample was identified and the rationale behind the
questions. The chronology of the research is outlined. The development of the research
adheres to the tenets of critical realism, such as using a combination of methods and re-
conceptualising the research as processes are uncovered.

5.2.1 Choosing appropriate techniques: issues of breadth versus depth

Research informed by critical realism accommodates intensive and extensive methods,
allowing both breadth and depth with the investigation. A combination of mail surveys
and interviews was chosen as suitable for this research. Section 5.2.1 firstly makes
explicit the assumptions about the accuracy of these techniques and justifies their
choices. It then outlines the advantages and limitations of each approach and asserts that
a combination of approaches can be complementary.

A fundamental assumption about methods in social sciences is that if enough individual
experiences are aggregated to the point where the information is becoming repetitive,
then an understanding of how a process or event unfolds should emerge (Sayer 1992;
Robson 2002). This is based on the premise that the most accurate knowledge individuals
possess is that of their own personal experience. Relevant to this research, those people
whose daily work, for example, is directly involved in procuring export contracts and
organising the transfer of their firm’s water-related goods and services to overseas locations, are assumed to be the best source of accurate information about this type of trade at the micro-level. These individuals are most knowledgeable of their own experience when dealing with clients, governments, financiers and various other actors. This assertion, however, is still mindful that the experiences of these individuals only represent a partial truth of the complex processes that explain trade.

There are several well-reported methods to gather information of individual experiences. These include surveys and interviews, ethnographic research and participant observation (Silverman 1985; Robson 2002). Participant observation has merits, being prominent in sociological studies, including business behaviour (Silverman 1985; Zhou 1996). However, for this research it is considered impractical for two reasons. First, as the researcher, I am an ‘outsider’ to this group, having had no prior industry contacts. It would therefore be intrusive of me to be present at meetings that involve an often lengthy and sensitive process of trade negotiations between an Australian firm and their Asian client. Second, even if permission was forthcoming to be present at trade negotiations, it would be possible - given logistic restraints - to spend time with only a few key players. While an intensive study would likely result, the limited number of cases is unlikely to be widely representative of the industry. Moreover, the time spent attending meetings might not justify the quality of information. The desirable strategy is to use methods that can generate sufficient information without being intrusive on the subject’s time or space.

Questionnaire surveys and interviews are the more practical methods, although both approaches have advantages and disadvantages. Questionnaires distributed by mail have a number of advantages, discussed in numerous studies (e.g. Dillman 1978; Feitelson 1991; Robson 2002). Advantages include widespread geographic coverage, the lowering of sample error because of a generally larger sample size, and the ability of closed-ended questions to reveal sufficient information. A comparison of mail surveys with personal interviews is made by Feitelson (1991), who concludes that mail surveys can be a viable, inexpensive alternative. The disadvantages include insufficient depth and problems with low response rates (Robson 2002). Careful design with follow-up requests, however, can
result in response rates of over 60% (Dillman 1978; Feitelson 1991; Robson 2002). To ensure a higher return rate, common sense approaches include avoiding ambiguity in questions and using stamped self-addressed envelopes (Payne 1951; Dillman 1978). In addition, questionnaire surveys designed to avoid sensitive, confidential and difficult questions can increase response rates, although this can also curtail the depth of information. Yet even with the most careful designs, several problems remain. For example, survey responses may be biased toward respondents with an interest in the research topic (Feitelson 1991), there may be miscomprehension by respondents, and subtle variations of question wording can produce very different answers (Payne 1951; Dillman 1978).

Interviews have the advantage of probing issues in more depth and revealing the complexity of relationships, whereas this can be very difficult to achieve in a survey (Schoenberger 1991). However, the direction of the interview still depends on the wording and delivery of the question (Payne 1951). Zhou (1996) notes that interviews give some account of changes over time, whereas surveys are basically snapshots of one time. Interviews are useful both before and after undertaking a survey. The two approaches are complimentary in that pre-survey interviews are crucial to questionnaire design, whereas post-survey interviews can supplement the survey information and inform the interpretation of the results (Zhou 1996).

Some commentators view questionnaire surveys and interviews as dualistic, such as Brannen’s (1992) simplistic assertion that qualitative approaches view the world through a wide lens and quantitative approaches through a narrow lens. Qualitative approaches are presented as soft and subjective, an anecdotal supplement to real science. Yet other commentators (Yeung 1997b; Winchester 1996) emphasise that interviews are not merely adjuncts to quantitative methods. Winchester (1996) argues that the validity of qualitative interviews does not rest on their representativeness or whether they are capable of generalisations in an empirical way but rather, whether they can help elucidate the structures and causal mechanisms that underpin observable behaviour. Qualitative interviews are essential to a critical realist approach (Sayer 1992). Warwick (1983),
Schoenberger (1991) and Layder (1993) highlight that a combination of methods increases the chances of militating against the biases of a single data source. While acknowledging the limitations inherent in each approach, the empirical work combines surveys and interviews to seek the causation of trade.

5.2.2 Identifying the sample and information sources

Conducting a comprehensive study of trade development for a single industry in one country presents challenges, especially if the industry is not large compared to the major global players. Deliberate targeting is required to maximise the sample size because random selection probably will not generate a representative sample.

The main publication used for identifying firms and organisations involved in the Australian water industry was the AWA (Australian Water Association) annual water directory (AWWA 1998; 1999; AWA 2000). This directory provides the most comprehensive listing of water industry firms in Australia. It includes a brief background of each listed firm and whether the firm is an exporter. The directory also includes contact names of key personnel in the firm. Having specific contact details is important for ensuring a good response to survey and interview requests. Additional knowledge of the industry came from other AWA periodicals – the monthly Water journal and Cross Currents, and the internet-based Waternews (www.awa.asn.au). This material provides information about current business developments, giving an idea of which firms are most active overseas. Although the main focus of the field work was exporting firms, particularly Australian-owned, the intention was to also include other prominent or smaller firms that did not export. These could serve as a comparison with the exporters. Having an equal number of exporters and non-exporters was not the intention. Rather, because of the small size of the industry, the strategy was to target as many firms as possible with an emphasis on exporters, but also to include non-exporters.

Other sources of supplementary information were Kompass Australia (1999; 2000) and Business Who’s Who of Australia (1999; 2000). These business directories provided useful basic quantitative information for most of the larger, and some of the smaller
firms. The information includes annual revenue, number of employees and the year established. This was useful for the survey implementation because when available for a firm, the details were recorded on the questionnaire prior to being sent to that firm. This made the questionnaire more user-friendly as the respondent did not have to fill in information that was available in the public domain. Other minor sources of additional knowledge of the industry were company web-sites and on-line annual reports, as the research was conducted during a time when web-sites were proliferating. Although some preliminary overview of companies could be gained by web-sites, detailed information was lacking, other than on-line annual reports for the handful of public companies. Conversely, the web-sites of government departments proved to be useful, as relevant reports (e.g. reviews of industry assistance schemes) could be accessed. Overall, the combination of AWA material, business directories and web-sites was useful for background research. It allowed for a succinct questionnaire design because unnecessary questions could be eliminated. It enabled better preparation for interviews so that intelligent lead-in questions could be asked. Being well informed about a firm before an interview is an essential strategy in corporate interview methods (Schoenberger 1991).

5.2.3 Choosing which entities to survey and which to interview

For the first 5 firms sampled, both a survey questionnaire and an interview were attempted (Table 5.2). However, it was soon apparent that this method would place unnecessary demands on the participants. Moreover, the combined methods might not guarantee added insights. It was necessary to decide which firms to survey and which to interview. The choice was dictated by the following criteria:

1. Where practical, interviews were the preferred method with major exporting firms (both manufacturers and service providers), research and industry organisations, and government departments. Interviews were conducted in Melbourne, Sydney, Canberra, Perth and Adelaide.

2. Four interviews were conducted with non-exporting firms, two of which were prominent in the domestic industry. It was reasoned that some interviews should be with non-exporting firms to ensure a representative interview sample.
3. Surveys were generally conducted with smaller manufacturers and service provider firms, usually non-exporters. In general, firms that were exclusively distributors of imported products were not included in the sample. However, in some cases a firm was both an on-site manufacturer and a distributor, hence it was included.

4. Surveys were used exclusively for firms in Queensland, including prominent exporters, as well as for the majority of firms in South Australia and Western Australia. This was because widespread interviews would have been impractical.

5. Three interviews and one survey were conducted with the commercialised arms of four large water utilities that pursue international markets. Most Australian water authorities were not included because they do not seek export markets.

5.2.4 Design of the questionnaires

The choice of questions in the surveys and interviews arises from the unknown or contentious issue identified in the theoretical development discussed in Part One. Table 5.1 describes how the theoretical strands generate the research questions, which in turn influence the development of survey and interview questions. Because the theoretical and empirical work evolved together, questionnaires do not emulate exactly the research questions. For example, there is no direct question about networks but this theme is explored in questions addressing the formation of export contracts. A consistency, however, has been maintained between the general theoretical themes and those covered by questionnaires.

Examples of survey and interview questionnaires are found in Appendix B (Displays B.1 and B.2). There are both closed-ended (e.g. ‘When did the firm begin exporting?’) and opened-ended questions (e.g. ‘How does this export trade develop?’). The interview questionnaires are not as tightly categorised as the surveys; this was deliberate so interviews could remain semi-structured. Interview questions depended on the entity being investigated, with different questionnaires for research institutions, consultancies and government departments (Appendix B [Display B.2]). Interviews could also investigate the history of the firm, how competitive advantage develops, and how corporate strategies change over time. Surveys were more restricted in investigation. A
consistency, however, was maintained in the language level and terms used in the surveys and interviews. It was assumed that the respondents were of a relatively similar educational level (i.e. usually graduates) so there was no need to drastically alter the language level or define basic business terms for individual cases.

5.2.5 Evolving research design

Critical realist philosophy stresses that theories and methods should inform each other, evolving as new knowledge comes to light. This research adheres to this tenet because the design of questionnaires proceeded in a number of stages (Table 5.2), with each stage informed by the accumulation and refinement of new empirical and theoretical knowledge. The reporting of research can give the impression of a well-planned, sequential strategy without setbacks. The reality with this research, however, is that of an emergent strategy with improvements as experienced was gained. The original intention was not for so many stages but possibly a pilot survey followed by a main survey - with the entire process completed within a few months. The reality was a more convoluted process, taking longer than expected. The result, however, produced a rich source of empirical information. Strategies are learnt by experience; for example, it was found that the telephone was not useful as a tool to initiate surveys or conduct interviews (see Section 5.3.1).
### Table 5.1 Relationship between theoretical strands, the research questions and questionnaires

<table>
<thead>
<tr>
<th>Theoretical strand (Part One: Chapters 2 &amp; 3)</th>
<th>Relationship with research questions (from Table 3.3)</th>
<th>Theme in survey/ interview questionnaires</th>
<th>Relevant survey/ interview questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a. Industrial organisation (1a is subset of competitive advantage because industrial organisation investigates linkages and clusters)</td>
<td>What are the characteristics and industrial organisation of the industry (i.e. firm-size; age; type; locations; ownership; supplier linkages)? How strong are linkages between related and supporting industry for firms in the water industry?</td>
<td>General information about the firm</td>
<td>Questions on revenue; year established; no. of employees; type of ownership; main commercial activities? From where are the main components sourced? Where do contractors/ equipment suppliers originate from when the firm is doing overseas work?</td>
</tr>
<tr>
<td>1. Competitive advantage and corporate strategies</td>
<td>How is competitive advantage created for firms in this industry? What types of corporate strategies are used and why? Is there a relationship between export performance measures and innovation proxies for water industry firms? What are the internal and external sources of innovation for firms in this industry?</td>
<td>Product development and competitive advantage (relevant to manufacturers) Development of expertise (relevant to service providers)</td>
<td>How is innovation/ technical knowledge acquired? What is the R &amp; D expenditure? What has been the influence of legislation and cleaner production trends on product development? What gives the firm/ organisation competitive advantage over its competitors, particularly foreign rivals?</td>
</tr>
<tr>
<td>2. Innovation creation and acquisition</td>
<td>How are export markets accessed and networks of trade contacts formed? Are there spatial barriers to forming networks and trust, especially for smaller firms?</td>
<td>Exports</td>
<td>Does the firm export and to where? If no, why? Why did the firm decide to export? How are export contacts made? Who approached whom? Year of first exports? Export turnover? What has been the impact of the Asian economic crisis?</td>
</tr>
<tr>
<td>3. The function of networks for market access</td>
<td>How does the state directly and indirectly influence trade for firms in this industry? How effective are industry associations for facilitating trade?</td>
<td>Government and industry association facilitation</td>
<td>Have COAG reforms had an impact? What product development and export facilitation programs have been used? How satisfactory were they (i.e. rating out of 5)? What industry associations have been used? How effective were they (i.e. satisfaction rating)?</td>
</tr>
</tbody>
</table>

**Note:**
1. Not all the research questions from Table 3.3 are included in Table 5.1. Rather, only the foundational questions are shown.

**Source:** Derived from Table 3.3 and author’s questionnaire design (see Appendix B).
Table 5.2 Chronicle of the research stages

<table>
<thead>
<tr>
<th>Time frame of research stage</th>
<th>Outcome (comments; response rates)</th>
</tr>
</thead>
<tbody>
<tr>
<td>May - June 1998 draft questionnaire for approval by ethics committee.</td>
<td>First questionnaire design. Ideas for the types of questions derived from literature and government department industry surveys.</td>
</tr>
<tr>
<td>July 1998 Perth interviews and questionnaire survey (Version 1) Note: Perth was chosen because I was visiting for a conference so took the opportunity to begin the fieldwork while there.</td>
<td>Interviews with 5 firms and trialled the survey questionnaire. It was realised the combined interview/survey method with each firm would be impractical. The survey questionnaire served as a pilot to be refined. However, material from the interviews was used in the research.</td>
</tr>
<tr>
<td>November 1998 survey forms distributed (Version 1)</td>
<td>5 survey forms sent, 2 returned (40% response rate) Questionnaire too long (30 minutes completion time), which is not practical for corporate business setting.</td>
</tr>
<tr>
<td>February - May 1999 interviews conducted in Melbourne.</td>
<td>16 interviews (from 20 requests)</td>
</tr>
<tr>
<td>May 1999 Version 2 of questionnaire survey developed. Also developed a separate interview questionnaire for firms and non-commercial organisations.</td>
<td>Ideas gained for how to streamline questionnaire. Developed a separate survey/interview questionnaire for manufacturers and service providers. Another modification was to list different State Government programs, depending on the location of the firm.</td>
</tr>
<tr>
<td>May 1999 survey forms sent to firms in Victoria.</td>
<td>25 sent, 20 returned (80% response rate) (includes 5 second requests with 3 returns)</td>
</tr>
<tr>
<td>June 1999 survey forms sent to firms in NSW.</td>
<td>12 sent, 6 returned (50% response rate) (includes 3 second requests with 1 return)</td>
</tr>
<tr>
<td>June - July 1999 NSW interviews</td>
<td>14 interviews (from 19 requests)</td>
</tr>
<tr>
<td>August 1999 ACT interviews</td>
<td>4 interviews (from 6 requests)</td>
</tr>
<tr>
<td>September 1999 - November 1999 survey forms sent to firms in VIC, NSW, QLD, WA and SA.</td>
<td>69 sent, 36 returned (52% response rate)</td>
</tr>
<tr>
<td>December 1999 - February 2000 first draft of theory chapters written.</td>
<td>Realised some aspects found in the literature could be empirically explored more (e.g. networks; COAG impacts).</td>
</tr>
<tr>
<td>March 2000 - October 2000 data entry of results and initial interpretation and analysis.</td>
<td>Interviews transcribed. Gained additional ideas for issues to be further explored.</td>
</tr>
<tr>
<td>May 2000 Adelaide interviews</td>
<td>5 interviews (from 6 requests)</td>
</tr>
<tr>
<td>June 2000 Version 3 of questionnaire survey developed.</td>
<td>Slightly streamlined the survey plus additional question about COAG influence.</td>
</tr>
<tr>
<td>August - September 2000 survey forms sent to firms in VIC, NSW, QLD, WA and SA.</td>
<td>47 sent; 22 returned (47% response rate). Includes 21 second requests from non-returns of previous year, with improved cover letter and survey. However, only 6 second requests returned.</td>
</tr>
<tr>
<td>October - November 2000 final interviews (VIC, ACT)</td>
<td>3 interviews (from 3 requests)</td>
</tr>
<tr>
<td>Summary of outcomes</td>
<td>59 interviews requested; 47 granted 158 survey forms sent (including 29 second requests); 86 returned. Interview request rate: 80% Survey return rate: 54%</td>
</tr>
</tbody>
</table>

Appendix B (Display B.1) shows examples of the three versions of the questionnaire. They all have similar themes (Table 5.1), allowing the information collected at different stages to be combined. The difference is that the later designs are more streamlined, capable of extracting the same information more efficiently (i.e. less time for the respondent). For example, for Versions 2 and 3 of the questionnaire, I recorded background information about the firm before sending the survey. As a result, respondents did not need to record repetitive information (e.g. name of the firm, what it does, the revenue and year established). Respondents could launch into the survey, designed to take no more than 15 minutes but yielding enough useful information to cover a number of themes. Other features of the design included the use of option boxes that respondents could tick if relevant. Options were provided for various sources of export contacts, different ways of acquiring innovation, and the types of government programs used. Listing options can also help with the respondent’s recall of information, although this method has a risk of inaccurate information if an option is just nominated out of convenience (Robson 2002). However, provision was made for respondents to record information not covered by the option listings. Another difference in latter designs was to have different questionnaires for manufacturers and service providers. Some questions were varied because early interviews revealed that these two groups generally have distinct methods of acquiring innovation. These examples of attention to detail probably helped with the good return rate.

5.3 Implementation of the methods

This section discusses how the methods were implemented. The importance of cover letters for initial contact with subjects is noted. Interview strategies are briefly described. The success of the methods and implementation is evaluated by describing the response rates, geographic coverage and how representative the sample is of the Australian water industry.
5.3.1 The importance of cover letters

A thoughtfully crafted letter of introduction (or cover letter), stating the purpose of the research, can have a positive influence on response rates because it can persuade the potential respondent that partaking in a survey or request for an interview is worth his or her time (Robson 2002). The cover letters used for this research had several points to convey: a description of what the research was about and its potential usefulness, why the respondent’s contribution would be important, and what would be required. A written statement guaranteeing confidentiality was included. Also, the legitimacy of the research was indicated by enclosing a copy of official university approval, including the code number from the ethics committee. Each cover letter was slightly modified to make it appropriate for the line of business of the firm. This was done by including a sentence or two explaining why, for example, a contribution from a pump manufacturer or an engineering consultancy would be regarded as important. The letters were generally addressed to the general manager for smaller firms, and the business development or export marketing manager for larger firms. Identifying the names of relevant personnel, by using the AWA handbook, is assumed to have helped with the satisfactory response rate (Section 5.3.3). Appendix B (Display B.3) indicates how the cover letter evolved. Early letters referred to a generic environmental technology industry, whereas later letters made more direct reference to the water industry and how a particular firm’s contribution would be beneficial. To establish a professional reputation, thank you notes for surveys returned and interviews granted are important.

The telephone was used to secure and confirm interviews; otherwise its use was kept to a minimum. Because a ‘cold’ (i.e. unexpected) telephone call can be intrusive, cover letters quickly proved to be the superior method of initial contact, for both survey and interview requests. Thus when a call was made - ideally a fortnight later - the potential respondent was not caught off guard. Usually an interview was granted, with the person targeted or an equally qualified person of the organisation. After early attempts at telephone interviews, I (as the researcher) would argue that the telephone is usually not a satisfactory tool for conducting interviews or gathering in-depth information. This is contrary to the experience of some researchers (e.g. Harrison et al. 1996; Lindahl and
Beyers 1999) whose corporate studies rely extensively on telephone interviews. It is possible that cultural factors account for this difference; these studies are based in North America where business people might be more open, whereas in Australia it would be presumptuous to expect an extended telephone interview. Also, an established academic possibly has more credibility to use someone’s time by this means. As a doctoral candidate with no industry contacts, my experience has been that to obtain useful information, I had to visit the person or post a questionnaire, and not rely on electronic forms of communication (e.g. telephone, faxes, E mails).

5.3.2 Interview strategy

There is abundant work covering interview techniques for academic research (e.g. Schoenberger 1991; Sayer 1992; Robson 2002). Much of this advice is well-reported so only the main points are outlined here. A prominent theme running through the literature is that the researcher should be aware of his or her hermeneutic position - that is, the recognition of the role of the researcher in interpreting a reality chosen for enquiry and that this will influence the type of knowledge received and interpreted. Schoenberger’s (1991) work also notes that the corporate interview is susceptible to problems of control, since the likely respondents are people accustomed to being in control. The resolution is to establish ‘collaborative dialogue’ that engages respondents, allowing him or her to shape the content of the discussion but without controlling. The literature also generally advocates open-ended interviews (e.g. Silverman 1985; Schoenberger 1991; Robson 2002). While this method does not lend itself to formal hypothesis testing, it can provide fertile ground for the generation of hypotheses about business behaviour (Schoenberger 1991). However, proponents that enthusiastically endorse open-ended interviews can overlook the reality of the business world where the interviewee may not have the same enthusiasm to ‘donate’ several hours of a busy schedule for an unstructured conversation.

For this research 47 interviews were conducted, lasting on average 45 minutes to about one hour. They were semi-structured with the flexibility to be more structured if the interviewee was pressed for time. In some cases two interviewees were present (Appendix B [Table B.1]). The purpose of interviews was to cover the themes described
in Table 5.1. Particular themes emerged as more relevant to some firms than others (e.g. use of government programs or innovation creation). Organisations, such as research institutions and government departments, required different questions. Interviews were recorded by either taking written notes or if permission was granted, being taped and later transcribed. Some minor editing (elimination of courtesies) occurred during transcriptions, though detail was left in rather than out. After interviews were transcribed, the material was organised into themes (e.g. background history of the firm, the creation of competitive advantage, export formation) to make the data-analysis easier. This did not always reflect the exact sequence of the interview but the content was still preserved. An example of a transcription is shown in Appendix B (Display B.4). Of the 38 interviews conducted with firms, 28 were of sufficient depth that thematic information could be directly compared.

5.3.3 Evidence of a representative sample: scope, location and activities

The objective of the methods was to gather information from a representative sample of manufacturing and service firms and organisations involved in the Australian water industry. This objective has been achieved; the following table and figures provide the evidence of a representative industry sample.

Table 5.3 reports on the scope of the research. The AWA 2000 handbook lists approximately 320 firms and organisations relevant to the intermediate water industry. (Note that this figure excludes water utilities that do not operate a commercialised arm for their expertise, and firms that are exclusively distributors of manufactured products.) The sample contains 124 firms and 9 organisations – about 40% of the AWA listing. The sample conceivably captures a greater proportion of the economic value of the industry because most of the larger prominent firms are included. A rough estimate is that about 60 to 70% of the value is represented, although the lack of official estimates (Section 4.1.1) means this claim cannot be substantiated. Because the domestic industry is relatively small, the intention was to target as many potentially useful subjects as possible. The sample includes exporters (72% of the sample). Also included are service providers, small firms and foreign-owned firms. Chapter 6 provides details of these
various sub-categories. In addition, Appendix B (Table B.1) identifies the firms and organisations, including what the main activity is of each.

**Table 5.3 Scope of the research**

<table>
<thead>
<tr>
<th>Type of firm or organisation</th>
<th>Number of personal interviews conducted</th>
<th>Number of survey questionnaires returned</th>
<th>Number of total responses: survey questionnaires and interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing establishments</td>
<td>13</td>
<td>68</td>
<td>81</td>
</tr>
<tr>
<td>Service providers (commercial entities)</td>
<td>25</td>
<td>18</td>
<td>43 1</td>
</tr>
<tr>
<td>Service providers (non-commercial)</td>
<td>Total = 9</td>
<td>Includes: 4</td>
<td>0</td>
</tr>
<tr>
<td>Industry associations</td>
<td>Total = 9</td>
<td>Includes: 2</td>
<td></td>
</tr>
<tr>
<td>Government departments</td>
<td>Total = 9</td>
<td>Includes: 3</td>
<td></td>
</tr>
<tr>
<td>Research institutions</td>
<td>Total = 9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>Total interviews = 47</td>
<td>Total survey forms returned = 86</td>
<td>Total responses: questionnaire surveys and interviews = 133 entities 2</td>
</tr>
</tbody>
</table>

*Notes:*
1. Includes 5 cases where different capital city locations of the same firm were surveyed or interviewed. Actual number of distinct service firms is 38.
2. Includes all firms (n = 124) and non-commercial organisations (n = 9).


Figure 5.1 shows the geographic representation of the sample. There is a predictable pattern – the majority of firms and organisations sampled are located in the most populous States (NSW and VIC). Tasmania and the Northern Territory are not represented because these locations do not have head offices of exporting water industry firms. Comparing the representation by State/territory for the sample with the distribution of AWA membership reveals a fairly similar proportion (Figure 5.1). The sample does have about 50% more firms represented from Victoria than the AWA proportion. The reason is that the researcher was based in Victoria during the fieldwork so it was logistically easier to gather information from Victorian firms. The sample also
has an under-representation of Queensland firms when compared with the AWA proportion, probably because the information obtained from firms based in Queensland was by postal surveys only, whereas information from firms in other States was by a combination of personal interviews and surveys.

Figure 5.1 Comparison of geographic origin of sample \(^1\) with proportion of Australian Water Association memberships by State/territory (1998 - 2000)

1. Sample includes commercial enterprises (n = 119) and non-commercial organisations (n = 9). Does not include different State offices of the same firm (5 cases).

The number of firms categorised by the different types of manufacturing and service activities found in the water industry are shown respectively in Figures 5.2 and 5.3. The categorisations are based on the organising framework depicted in Figure 4.1. The figures demonstrate that the sample contains diverse activities, which is reflective of the industry. Each firm is confined to one main activity to avoid double counting, although in practice firms frequently engage in two or more activities (e.g. some firms manufacture both water and wastewater treatment equipment, others carry out both manufacturing and service activities). However, in such cases there is usually one predominant activity. Most of the activities have a high proportion of exporters, mainly because the sample has an emphasis on exporting firms.

Figure 5.2 Number of manufacturing firms\(^1\) (exporters and non-exporters) categorised by main activity \((N = 81)\)

![Bar chart showing number of manufacturing firms by main activity for exporters and non-exporters.]

Note:
1. The terms ‘firms’ and ‘organisations’ used in the captions for figures and tables in Chapters 5 to 10 refer to entities involved in the Australian water technology and management industry. Thus it will not be necessary to depict the full caption each time.

Figure 5.3 Number of service firms\(^1\) (exporters and non-exporters) and non-commercial organisations\(^2\) categorised by main activity (N = 47)

<table>
<thead>
<tr>
<th>Activity</th>
<th>No. of firms</th>
<th>Non/ exporters</th>
<th>Exporters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Gov. Dept.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooperative Research Centres</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry associations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dev. organisations (private sector)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management/ operations/ BOOT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory/ analytical services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asset management/ maintenance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design/ consultancy</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. Refers to firms and organisations in the water industry (see footnote 1; Figure 5.1).
2. Organisations refer to government departments, industry associations and research institutions.


5.3.4 Data analysis

Surveys and interviews shared common questions. Different types of data were collected from responses: nominal (e.g. a particular export method or innovation source was given an identifying code); numerical (e.g. actual export revenue or R & D expenditure); and ordinal (e.g. satisfaction rating out of 5 for the usefulness of particular types of government programs). The information was entered into an Excel spreadsheet and the appropriate statistical analysis was conducted (e.g. constructing histograms for nominal data; determining the median and mode for ordinal data; and for numerical data, running
t-tests, U tests and ANOVAs for comparing means, and regression analysis for
determining relationships). The software used was Microsoft Excel (XP Office) and
SPSS Version 11.5.

Interview material was used to give further depth to the analysis. For example, it
provided explanations for causation when regression analysis did not uncover a
statistically significant relationship, such as when comparing R & D proportion with
export proportion. Quotations from interviews were useful to reinforce a pattern found or
to offer a contrary explanation when a quantitative relationship was lacking. The critical
realist philosophy underpinning the methods does, however, create awareness that even
letting the interviewee’s own words speak for themselves involves a choice on the part of
the researcher (Winchester 1996).

**5.4 Conclusion**

This chapter has discussed the philosophical foundations of the research, and the
development and application of the methods used to gather empirical material. A
philosophy of critical realism provides the epistemological and ontological assumptions
about the knowledge being sought. It allows for the research to be re-conceptualisation
and for methods to be combined. Re-conceptualisation applied to this research means that
the theoretical and empirical knowledge interact and inform each other. Early empirical
analysis informed the theoretical development in Chapters 2 and 3; this theory in turn
informs subsequent empirical work. The theoretical framework is appraised and possibly
further modified in Chapter 11 when reconciling the empirical analysis. Re-
conceptualisation is also evident in the evolving design of the questionnaire, modified as
experience was gained and different aspects emerge. Yet enough consistency has been
maintained for the information from early and latter questionnaire versions to be
combined. The discussion of research methods has advocated that combining qualitative
and quantitative techniques can help gain a deeper understanding of the causal processes
that explain trade, rather than relying on just one method.
This chapter has demonstrated that a representative sample has been obtained, sufficient to provide the information required to explain how trade develops for the Australian water technology and management industry. The next five chapters (Part Three) describe and analyse the results from the sample, obtained by the methods discussed. As the results are worked through, the limitations of the methods will be noted. For example, some issues may emerge where different questions could have been asked. The appraisal of the research in Section 11.3 addresses these limitations.
Chapter 6
The characteristics and organisation of the Australian water technology and management industry

The theoretical framework in Part One identified four strands as important for explaining how trade develops: competitive advantage and corporate strategies, innovation creation, networks, and the state and institutions. Part Three of this thesis (Chapters 6 - 10) uses this framework to analyse empirical findings from firms and organisations representing the Australian water technology and management industry. The previous chapter explains the methods used to identify the sample and collect the information. Chapter 6 describes the characteristics of the sample and discusses the organisation of the industry. Chapters 7 to 10 deal respectively with each of the four strands, using empirical findings to address the appropriate questions from Table 3.3. The general approach in the various sections is to describe the results, followed by a discussion of the findings. In keeping with a realist philosophy, the theory and empirical work interact to inform each other. Chapters 6 to 10 use the theoretical framework to analyse the empirical work; in Chapter 11 (Part Four) the empirical findings are used to appraise the framework.

Chapter 6 begins by describing the characteristics of the Australian water industry. This provides a context for the analysis throughout Part Three. Section 6.2 offers explanations to account for the diversity of firms. Section 6.3 investigates linkages between firms and supplier industries. Section 6.4 discusses these findings and argues that fragmentation and the lack of spatial clustering do not preclude innovation. The conclusion - Section 6.5 - asserts that strong localised linkages are not a prerequisite for creating competitive advantage and innovation. As Chapter 6 develops, the process commences of addressing the supporting research questions (Table 6.1).
Table 6.1 Research questions addressed in Chapter 6

<table>
<thead>
<tr>
<th>Questions from theoretical discussion (Table 3.3)</th>
<th>Relevant section in Chapter 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are the characteristics and industrial organisation of the industry (i.e. firm-size, age, type, locations, ownership and supplier linkages)?</td>
<td>6.1</td>
</tr>
<tr>
<td>Are clusters evident for this industry? Why or why not?</td>
<td>6.2; 6.3</td>
</tr>
<tr>
<td>How strong are linkages between related and supporting industries for firms?</td>
<td>6.4</td>
</tr>
</tbody>
</table>

Source: selected questions from Table 3.3.

6.1 Characteristics of the industry

In this section, five distinct categories are created to describe the characteristics of the firms of the sample: the location, size (measured by annual turnover and employee number), age, type of ownership, and whether they are exporters or non-exporters. These categories are used throughout the empirical work. In particular, the size of firms is an important categorisation as it forms part of some theoretical explanations of trade and competitive advantage (Sections 2.3.1; 3.3.2.1).

6.6.1 Location

The water industry is located in most States of Australia, with almost 70% of firms from NSW and Victoria (Section 5.3.3). This proportion is consistent with aggregate Australian industrial employment and output where these two States are dominant (ABS 2000, #8104; ABS 2000; #5302). Figures 6.1 and 6.2 show that within the States, most of the firms are located in the metropolitan capital cities, as expected given the highly urbanised nature of Australia (Rich 1987). Four observations are made:

1. Of the sample of manufacturing firms, 28% are found in Sydney’s western and Melbourne’s southern suburbs (Figure 6.1). These locations are popular because they are commercial centres with good infrastructure, yet with cheaper rentals than central business districts (CBDs) (p.c. [personal communication] Interview Codes #44; #81).

2. For service provider firms, Sydney’s north (e.g. North Sydney, Artarmon, St Leonards and Chatswood) and Melbourne’s CBD (including Southbank) are popular locations (Figure 6.2). This is because of the availability of a skilled labour
pool, developed infrastructure and proximity to other producer services (Forster 1999). Although Adelaide CBD records the highest number of service firms, this is probably reflective of a slight sampling bias for obtaining South Australian examples because of that State’s emphasis on an exporting water industry.

3. Only 7% of firms sampled are outside capital cities (3 in Newcastle; 1 in Rutherford, NSW; 1 in Nowra, NSW; 2 in regional Queensland [Warwick and Ipswich]; and 1 in regional Victoria [Hartwell]). Of these 8 firms, 7 are exporters. (Note that these firms are not shown in Figures 6.1 and 6.2 because of the low frequencies.)

4. Figures 6.1 and 6.2 show evidence of the water industry being concentrated in the larger capital cities, suggesting agglomeration of activity. Section 6.3 investigates whether these agglomerations are a result of nearby firms having direct linkages (i.e. localisation economies), or just the influence of urbanisation economies.

**Figure 6.1 Most frequent locations by region for manufacturing firms (1998-2000)**

N = 63 firms

<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Manufacturing Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney (western suburbs)</td>
<td>12</td>
</tr>
<tr>
<td>Sydney (northern suburbs)</td>
<td>8</td>
</tr>
<tr>
<td>Sydney (southern suburbs)</td>
<td>6</td>
</tr>
<tr>
<td>Melbourne (southern suburbs)</td>
<td>9</td>
</tr>
<tr>
<td>Melbourne (eastern suburbs)</td>
<td>7</td>
</tr>
<tr>
<td>Melbourne (western suburbs)</td>
<td>5</td>
</tr>
<tr>
<td>Melbourne (northern suburbs)</td>
<td>4</td>
</tr>
<tr>
<td>Brisbane (south-west suburbs)</td>
<td>4</td>
</tr>
<tr>
<td>Perth (northern suburbs)</td>
<td>2</td>
</tr>
</tbody>
</table>

**Notes:**
1. This is not time series data but fixed points collected from 1998 to 2000. All figures and tables refer to this period. The early surveys and interviews were done in 1998, with the majority conducted during 1999 and 2000 (see Section 5.2.5).
2. There are 81 manufacturing firms in the sample. The 18 firms not represented in the figure are from 18 diverse locations. These are omitted to avoid cluttering the diagram.

**Source:** author’s surveys and interviews 1998 – 2000.
6.1.2 Firm-size

Descriptive statistics for firms categorised as small, large and medium are reported in Table 6.2. The table also defines boundaries used throughout the empirical work for the designation of different sizes of firms. The sample represents a range of firm-sizes, with about half comprising small firms. Yet as a proportion of aggregate turnover and employment, small firms account for a miniscule proportion. Conversely, less than 18% of firms in the sample are large, but due to sheer size capture the majority of aggregate employment and turnover.

There are two caveats to note about the data in Table 6.2. First, for many firms the precise turnover figure fluctuates annually (particularly for small firms where revenue would be affected by gaining or losing one or two major contracts). Turnover figures need to be treated with caution, as the amount cited may not represent an average year for the firm. However, the order of magnitude - whether in the range of a few million or tens of millions of dollars - is still captured. The second caveat is that the distinction between firm-sizes is arbitrary with some flexibility in cut-off boundaries. For example, some firms might have a
turnover near the limits of the medium size range but employment well within the large range. In such cases the firm is classified as large.

**Table 6.2 Employment and turnover by firm-size (1998 - 2000)**

<table>
<thead>
<tr>
<th>Firm-size</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
<th>All firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>&lt; 25 emp.</td>
<td>&lt; A$ 5 M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>&lt; 150 emp.</td>
<td>&lt; A$ 50 M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large</td>
<td>&gt; 150 emp.</td>
<td>&gt; A$ 50 M</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No of firms in sample</th>
<th>59</th>
<th>42</th>
<th>18</th>
<th>119</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of sample</td>
<td>50%</td>
<td>35%</td>
<td>15%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aggregate turnover 3; 4</th>
<th>N = 52</th>
<th>N = 38</th>
<th>N = 18</th>
<th>N = 108</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A$ million)</td>
<td>151.3</td>
<td>850.7</td>
<td>2683.0</td>
<td>3685.0</td>
</tr>
<tr>
<td>Proportion of sample</td>
<td>4%</td>
<td>23%</td>
<td>73%</td>
<td>(11 firms where turnover is unknown)</td>
</tr>
<tr>
<td>Mean</td>
<td>2.9</td>
<td>22.4</td>
<td>149.1</td>
<td>34.1</td>
</tr>
<tr>
<td>Standard deviation (s.d.)</td>
<td>(2.3)</td>
<td>(18.7)</td>
<td>(121.4)</td>
<td>(72.2)</td>
</tr>
<tr>
<td>Median</td>
<td>2.5</td>
<td>15.5</td>
<td>115.0</td>
<td>6.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aggregate employment 3; 4</th>
<th>N = 55 firms</th>
<th>N = 41</th>
<th>N = 18</th>
<th>N = 114</th>
</tr>
</thead>
<tbody>
<tr>
<td>(emp.)</td>
<td>562 (emp.)</td>
<td>2772</td>
<td>14 780</td>
<td>18 114 employees</td>
</tr>
<tr>
<td>Proportion of sample</td>
<td>3%</td>
<td>15%</td>
<td>82%</td>
<td>(5 firms where employee nos. are unknown)</td>
</tr>
<tr>
<td>Employment Mean</td>
<td>10 (6)</td>
<td>68 (43)</td>
<td>821 (546)</td>
<td>159 (359)</td>
</tr>
<tr>
<td>(standard deviation)</td>
<td>8</td>
<td>50</td>
<td>800</td>
<td>30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age of establishment (years)</th>
<th>N = 51 firms</th>
<th>N = 37</th>
<th>N = 18</th>
<th>N = 106</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>10-15 yrs</td>
<td>15-20yrs</td>
<td>&gt; 25 yrs</td>
<td>10-15yrs (est.1985-89)</td>
</tr>
<tr>
<td>Mode</td>
<td>10-15 yrs</td>
<td>&gt; 25 yrs</td>
<td>&gt; 25 yrs</td>
<td>(13 firms of unknown age)</td>
</tr>
</tbody>
</table>

*Notes: see p. 157*

Notes (Table 6.2)

2. Does not include different branches of the same firm so as to avoid double counting (5 cases). There are 3 firms where one branch office of each firm was surveyed and 1 firm where its 2 branch offices were surveyed. Assume that all tables and figures do not include these 5 extra branches unless explicitly stated.
3. Turnover and employment figures are only for commercial entities. This includes the commercialised arms of corporatised water utilities that export (4 cases), but not the whole utility. The aggregate figures do not include industry associations, research institutions specialising in water technology and management, and relevant government departments (e.g. AusAID and Environment Australia).
4. There are 3 cases of large diversified firms where the turnover amount cited does not differentiate water-related products and services from other activities. In these cases it is estimated that water-related activities might be roughly 10% of revenue of the firm (based on an interview with one such company {p.c. Interview Code #18}). Therefore, only 10% of the turnover and employment amounts are recorded to avoid exaggerating these amounts. For some diversified engineering firms, turnover is not adjusted because it is not possible to separate the proportion of water-related activities from other civil projects. However, most of the engineering firms included are water specialists so turnover figures cited most probably reflect the correct magnitude.
5. ‘Turnover’ refers to the sales revenue generated from the provision of goods and services for a particular accounting period (usually per annum). ‘Revenue’ refers to an increase in a firm’s assets arising from sales of goods and services (Penguin Macquarie Dictionary of Economics & Finance 1988). ‘Turnover’ is a more generalised definition and is the preferred term used throughout this research. Note that ‘turnover’ and ‘revenue’ are often used interchangeably in the primary sources of data (e.g. personal interviews, questionnaire surveys and company annual reports), so the strict distinction between the terms is not always obeyed.
6.1.3 Types and nationality of firm-ownership

The number of firms by size representing different types of ownership structures is illustrated in Figure 6.3. There are some interesting features. One is that Australian Stock Exchange (ASX) listed water technology and management companies are few and not dominated by any one size of firm. Publicly listed firms include innovative small and medium size firms often involved in wastewater technology. The impetus for a stock exchange float is usually to provide the capital for further growth (p.c. Interview Codes #51; #61; #71; #78). Interviews further reveal that 2 of the 7 ASX-listed firms have a mining background. The uncertainty of commodity prices resulted in diversification, plus there were opportunities to apply technical knowledge to an emerging environmental technology market (p.c. Interview Codes #51; #61).

Another feature of Figure 6.3 is that over one-quarter of the private firms (proprietary limited [pty ltd]) sampled have links to an overseas parent company that is a publicly listed company in its home country. Such firms tend to be medium or large. A third feature is that while private firms account for about two-thirds of the sample, the remaining third is a mixture of ownership types. Although large firms capture almost three-quarters of the total turnover and employment for the industry (Table 6.2), in terms of numbers, privately owned small and medium size firms are the majority: thus the reference throughout this research to a ‘diversified industry’ with respect to size, as well as activities (Figures 5.3; 5.4). The last feature is that the term ‘multinational’, while often applying to larger firms, can also include smaller firms that have links to larger foreign parent companies. This is an example of firms overcoming size constraints by using fluid boundaries and interacting with external determinants to increase influence (Section 3.1.1).
Figure 6.3 Ownership types by firm-size (N = 112)  

![Graph showing ownership types by firm-size](image)

**Note:**
1. Ownership-type is unknown for 7 firms.

**Source:** author’s surveys and interviews 1998 – 2000.

Figure 6.4 shows that Australian owned firms capture the largest proportion of total revenue. The majority of these firms are small and medium (also see Figure 6.5). However, there are some large Australian firms; one firm - Henry Walker Environmental - accounts for about one fifth of the Australian portion in Figure 6.4. Australian firms have an advantage of being familiar with local conditions (p.c. Interview Codes #85; #120). Yet the theoretical work suggests that sustaining long-term competitive advantage requires more than just familiarity with local conditions, as foreign multinationals (MNCs) can collaborate with local partners to gain this knowledge themselves (Sections 2.4; 3.2.3).

While the findings in Figure 6.4 do not mirror the pattern of UK and French dominance of the global industry, firms from those countries still command a significant proportion of revenue. Also notable in this sample is the large presence of US firms, since some of the larger engineering consultancies have a US parent company. Recall from Section 4.2.3 that US firms are not generally major players in the global water industry. Swedish firms make an appearance due to strengths in producing elaborately transformed manufactured goods. The influence of MNC activity on outward trade flows is discussed in Section 7.4.3.
Figure 6.4 Proportion of Australian water industry turnover by nationality of firm ownership
(N = 119 firms)\(^1\) Total turnover of sample = A$ 3685 million

Notes:
1. Non-commercial organisations (industry associations, research centres and government departments) are not included.


The results in Figure 6.5 are clear: over three-quarters of small firms are Australian owned, whereas under half the large firms are Australian owned. Because this research is not longitudinal, it is not known whether successful domestic firms are susceptible to foreign multinational takeover at a certain stage of their life cycle. This has certainly happened in a few cases (e.g. Memtec being acquired by Vivendi) but no conclusions are reached here.
The majority of Australian firms are small because the domestic market for these goods and services is limited. Developing export markets is a way to grow the firm. Yet accessing the required capital can be difficult, partly because the venture capital market in Australia is not well developed (McKinsey et al. 1993; Button 1998; Brain 1999). Corporate strategies provide an alternative means of expansion. Forming an alliance is common (see Section 7.4.1). Another option is allowing a larger firm - often foreign - to acquire a controlling interest. During the field work, three firms reported that they would either be acquired or form collaborations in the following year (p.c. Interview Codes #79; #95; #96). Reports show this has eventuated (e.g. *Cross Currents* June 2000; *Water Business* September/October 2000; *Water News* 13 May 2002).

### 6.1.4 Comparing the characteristics of exporting and non-exporting firms

Although this research has a focus on exporting firms, enough non-exporting firms have been included to make comparisons. Some of the basic features of these two groups are compared in Table 6.3. The expectation is that exporting firms have a larger turnover than non-exporters. There is a statistically significant difference in turnover size between the groups ($p = 0.015$; one-tailed). Entering foreign markets requires more resources but can also generate higher turnover. Likewise, testing by firm-size shows that exporters are
significantly larger than non-exporters (p = 0.02; one-tailed). One reason is that larger firms are often MNCs that have a propensity to export, as explained by Dunning’s eclectic paradigm. In addition, larger firms often have a greater capacity to innovate than smaller firms and so are more likely to export (Wakelin 1997). These assertions are tested further in Sections 7.1 and 8.1.

Table 6.3 reveals, however, that there is no significant difference in firm-age between exporters and non-exporters. Experienced personnel with overseas networks are employed by both young and established firms. Therefore, provided young firms have sufficient resources, accessing export markets should be possible once an initial reputation is established. Also, some start-up firms pursue export markets from the outset, whereas some old firms exclusively concentrate on the domestic market (p.c. Interview Codes #61; #78).

Turnover per employee is included as a proxy for productivity and thus competitiveness (see Section 3.2.1; also Porter 1990; Lindahl and Beyers 1999). This proxy is used throughout the empirical work so it is appropriate at this point to justify its use. More productive firms can produce cheaper or better quality goods and services than less productive counterparts (detailed in Sections 2.3.1; 3.2; 3.3). The expectation is that productive firms have a propensity to trade because productivity leads to competitiveness which extends the spatial reach of the market. This is because the goods and services of the more productive competitor are more attractive to buyers than those of the less competitive rival. One way productivity can be measured is by turnover per employee because firms with high productivity achieve a higher turnover per unit of production input than less productive firms (Lindahl and Beyers 1999). Turnover per employee is a suitable general proxy for productivity: for manufacturers the proxy reflects the value embedded in better or cheaper products; for service providers the proxy reflects value-added information. Another measure for productivity is by calculating the value-added output per unit of capital expenditure (Webber and Rigby 1996: 385-6); however, this method is not used here because the necessary data is not available for the water industry. Furthermore, capital expenditure is not as relevant in service industries as it is in manufacturing industries.
Despite the theoretical expectation, the empirical testing shown in Table 6.3 reveals no significant difference between the means of turnover per employee for the exporting and non-exporting groups. Note, however, that the median turnover per employee is higher for exporters than for non-exporters, hinting that a difference in productivity might be revealed with a larger and more diverse sample. Also, while higher productivity for a firm theoretically increases the propensity to export, this does not necessarily mean that the firm will export as it may be satisfied expanding in the domestic market. The lack of stark quantifiable differences between the two groups suggests that an explanation of how trade develops also needs to explore qualitative factors. This is done in subsequent chapters.

**Table 6.3 Comparison of basic features between exporters and non-exporters (N = 119)**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Exporters</th>
<th>Non-exporters</th>
<th>Statistical summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of firms</td>
<td>N = 86</td>
<td>N = 33</td>
<td>72 % of sample are exporters</td>
</tr>
<tr>
<td>Turnover (A$ million)</td>
<td>N = 78</td>
<td>N = 30</td>
<td>T test (equal variance; log transformed)</td>
</tr>
<tr>
<td>Mean</td>
<td>40.8</td>
<td>16.8</td>
<td>t (106) = 2.19</td>
</tr>
<tr>
<td>(s.d.)</td>
<td>(82.3)</td>
<td>(28.4)</td>
<td>p = 0.02 (one-tailed)</td>
</tr>
<tr>
<td>Median</td>
<td>6.5</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>Turnover per employee (i.e. productivity) (A$ thousand)</td>
<td>N = 77</td>
<td>N = 29</td>
<td>T test (equal variance; log transformed)</td>
</tr>
<tr>
<td>Mean</td>
<td>325</td>
<td>320</td>
<td>t (104) = 1.01</td>
</tr>
<tr>
<td>(s.d.)</td>
<td>(301)</td>
<td>(299)</td>
<td>p = 0.16 (one-tailed)</td>
</tr>
<tr>
<td>Median</td>
<td>250</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Firm-size</td>
<td>N = 86</td>
<td>N = 33</td>
<td>Mann-Whitney U test</td>
</tr>
<tr>
<td>Median</td>
<td>Medium size</td>
<td>Small size</td>
<td>U (117) = 1115.5</td>
</tr>
<tr>
<td>Mode</td>
<td>Small size</td>
<td>Small size</td>
<td>p = 0.02 (one-tailed)</td>
</tr>
<tr>
<td>Age (years old in 2000)</td>
<td>N = 81</td>
<td>N = 27</td>
<td>T test (equal variance; log transformed)</td>
</tr>
<tr>
<td>Mean</td>
<td>17.8</td>
<td>15.8</td>
<td>t (106) = 1.07</td>
</tr>
<tr>
<td>(s.d.)</td>
<td>(9.0)</td>
<td>(9.1)</td>
<td>p = 0.14 (one-tailed)</td>
</tr>
<tr>
<td>Median</td>
<td>18</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Median age range</td>
<td>1980-84</td>
<td>1985-89</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
1. Includes all commercial entities. Does not include branch offices of the same firm (5 cases). Does not include industry organisations, non-commercial research institutions or government departments.
2. Turnover
3. Before running statistical comparisons the data is transformed to the natural logarithm to smooth out the distribution and move the skewness closer to zero, as recommended by Wright (1997: 63-4). Log transformations on the data are done where appropriate throughout the empirical work.
4. An asterisk (*) denotes significance difference at p < 0.05.
5. All turnover per employee figures for this table and subsequent tables are rounded to nearest A$ 1000.
6. Mann-Whitney U-test is used as firm-size is ordinal data (small [1]; medium [2]; large [3]).

6.1.5 Some features of the exporters: magnitude, main destinations, the ‘Asian crisis’ and exporting history

The aggregate export revenue is A$ 626.2 million, approximately 17 % of the total turnover for all firms in the sample. (This is an underestimate of the actual amount because 20 exporters with unknown export revenues are not included in the aggregate.) The definition of an ‘exporter’ is a firm with regular overseas exchange and not just a one-off order or plans to export in the future. The main export destinations are in the Asia Pacific region. The countries include Malaysia, Vietnam, Philippines, China and Indonesia. Other secondary destinations are the Solomon Islands, Papua New Guinea, Fiji and New Zealand. Often, it is a service that is traded (e.g. project management skills or the design of water and wastewater treatment plants). There are also minor markets in the US and Europe - mainly for specialist equipment (e.g. micro-filtration and monitoring devices).

Manufacturers sometimes export the design of an innovative product rather than the actual product. For example, one company exports the design of stormwater litter traps that are then manufactured by its subsidiary company in the US because this is cheaper than transporting the heavy assembled product (p.c. Interview Code #61).

When comparing the proportion of exporters located in the ‘core’ industrial States (NSW and Victoria) and the ‘periphery’ (WA; SA and QLD), no significant difference is detected in the sample: 77% (n = 68) of firms in the core are exporters; 64% (n = 23 firms) in the periphery are exporters (z = 1.53; p = 0.13 [two-tailed]). In the peripheral States most firms are still located in large urban centres; as long as there are urbanisation economies then firms aspiring to export can draw on the external resources required (e.g. government departments, financial institutions). Also, given the absence of specific clusters of water industry firms (i.e. the lack of localisation economies [Section 6.3]), then it is unlikely that any one State or region would dominate with exporting firms.

This research does not investigate in detail the demand drivers in export locations, as it is primarily a supply-side study of trade (i.e. the factors driving trade from Australia). Suffice to say, some of the factors creating demand include infrastructure development and the implementation of more stringent environmental laws in importing countries (p.c. Interview Codes #55; #99a). For example, several Australian consultancies are involved in instigating
an extensive environmental management program in Indonesia - known as BAPEDAL (p.c. Interview Codes #95; #98b; #99a). Engineering firms from Australia frequently have an alliance with other international firms involved in water infrastructure projects in Asia, which in turn are often funded by international banks and aid organisations. Australian firms themselves are not active in overseas BOOT (build, own, operate and transfer) arrangements; these types of franchising contracts for water plants are more commonly the domain of the French and British firms.

Given that South East Asia is an important export market and much of the empirical work was conducted the year following the Asian currency crisis, it is interesting to note the impact of the 1998 ‘Asian downturn’. Respondents from exporting firms were asked to rate the impact experienced by their firm or organisation on an ordinal scale (with 1 representing no impact and 5 indicating a severe impact). For the sample, the median and mode are both 3. Furthermore, assessing the impact by firm-size does not change the median and mode (see Appendix C [Table C.1]). Some firms were not adversely affected and remained competitive because the lower value of the Australian dollar made Australian goods and services cheaper relative to European and US competitors (p.c. Interview Codes #106). However, other firms experienced a severe impact because a number of major projects in Asia were cancelled (p.c. Interview Codes #55; #95; #96; #99a). When averaged, the sample reveals a moderate impact.

Exporting in the industry is relatively recent, with the overall median period for first export orders being 1990-94, about a decade after the median period of establishment (Table 6.4). There was little exporting from Australia before the 1980s - consequently there is scant literature on this history (Section 4.3.1). As shown in Figure 6.6, long-term exporters (i.e. before 1980) are large and medium size firms. This is an expected result, as exporting for over two decades probably has provided the capital for a firm to grow. Smaller firms - usually because they are younger and have less capital and experience - have a more recent exporting history. There are also some large firms with recent exporting histories, possibly because a saturated domestic market has hindered these firms and so opportunities have been sought in Asia.
The time elapsed between the establishment of firms and when they begin to export is reported in Table 6.4. For all sizes the median time period is 10 years. About one-third of firms do export within a few years of establishment, suggesting that their strategy at formation was to intentionally be an exporter. Examples of this type include small ‘start-ups’ with an innovative product (p.c. Interview Codes #61; #78). For a number of firms that are foreign owned, their establishment in Australia was to serve primarily the domestic market. Exports developed some years later, and then often as an adjunct to their domestic activities (p.c. Interview Codes #94; #96; #101). These findings support the earlier explanation of why no significant difference is detected in age between exporters and non-exporters.

Table 6.4 Time of establishment and first export orders for exporting firms by size (N = 67)

<table>
<thead>
<tr>
<th>Period</th>
<th>Time of firm establishment (exporters only)</th>
<th>Time of first export orders/ contracts</th>
<th>Time elapsed between establishment and first export orders/ contracts (years)</th>
</tr>
</thead>
</table>
| All exporting firms | N = 67  
Median 1980-84  
Mode <1975 | N = 67  
Median 1990-94  
Mode 1995-99 | Median 10 years  
(although 23 firms < 5 years) |
| Small | N = 31  
Median 1985-89  
Mode 1980-84 | N = 31  
Median 1990-94  
Mode 1995-99 | Median 5 years  
(for 9 firms < 5 years)  
(for 3 firms > 20 years) |
| Medium | N = 23  
Median 1985-89  
Mode 1985-89 | N = 23  
Median 1990-94  
Mode 1990-94 | Median 5 years  
(for 10 firms < 5 years)  
(for 2 firms > 20 years) |
| Large | N = 13  
Median <1975  
Mode <1975 | N = 13  
Median 1985-89  
Mode 1985-89 | Median 10 years  
(for 4 firms < 5 years)  
(for 1 firm > 20 years) |


Two reasons account for this relatively recent export history. First, developments within the domestic industry over the past decade have changed home demand conditions. The most notable are the corporatisation of water utilities and more stringent environmental legislation (Section 4.3.3). These developments have resulted in some firms becoming more competitive because of the ability to meet new demand conditions. Domestic competitive advantage develops, with some firms seeking overseas markets for new opportunities (p.c. Interview Codes #27; #71; #99a). This observation is consistent with Porter’s (1990) idea that strong demand in the home market creates a more vibrant competitive industry with export potential.

A second reason is the growth of overseas markets, particularly in South East Asia, because of rapid infrastructure development and the need for expertise in water technology and management (Section 1.1). Legislation helps drive demand, as well as an economic imperative to protect fisheries and tourism from environmental degradation (OECD 1996). Since the early 1990s Australian firms and government departments have recognised the
potential of overseas demand (Economic Development Committee 1995). However, as Section 4.2 reported, international competition is fierce.

6.1.6 Summary of characteristics

Section 6.1 has described some of the characteristics of the industry in terms of the location, size, type and ownership of firms, and features of the exporters. The industry is mainly located in capital cities, with the majority of firms in Melbourne and Sydney. The industry is a diverse collection of large, medium and small firms, engaged in an array of manufacturing and service activities. About one third of the sample is small, privately owned Australian firms. Although large multinational firms comprise the major proportion of aggregate turnover, small and medium size firms still have about quarter of the share. Importantly for testing theories, the sample has exporters and non-exporters. About half of the ASX-listed firms are small Australian start-ups. Exporting firms tend to have a greater turnover and be larger than non-exporters. The exporting history for the majority of firms is quite recent.

6.2. Explaining diversity

The industry is characterised by diversity in size, activity and type of ownership. This section proposes reasons why. The co-existence of small and large firms in the water industry reflects much industrial development where no one organisational form dominates; rather there is a combination of standardised mass production and flexible specialisation (Dicken 1992; Malmberg 1994; Park 1996). An OECD (1992) profile of the global environmental technology industry, for example, reports that Australia has a typical structure where a few large firms account for about 50% of output, with the remainder consisting of many small and medium size firms.

For intermediate goods and services, there are several general explanations why small firms can co-exist with larger firms. One is that the specialist requirements of some clients create opportunities for specialist firms (Bryson et al. 1993; Lindahl and Beyers 1999). Flexible specialisation by larger firms creates opportunities for subcontracting smaller firms (Piore and Sabel 1984). It is also argued that economies of scale are not as crucial to competitive
advantage as in previous production regimes, due to specialist requirements in manufacturing and services (McKinsey et al. 1993; Dicken 1998). Information technology is another reason that allows smaller firms to compete internationally, even in a semi-peripheral economy like Australia’s (McKinsey et al. 1993).

Water industry reform in Australia also has implications for the size of firms. The outsourcing by water utilities has created opportunities for some smaller specialist consulting firms (p.c. Interview Codes #85; Survey Code #83). More stringent environmental legislation has also contributed to demand in specific areas (e.g. monitoring equipment) (p.c. Interview Code #27; Survey Code #29). A few smaller firms have been able to exploit these opportunities because of their flexibility to adapt quickly. Medium size consulting firms, previously involved in other civil engineering projects, have also moved into this market (Survey Code #93). Multinational water firms from France and the UK have been active in the more competitive domestic environment. In particular, the French firms are vertically integrated, which also limits opportunities for domestic firms. The speculation is that over time the industry will become more homogenous as larger firm become more dominant (p.c. Interview Codes #106; #120). Time series data would be needed to confirm any trends.

The water industry also displays diversity in the types of activities (see Figures 5.3; 5.4). In one respect this diversity is simply because when most industries are broken down into supporting and related constituents, then an array of activities is revealed. Also by its nature, providing potable water requires a number of manufactured products and services (see Figure 4.1). In addition, different geographic regions can create different demands. For example, expertise in groundwater management is more specific to the water industry in Perth than in Melbourne (p.c. Interview Code #92).

Diversity is further evident in the different types of ownership arrangements. A number of factors account for this. Some larger Australian engineering firms are not ASX-listed because managers do not want to relinquish control (p.c. Interview Codes #99a; #100a). Alternatively, a few smaller manufacturing firms are listed to gain access to capital for expansion (p.c. Interview Codes #51; #61; #71; #78). The majority of the sample is small
privately owned firms (Figure 6.3). This is partly because the specialist requirements of the industry allow some small firms to find niches and thrive. However, recall from Table 6.2 that large firms command almost three-quarters of the proportion of industry turnover. The influence of small specialist firms, while important, needs to be kept in perspective as large multinationals still wield considerable influence.

6.3 The industrial organisation: linkages with related and supporting industries

Investigating the linkages that firms have with related and supporting industries reveals the geography of industrial organisation. This can partially explain how competitive advantage and trade develop (Sections 2.3.4; 3.2.1). Section 6.3 determines the strength of the linkages that Australian water industry firms have with domestic related and supporting industries. Three sub-questions are asked: 1) what proportion of the manufacturing firms in the sample rely on domestic suppliers; 2) is there a difference between manufacturing exporters and non-exporters in the use of domestic and overseas suppliers; 3) when service firms from Australia work overseas, where are component supplies and sub-contractors sourced from?

Table 6.5 outlines the findings from the first question. Domestic linkages between manufacturers and component suppliers are not well developed since less than one-third of manufacturing firms (both exporters and non-exporters) obtain their supplies nationally. Moreover, domestic supplies are often ‘low-tech’ inputs (e.g. pipes, sheet metal and electrical wire (p.c. Interview Codes #35; #55). In contrast, manufacturers dependent on overseas suppliers often import elaborately transformed components that cannot be sourced domestically (e.g. electronic devices, highly engineered hardware such as specialised valves or pumps) (Survey Codes #48; #62; p.c. Interview Codes #37; #81). Those firms that depend on a combination of sources tend to use Australian suppliers for basic inputs and overseas suppliers for more complex inputs (Survey Codes #3; #29; p.c. Interview Codes #27; #44). As expected, foreign owned firms often obtain components from their parent company. Yet over half of the Australian owned firms (both exporters and non-exporters)
also rely on overseas suppliers. Of the 48 Australian owned manufacturing firms, 11 import critical components and a further 15 use a combination of local and overseas suppliers.

A question raised during some interviews was why import critical components to be assembled into a product to be sold domestically or overseas, when the final buyer could import the finished product from Europe or the US and by-pass the local manufacturer. The answer is that competitive Australian labour costs make this viable: although imported components are expensive, the total fabrication costs in Australia are still lower than for European or US counterparts. It can be cheaper to import individual components to be assembled and sold domestically or internationally, rather than importing the finished goods (p.c. Interview Codes #64; #35).

There are a few cases of firms have strong linkages with domestic suppliers of critical components. This is because of specialist requirements. For example, one filtration manufacturer obtains its plastic fittings from specialist local suppliers. As explained: “(because the components come into contact with drinking water), the raw materials have to be controlled and that creates a need to work closely with raw material suppliers because if they change their product this nullifies our approval” (p.c. Interview Code #55).

However, it was added that because the input materials are relatively light and the filtration manufacturer is not large scale (but rather low volume/ high value), then such suppliers can be 40 or 50 km away.

**Table 6.5 Location of suppliers for manufacturers** (N = 78) (exporters and non-exporters)

<table>
<thead>
<tr>
<th>Location of suppliers</th>
<th>No. of firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mainly use Australian suppliers</td>
<td>24 (31%)</td>
</tr>
<tr>
<td>Mainly use overseas suppliers</td>
<td>31 (40%)</td>
</tr>
<tr>
<td>Combination</td>
<td>23 (29%)</td>
</tr>
</tbody>
</table>

*Notes:*
1. Australian suppliers could be either local or national. The question did not distinguish this as the comparison is primarily between the national and international scales.
2. Percentages have been rounded.

In addressing the second question, Table 6.6 reveals that exporters proportionally rely more on Australian suppliers than non-exporters. Conversely, non-exporters use overseas suppliers to a greater extent. This finding is theoretically supported by Porter’s (1990) ideas about the importance of strong related and supporting industries for competitiveness. However, the result shown in Table 6.6 only borders on statistical significance. It is suggested from this evidence that the use of Australian suppliers possibly increases the propensity to export. Yet almost two-thirds of the exporters rely on overseas suppliers, or a combination of overseas and domestic suppliers. Determinants other than supplier location account for competitiveness and export propensity, as explored in subsequent chapters.

### Table 6.6 Location of suppliers for manufacturers: exporters and non-exporters
(N = 78)

<table>
<thead>
<tr>
<th>Location of suppliers</th>
<th>Exporters N = 55</th>
<th>Non-exporter N = 23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mainly use Australian suppliers</td>
<td>No. of firms 19</td>
<td>Proportion 35% (16.9)</td>
</tr>
<tr>
<td>Mainly use overseas suppliers</td>
<td>No. of firms 17</td>
<td>Proportion 30% (21.9)</td>
</tr>
<tr>
<td>Combination</td>
<td>No. of firms 19</td>
<td>Proportion 33% (16.2)</td>
</tr>
</tbody>
</table>

\[ X^2 (2) = 6.15; p = 0.05 \]

**Notes:**
1. Numbers in parentheses are expected values for a model of no association between export status and location of suppliers.

**Source:** author’s surveys and interviews 1998 – 2000.

The linkages that service firms have with upstream suppliers when working overseas are shown in Table 6.7. The main finding is that there is minimum reliance on Australian suppliers and contractors (question 3). Even considering the large proportion of unknown data, almost one-quarter of the sample indicated that they use contractors (e.g. for construction, pipes, electrical work) from the country they are working in (p.c. Interview Codes #96; #100a; #105; #114). Part of the reason is that because many projects are funded
by international banks and aid organisations, there is a stipulation to use local content from the recipient country. Also it can be cheaper to use local firms, particularly in Asia, for construction and electrical work (p.c. Interview Code #105). Note that there is a distinction between sub-contractors (defined as temporary, vertical linkages), and alliances and joint ventures (defined as more permanent, horizontal linkages). Arrangements involving horizontal linkages frequently involve an Australian firm teaming with a local partner in the recipient country to gain export access. This method of export is discussed in Section 9.1. Subcontracting, on the other hand, is infrequently used as a method of export access. The low reliance on Australian subcontractors when working overseas is evidence of weak linkages between Australian firms.

Table 6.7 Location of suppliers/ contractors for service firms when working overseas
(service exporters only N = 33)

<table>
<thead>
<tr>
<th>Use of local contractors/ firms in importing location</th>
<th>Use of contractors &amp; equipment suppliers from Europe</th>
<th>Large reliance on Australian sub contractors 2 &amp; equipment suppliers</th>
<th>Unknown/ not answered</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 firms (24%)</td>
<td>3 (9%)</td>
<td>1 (3%)</td>
<td>21 (64%)</td>
</tr>
</tbody>
</table>

Notes:
1. Includes branch plants of same firm (5 cases).
2. Refers to subcontracting such as electrical work, plumbing, building and construction. Does not include design or consultancy collaboration or joint ventures.
3. The large proportion of unknown data is because only latter surveys and interviews explored the linkages of service exporters. This neglect was due to an undeveloped theoretical understanding at the time.


Local linkages between service providers working in Australia and domestic component suppliers are also not well developed. Several respondents from design and consulting firms noted that some domestic projects use equipment manufactured in Australia (p.c. Interview Codes #87; #98b; Survey Codes #93; #103b). However, no evidence was forthcoming for consulting engineering firms having linkages with nearby (i.e. 5 km radius) supplier firms or research institutions (p.c. Interview Codes #99b; #105; #109). Interestingly, the Australian industry was described as ‘fragmented’ in 4 cases, without any prompting from the interviewer (p.c. Interview Codes #85; #101; #123; #127). As one respondent commented: “The whole question of networking within the industry is a
problem because it is dominated by SMEs (small and medium enterprises) and is fragmented” (p.c. Interview Code # 101).

Section 6.3 has found that the local linkages are weakly developed between Australian water industry firms and related and supporting industries. For a number of manufacturing firms, critical components are imported before being assembled in Australia for export. Service firms doing overseas contract work often rely on sub-contractors in the recipient country; Australian component suppliers and contractors are infrequently used. In addition, there is no evidence of strong links between local consulting firms and nearby suppliers or research institutions. There is, however, a suggestion that linkages with domestic related and supporting industries are more common with manufacturing exporters than non-exporters. For most firms though, the reliance on local suppliers is not strong and there are not distinct industry clusters.

6.4 Why are the linkages weak?

The findings from this sample are consistent with other reports on the water industry and the broader Australian environmental industry. For instance, Bainbridge (1997), the Environment Industry Development Network (1996), and the Environment Industries Focus Unit (1998) have referred to the industrial organisation as fragmented and having weak linkages between supplier industries. Some reasons are proposed to account for this.

National industrial characteristics are a major reason for the lack of strong supporting and related industries. Australia has a relatively small manufacturing sector compared with larger OECD nations (Rich 1987). As the empirical work finds, most of the elaborately transformed components used as supply inputs originate from countries where the manufacturing and engineering sectors are more developed, namely Germany, the UK and Sweden. These nations have strong related and supporting industries that are relevant to water technology. For example, Germany has a large chemical industry that has led to the development of world-class suppliers of pumps, liquid measurement and control equipment (Porter 1990: 140). Often hardware is imported into Australia, or equipment is manufactured locally under licence by branch plants of parent firms from these countries.
(Survey Codes #3; #58; #63; #66). Most Australian industries usually lack the scale economies that enable domestic firms to strongly compete with firms from the larger manufacturing economies (McKinsey et al. 1993; DISR 1999).

Another reason for the weak linkages is that intense domestic demand conditions for this industry are only a recent development (Section 4.3.1). Decades of vertically integrated State ownership of water services are likely to have stifled opportunities, especially for sub-contractors (p.c. Interview Code #120). Porter (1990) argues that demanding buyers are necessary for related and supporting industries to constantly upgrade. For the Australian water industry such conditions are possibly still evolving, since it has only been over the past decade that water industry reforms and exposure to international competition have made buyers (e.g. engineering firms and water utilities) more demanding. Furthermore, stringent environmental legislation that stimulates demand for certain technologies and expertise still has a relatively recent history (ABC Radio National 1998). Over time, the emergence of an exporting industry could create the demand conditions to coalesce domestic relating and supporting industries, thereby creating a virtuous cycle.

A third reason is that water industry firms do not have a high propensity to cluster. Possibly the weak linkages result in a lack of clustering. Other reasons are that the water industry is not confined to particular geographies due to the ubiquitous nature of the resource, and also because the related technologies are usually not confined to particular geographies (p.c. Interview Code #106). While there are concentrations of water industry firms in urban centres (e.g. manufacturers and service provider firms in Melbourne’s southern suburbs [Figures 6.1; 6.2]), these are indications of urbanisation economies, not localisation economies. Furthermore, there appears to be no evidence in the literature of agglomerations of water industry firms, even in France. However, this claim is based upon literature searches confined to the English language. There are broad, cursory references to clusters of environment technology manufacturers in Southern China and Arizona (USA), but no other information is forthcoming (e.g. Wetzel 1995; United States Department of Commerce 1997).
So does the absence of localisation economies mean that the domestic industry has limited capacity for innovation? As was discussed in Section 2.3.4, spatial clustering is not an essential condition for innovation. Malmberg (1996; 1997) and McCann (1995) contend that few studies are able to show predominantly local linkages. Corporate strategies involving intra and inter-firm linkages can allow firms to access innovation from geographically external sources (Caves 1989; Dicken and Lloyd 1990; Appold 1995; MacKinnon et al. 2002). Networks across space facilitate technology transfer (Bryson and Daniels 1998). Furthermore, the empirical work reveals several cases of innovative exporting firms located in relative isolation from urban cores (e.g. CDS Technologies located at Mornington, Victoria; Memtec/US Filter Corporation at Windsor, NSW; and Greenspan Technology Pty Ltd at Warwick, Queensland). These firms obtain innovation and competitive advantage from inter-firm linkages, networks with distant research institutions, and internal R & D (p.c. Interview Codes #55; #61; Survey Code #29). Localisation economies are not involved in the process. In these particular cases, the influence of urbanisation economies is probably still present to some extent, as the locations are on the fringe of urban areas. The firms are manufacturers so possibly do not require as much on-going face-to-face consultation with clients, whereas service providers do require contact and so are located much closer to urban cores. Research by Harrison et al. (1996) of the US metalworking sector also finds that the most innovative manufacturers are located at urban fringes. This suggests that even strong urbanisation economies may not be essential to innovation creation.

6.5 Conclusion

Chapter 6 has provided a statistical description of the sample. Some of the research questions have been addressed: the characteristics and organisation of the industry, whether there is evidence of clusters, and the types of linkages between related and supporting industries (Table 6.1). What has been found is that the industry is a diverse collection of different sizes of firms and ownership structures. The opportunities for specialist firms and water industry reforms account for this diversity. The sample’s diversity is useful to test the explanation developed in Part One. Some characteristics of exporting and non-exporting firms have been compared but more analysis is required to distinguish differences.
The most significant finding of this chapter is that although most firms are in urban regions, localisation linkages are not evident. The linkages between local related and supporting industries are weak. This is a reason why clusters of related and supporting industries do not form. The conclusion is that competitive advantage for this industry is not an outcome of strong related and supporting industries. The sources of innovation are also not likely to be from intense interactions between firms located in spatial clusters. Subsequent chapters search for other explanations for the development of competitive advantage and innovation, and ultimately trade.
Chapter 7
Explaining competitive advantage for the water industry

As discussed in Part One, competitive advantage is a vital strand in an explanation of trade. Chapter 3 explains how competitive advantage manifests at the level of the firm. Chapter 7 builds on these theoretical ideas to explain how competitive advantage is created for the water industry and to discuss why these results are found. In the process several research questions are addressed (Table 7.1).

Table 7.1 Research questions addressed in Chapter 7

<table>
<thead>
<tr>
<th>Questions from theoretical discussion (Table 3.3)</th>
<th>Relevant section in Chapter 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the relationship between competitiveness and export performance?</td>
<td>7.1.1</td>
</tr>
<tr>
<td>Does the size and age of firms have an influence on firm-performance?</td>
<td>7.1.2</td>
</tr>
<tr>
<td>How is competitive advantage created for firms in industry?</td>
<td>7.2</td>
</tr>
<tr>
<td>Are particular competitive strategies related to the performance of firms? Why or why not?</td>
<td>7.2.4</td>
</tr>
<tr>
<td>How does Porter’s ‘diamond’ model relate to this industry?</td>
<td>7.3</td>
</tr>
<tr>
<td>Does factor disadvantage contribute to an explanation of trade for this industry?</td>
<td>7.3.1</td>
</tr>
<tr>
<td>What types of corporate strategies (e.g. alliances, licensing, acquisitions, merger, FDI) are used and why?</td>
<td>7.4</td>
</tr>
<tr>
<td>What is the relationship between inward FDI and domestic industry exports?</td>
<td>7.4.3</td>
</tr>
</tbody>
</table>

Source: selected questions from Table 3.3.

The structure of this chapter is as follows. Section 7.1 tests the relationships between proxies for competitiveness and export performance. These proxies are assumed to measure the level of performance by the firm (Wakelin 1997; Lindahl and Beyers 1999). The influences of the size and age of firms on these proxies are considered. Section 7.2 investigates how competitive advantage is created for the water industry. Competitive advantage is found to be a multifaceted concept. The relationship between the performance of firms and the type of competitive strategy pursued is also investigated. In
Section 7.3 the characteristics of the industry are related to the determinants of Porter’s diamond model. The type of corporate strategies that are prevalent and why they are used is the subject of Section 7.4. Section 7.5 appraises what has been found and suggests several interpretations.

**7.1 Competitiveness: testing assumptions and relationships**

Firms that are more productive are assumed to be more competitive and have a greater propensity to trade. This fundamental concept has been explained at several points in the thesis (Sections 2.3.1; 3.2; 3.3; 6.1.4). Turnover per employee is used as proxy to measure productivity and thus competitiveness (O’Farrell et al. 1992; Beyers and Lindahl 1996; Lindahl and Beyers 1999). Section 7.1.1 tests the assumption that greater competitiveness at the level of the firm leads to trade. Reasons are proposed for the weak relationships. The influences of size and age on proxies for firm-performance are tested in Section 7.1.2.

**7.1.1 Relationships between competitiveness and export performance**

Two related hypotheses are tested for export performance (i.e. the proportion of exporting firms and the proportion of export revenue by these firms). The first hypothesis is that the quartile with the highest turnover per employee has the highest proportion of exporters. Conversely, the quartile with the lowest turnover per employee has the lowest proportion of exporters. Column 2 of Table 7.2 reports the findings. Although the second quartile shows a higher proportion of exporters, a chi-square test reveals no significant difference between the quartiles (p = 0.56).

The second hypothesis is that for the exporting firms, those in the upper quartiles have a higher mean export proportion (i.e. export turnover per total turnover) than the group of exporters in the lower quartiles. No significant difference is detected between mean export proportion for exporting firms in the upper quartile of turnover per employee when compared to the lowest quartile (p = 0.49) (Table 7.2 Column 3). The null hypothesis - that export proportion is not related to sales per employee - cannot be rejected on this evidence. The findings fail to find evidence of a relationship between
turnover per employee (as a proxy of competitiveness) and the amount of exporting done by a firm.

**Table 7.2 Relationship between turnover per employee and export performance**

<table>
<thead>
<tr>
<th>Turnover per employee by quartile</th>
<th>Proportion of exporters as % of total in each quartile (taking 72% (^2) as expected value)</th>
<th>Average export proportion (per turnover) for exporters in each quartile</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 106 (exporters &amp; non-exporters) (13 firms with unknown amounts)</td>
<td>N = 77 (exporters only)</td>
<td>N = 57 (exporters only) (20 exporters with unknown values)</td>
</tr>
</tbody>
</table>
| 1\(^{st}\) quartile N = 27        | 63% (17 exporters)                                                                            | N = 10
Mean = 0.20
(s.d. = 0.29)
Median = 0.1 |
| 2\(^{nd}\) quartile N = 26        | 92% (24 exporters)                                                                            | N = 18
Mean = 0.19
(s.d. = 0.23)
Median = 0.09 |
| 3\(^{rd}\) quartile N = 26        | 73% (19 exporters)                                                                            | N = 14
Mean = 0.18
(s.d. = 0.20)
Median = 0.11 |
| 4\(^{th}\) quartile N = 27        | 63% (17 exporters)                                                                            | N = 15
Mean = 0.22
(s.d. = 0.22)
Median = 0.13 |
| Statistical summary              | Chi–square test \((X^2 (3) = 2.09; p = 0.56)\)                                                | Comparison of means between upper and lowest quartile T test (equal variance; log transformed) \(t (23) = -0.705\) \(p = 0.49\) (two-tailed) |

**Notes:**
1. Export performance is a collective term for the proportion of exporters in a category and the average export proportion.
2. Of the 119 commercial firms and research organisations surveyed, 86 are exporters (72.3%) (Table 6.3).

**Source:** author’s surveys and interviews 1998 – 2000.
Reinforcing the findings in Table 7.2, a regression analysis reveals no detectable relationship between turnover per employee and export proportion (adjusted $R^2 = -0.02$; $F(1,55) = 0.01; p = 0.91$) (see Appendix D [Figure D.1] for scatterplot). Log transformations on the raw data are conducted to detect any underlying linear relationships (Wright 1997). A scatterplot of this is shown in Figure 7.1. The relationship remains not significant ([log transformed] adjusted $R^2 = -0.01; F(1,55) = 0.20; p = 0.66$). Note that Table 6.3 also did not detect a significant difference between the exporting and non-exporting groups for turnover per employee.

**Figure 7.1 Relationship between turnover per employee and export proportion**

(\(N = 57\) (exporters only) (log transformed))

\[
\ln \text{Export proportion} = -2.46 - 0.06*\ln(\text{turnover/ employee}) \quad \text{(Note: asterisk between coefficients denotes } \times)\]


The lack of evidence of a strong relationship between turnover per employee and export performance is accounted for by several reasons. Firstly, not all firms - even those with a high turnover per employee - aspire to be exporters. As shown in Table 7.2, in both the highest and lowest quartiles for turnover per employee, over one third of firms are non-exporters. Some firms do not export because of various impediments such as the lack of

---

1 Adjusted R square is employed because this is sample data used to estimate a population (Cortson and Colman 2003). The population is the Australian water technology and management industry.
experienced staff, insufficient financial capital, and economic uncertainty and the risk of
default of payment in the importing location (p.c. Interview Code #46; Survey Codes
#47; #76; #77; also see Table 9.3). Secondly, some branch firms of smaller foreign
owned firms do not export because they concentrate exclusively on the domestic market
(Survey Code #2; #32). Third, exporting requires additional staff so the extra turnover
generated by overseas sales may not greatly change the ratio of turnover per employee.

Fourthly, expecting a causal relationship between a simplistic measure of productivity
and export proportion could be a flawed assumption. It is possible that exposure to
foreign competition can spur productivity growth in firms, rather than exports simply
being an outcome of productivity (Bernard and Jensen 1995; Leichenko 2000).

Another related reason is that the definition of productivity (and competitiveness) is
limited to turnover per employee. There are other measures that are valid proxies,
including the value of fixed capital costs and output per unit of capital expenditure
(Webber and Rigby 1996: 187-9). The empirical work, however, lacks the necessary data
to use alternative measures of productivity.

There are other reasons that explain exports, independent of what the turnover per
employee is. Networks are an important determinant, such as a firm having an established
reputation amongst numerous contacts. Possessing appropriate technology is another
factor (Bryson et al. 1993; O’Farrell et al. 1993; Lindahl and Beyers 1999).

A final reason for not detecting any relationship is that this sample contains
heterogeneous firms (i.e. service providers and manufacturers). Inaccuracies result
because exporting service firms possibly require more staff per unit of turnover than
capital-intensive manufacturing firms. Manufacturing firms in the Australian water
industry are found to have a significantly higher turnover per employee than service firms
(see Table 8.9). More accurate tests of relationships would require comparing large
samples of firms involved in relatively similar goods or services.
7.1.2 The influences of size and age on firm-performance

From the previous chapter (Table 6.3), a comparison of exporting and non-exporting firms suggests that size makes a difference to export propensity but age does not. In developing an explanation of trade, it is useful to test further the influences of size and age on firm-performance (i.e. competitiveness and export proportion).

Table 7.3 reports the relationship between turnover per employee (i.e. competitiveness) as the dependent variable and the independent variables of size and age. The regression analysis reveals a weak relationship, but still statistically significant ([log transformed] adjusted $R^2 = 0.07$; $F (2, 85) = 4.13; p = 0.02$). Firm-size appears to influence competitiveness ($p = 0.03$). Economies of scale possibly play some role because a large firm can generate more turnover per unit of labour than a smaller firm. Multinational linkages give some large firms the ability to use different locations to generate higher turnover per employee than if production takes place in one location. Although significant, the relationship between size and competitiveness is not particularly strong (i.e. not substantially significant) because scale economies are not dominant across the industry. This is because capital equipment used in the water industry is usually not mass-produced (p.c. Interview Codes #55; #79). Moreover, there are opportunities for specialist firms (p.c. Interview Code #71; #96).

Firm-age is not a predictor of turnover per employee. Although competitiveness can take time to develop, newly established firms can employ individuals with long industry experience and so develop expertise rapidly (Interview Code #78). Thus the use of ‘young’ may be a misnomer in these cases. Some young firms have a high turnover per employee if they are specialists. Other young firms have a lower turnover per employee because the business is fledgling and growing. In addition, some older firms that are involved in an activity of the industry considered mature (e.g. pumps and chemicals), might show a lower turnover per employee because the market is stagnant for their product. Alternatively, other older firms possibly have economies of scale and achieve higher turnovers per employee.
Table 7.3 Multiple regression analysis for turnover per employee (dependent variable) and turnover (i.e. firm-size) and firm-age (independent variables)

N = 88 firms (exporters and non-exporters where sufficient data is available) (log transformed)

\[
\ln \text{Competitiveness} = -1.96 + 0.26*\ln \text{turnover} + 0.07*\ln \text{years}
\]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>Adjusted R² = 0.07</td>
</tr>
<tr>
<td>F (2, 85) value = 4.13</td>
<td>p = 0.02 *</td>
</tr>
<tr>
<td>Turnover (A$ M p.a.) (log transformed)</td>
<td>p = 0.03 *</td>
</tr>
<tr>
<td>Firm-age (age of firm in 2000) (log transformed)</td>
<td>p = 0.53</td>
</tr>
</tbody>
</table>

Note:
1. Rigby (2004) comments that firm-size and age could alternatively be dependent on turnover per employee. This question of endogeniety could be addressed if more variables were available.


Table 7.4 shows the results from testing whether export proportion can be explained by turnover per employee, firm-size and age. No relationship is detected ([log transformed] adjusted R² = -0.05; F (3, 57) = 0.09; p = 0.96). Section 7.1.1 explained why no relationship is established between turnover per employee and export proportion. Nor is there an evident relationship between firm-age and export proportion. Age is not related to export proportion because young firms can export soon after being established (see Table 6.4). This is particularly so if the new firm offers a specialist product or service (p.c. Interview Codes #51; #61; #78). Also, young firms can employ personnel who have experience with export markets (p.c. Interview Code #51).

No relationship is evident between firm-size and export proportion (Table 7.4). The diversity of activities in the water industry provide specialist niches for small firms. The competitive advantage of small specialist firms has been noted by other researchers (Piore and Sabel 1984; O’Farrell et al. 1993; Beyers and Lindahl 1996; Keeble and Bryson 1996). Some smaller firms become successful exporters, partly because they can be more flexible to exogenous change than the more rigid management structures of larger firms (Porter 1990; McKinsey et al. 1993; Beyers and Lindahl 1996). Indeed, ABS (1998 #8154.0) research finds that three-quarters of exporting Australian firms are small (although they only account for 13% of total export revenue). The ability to develop a niche can give smaller players a competitive edge, whereas larger organisations can be
less flexible and slower in responding quickly to changing market conditions (Porter 1990).

An addition factor why size appears unrelated to export proportion is that foreign-owned branch offices tend to focus on the Australian market, with exports usually serving as an adjunct activity (p.c. Interview Codes #90; #92; #101). Of the sample of large firms, 60% (11 out of 18 firms) have an overseas multinational parent. Only one of these foreign MNCs (an arm of an UK utility) mentioned it was using Australia primarily as a platform for exporting into Asia (p.c. Interview Code #90).

Why does the size of the firm not seem to influence export proportion, yet does influence turnover per employee? Wakelin (1997: 129) offers a hypothesis why a large firm can have a high productivity measure but not export. A large domestic monopoly may have no incentive to export because the monopoly would become a price-taker in a competitive foreign market with a higher elasticity of demand. Therefore, there may be scale economies resulting in a high turnover per employee but because the firm is satisfied with its position in the domestic market, it does not export.

Table 7.4 Multiple regression analysis for export proportion (dependent variable) \(^1\); turnover per employee; firm-age and turnover (independent variables)

\( N = 61 \) (exporters only) (log transformed)

\[
\ln \text{Export proportion} = -2.5 - 0.07*(\ln \text{turnover per employee}) + 0.02*(\ln \text{years}) - 0.001*(\ln \text{turnover})
\]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>Adjusted ( R^2 = -0.05 )</td>
</tr>
<tr>
<td>( F (3, 57) ) value = 0.09</td>
<td>( p = 0.96 )</td>
</tr>
<tr>
<td>Turnover per employee (log transformed)</td>
<td>( p = 0.62 )</td>
</tr>
<tr>
<td>Firm-age (age of firm in 2000) (log transformed)</td>
<td>( p = 0.92 )</td>
</tr>
<tr>
<td>Turnover (AS M) (log transformed)</td>
<td>( p = 0.99 )</td>
</tr>
</tbody>
</table>

1. Note:
Export proportion is used as the dependent variable because the investigation is to test what determines export performance. Rigby (2004) cautions that specification bias may be present. To lessen the likelihood of bias, in Section 11.1.2 a factor analysis is conducted on all variables. No dominant factor is found that distinguishes exporters from non-exporters.

The evidence presented in Section 7.1 does not support the assumption that firms with the higher turnover per employee have a greater propensity to export, or have higher proportional export revenue, than firms with a lower turnover per employee. One reason is that some firms with a high turnover per employee are not necessarily exporters. Testing firm-performance using the variables of size and age reveals that size appears to have an influence on turnover per employee. Economies of scale are a probable factor. No evidence is found that size and age are related to export proportion. Reasons include characteristics of the industry where small and young specialist firms can create competitive niches. There is awareness that using turnover per employee as a proxy for competitiveness has limitations. A qualitative approach is pursued next to understand further how competitive advantage is constructed and related to trade.

7.2 The creation of competitive advantage in this industry

In Porter’s interpretation (1985; 1990), firms create competitive advantage by pursuing two basic competitive strategies: cost and differentiation. Porter strongly contends that firms are rarely successful if simultaneously attempting both strategies (Section 3.2.1). Using these ideas as a basis, this section firstly describes how competitive advantage is created for the water industry. Section 7.2.2 explains why certain strategies prevail. Section 7.2.3 highlights a factor that lies outside Porter’s model - cultural affinity. The relationships between competitive strategy and firm-performance are investigated in Section 7.2.4. Section 7.2.5 proposes reasons for the lack of relationships found. Section 7.2.6 summarises how competitive advantage is created in the water industry.

7.2.1 How competitive advantage is created

Respondents were asked in interviews to define competitive advantage for their firm, mainly in the context of international markets. The question was left open-ended, unlike Lindahl and Beyers’s (1999) approach on a similar question where respondents were asked to rate the importance of a predetermined list of factors. The open-ended approach was chosen so answers were not constrained. Without any soliciting from the interviewer, a number of common factors emerge (Table 7.5). Focused differentiation strategies are dominant, with cost strategies assuming minor importance. No firm mentioned cost
The two main themes underpinning the most frequently mentioned factors are the importance of business relationships and having appropriate and adaptable products and services.

**Table 7.5 Factors noted as important for contributing to competitive advantage**

(N = 28 firms) (19 service providers; 9 manufacturers)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Frequency of citation</th>
<th>Classification of competitive strategy related to factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Providing backup service/operator training</td>
<td>11</td>
<td>F.D.</td>
</tr>
<tr>
<td>Cost competitiveness</td>
<td>8</td>
<td>C.</td>
</tr>
<tr>
<td>Unique or innovative products.</td>
<td>7</td>
<td>F.D.</td>
</tr>
<tr>
<td>Being a specialist</td>
<td>7</td>
<td>F.D.</td>
</tr>
<tr>
<td>Part of multinational group/network</td>
<td>7</td>
<td>M.</td>
</tr>
<tr>
<td>Cultural affinity</td>
<td>6</td>
<td>n.d.s.</td>
</tr>
<tr>
<td>Project management skills (i.e. ability to assemble appropriate teams for projects)</td>
<td>6</td>
<td>F.D.</td>
</tr>
<tr>
<td>Appropriate technology suited to clients needs</td>
<td>5</td>
<td>F.D.</td>
</tr>
<tr>
<td>Having access to international R &amp; D</td>
<td>3</td>
<td>M.</td>
</tr>
<tr>
<td>Reliability</td>
<td>2</td>
<td>F.D.</td>
</tr>
<tr>
<td>Geographic proximity to Asia.</td>
<td>2</td>
<td>n.d.s.</td>
</tr>
<tr>
<td>‘Clean &amp; green’ image.</td>
<td>1</td>
<td>n.d.s.</td>
</tr>
</tbody>
</table>

**Notes:**
1. This sample is from interviews only. There were 38 interviews in total with commercial entities (Section 5.3.2). Of these, 28 interviews yielded sufficient detail for findings to be compared across a range of factors. Surveys did not explore competitiveness.
2. Some of the nominated factors could arguably cross over (e.g. backup service and reliability) but are recorded as separate to remain true to the interview source.
3. An individual firm may nominate more than one category so total responses exceed number of firms.
4. Classifications of strategies are adapted from Porter (1985; 1990) and Lindahl and Beyers (1999). Porter also includes cost leadership and general differentiation as strategies for markets with a broad clientele (see Section 3.2.1). The water industry, however, comprises producers of specialised intermediate goods and services; hence the classifications are confined to two of Porter’s sub-categories (focused differentiation and cost focus). (Source [Table 7.5]: author’s interviews 1998 – 2000.)
Focused differentiation

Most of the factors reported in Table 7.5 fall into Porter’s (1985) strategic classification of focused differentiation (i.e. specialist expertise is important but not the price or range of expertise). This strategy itself is multifaceted as 12 out of the 15 firms pursuing differentiation mentioned two or more factors.

The most cited factor within the classification of focused differentiation is back-up service. This factor is integral to the marketing of industrial products (Lynch 1994; Wright 1994; Morris et al. 2001). One representative from a multinational engineering firm commented that project failure is often because companies do not provide follow-up training to the indigenous operators, adding: “Australia and New Zealand have good reputations in providing operating skills with products” (p.c. Interview Code #98b). A characteristic of the water industry - and industrial products generally - is that many manufacturers also need to be service providers to remain competitive. A representative of a specialist manufacturer of industrial wastewater treatment noted: “With industrial waste and effluent, each site is unique, (so) chemical characteristics of wastewater need to be taken into account. You just can’t take off-the-shelf technology, as some companies in Australia have done in the past. To export you need to bundle up services” (p.c. Interview Code #79).

Appropriate technology (i.e. having a product or service suited to the technical expertise of the users) is another prominent factor contributing to competitive advantage. This factor is related to back-up service. A number of respondents emphasised that often a ‘high-tech’ solution can be inappropriate in the absence of specialised training and back-up service, particularly in developing countries (p.c. Interview Codes #78; #81; #98b; #106). This has implications for defining competitiveness and innovation in this industry (discussed in Chapter 8). Tendering for certain size projects is another competitive strategy that allows some smaller firms to compete directly with multinationals. A representative from an industry association commented: “We (Australian companies) can always pick up a niche. It could be the big players couldn’t be bothered at that scale - say up to $50 million - because it doesn’t suit their size, scale and scope but to us it is ‘big
bickies’. There’s a market there (that) we can come in at a certain level and mop up” (p.c. Interview Code #121).

Project management skills fall into the classification of focused differentiation, with some consulting firms citing this as a competitive factor. For example: “True competitive advantage is to assemble an appropriate team. …. Australian businesses are reasonably regarded by our Asian clients. However, in the end it is the team you put together. It could just as easily be French, German or American – they all have the know-how” (p.c. Interview Code #98a).

**Multinational group strategy**

Being part of a multinational group is a strategy that is distinct from an exclusive differentiation or cost strategy. Four firms cited this as their sole source of competitive advantage (3 other firms in the sample noted this strategy in combination with other classifications). One respondent from a small firm affiliated with a prominent MNC mentioned: “Our competitive advantage comes from having access to a large multinational R & D network (p.c. Interview Code #112). Inter-firm trade is also part of corporate strategy, discussed in Section 7.4.

**Cost focus**

Competing on cost is only a secondary factor for this industry. No firm in the sample competed solely on cost. Rather, cost was always mentioned in conjunction with quality differentiation factors such as back-up service and the ability to assemble an appropriate team. One respondent commented: “Service industries are built on relationships, (it has) very little to do with the price of the product” (p.c. Interview Code #79). (The function of relationships in creating competitive advantage is discussed in Sections 7.2.3 and 9.2.)

**No definite strategy**

Proximity to Asia and having a favourable environmental image are noted by some firms as competitive factors. These factors alone are insufficient to sustain international trade in an intermediate industry where technological advantage and quality of service are paramount. Yet proximity and environmental image are cited in some reports as strong
sources of competitive advantage for Australian manufacturers, including those involved in environmental technologies (e.g. DITRD 1993; McKinsey et al. 1993; EDC 1995; DIST 1996). Perhaps these reports represent certain interest groups and are liable to make simplistic generalisations to support a particular agenda, without the benefit of extensive fieldwork to test assumptions.

7.2.2 Explaining why differentiation strategies prevail

Competitive advantage for this industry is based more on focused differentiation than cost factors. An AusAID (1999) document supports this observation, stating that when procuring tenders for infrastructure projects, price is 10 to 20% of the evaluation, with technical merit comprising the rest.

There are several reasons why differentiation strategies prevail in industries that feature specialist manufacturers and producer services. According to Lindahl and Beyers (1999), the unstandardised, non-routine nature of producer services is the main reason why cost-based factors are not important. Monnoyer and Philippe (1991) observe that for producer services there is an increased demand for face-to-face contact, making specialised knowledge-intensive labour expensive. Often demand is based on the buyer’s need for specialised knowledge (Bryson et al 1993; O’Farrell et al. 1992; 1993; Lynch 1994; Beyers and Lindahl 1996; Lindahl and Beyers 1999). In Table 7.5, the frequent citations of ‘unique, innovative products’ and ‘being a specialist’ exemplify the importance of specialisation. Yet cost factors are identified as a competitive advantage for some firms. The lower cost of Australian firms relative to European counterparts is mentioned in several cases (p.c. Interview Codes #94; #108; #120). However, cost is always mentioned in combination with other differentiation factors. This finding supports Lindahl and Beyers’s argument that multiple strategies can create competitive advantage. The conflict between this and Porter’s interpretation is discussed further (Section 7.2.4).

Focused differentiation has an emphasis on specialisation and the targeting of specific markets (Table 3.2). This can be conducive to trade for several reasons. Specialisation allows firms to compete at a greater distance (Monnoyer and Philippe 1991; O’Farrell et al. 1992; 1993). This is because a particular product or service provided by a specialist
may be what a discerning buyer in a distant location is seeking. If firms within the buyer’s locality cannot satisfy particular requirements, then specialist firms outside the locality are sought. In addition, a firm offering a specialist product or service will usually not have as many buyers (or clients) in its locality as a firm providing a more general service. To grow, the specialist firm has to look outside its local area. This search may involve gaining overseas clients. In addition, specialisation in producer services increases the demand for face-to-face contact in service delivery, with the seller or buyer often having to travel some distance (Monnoyer and Philippe 1991). Specialisation can also drive intra-firm trade. An example is USF Memcor (formerly Memtec), located at Windsor NSW. Much of its business is supplying its specialist products to different international branches of its French multinational parent (p.c. Interview Code #55).

Yet specialisation by sectors of the Australian environmental industry is noted by some reports as a potential competitive disadvantage (e.g. EIDN 1996; EIFU 1998). This is because overseas clients want integrated solutions and to not have to deal with multiple suppliers (p.c. Interview Code #127). What is recommended is that specialist individual firms form consortiums and strategic alliances to compete internationally. Compared to European counterparts, Australian firms are not practised at forming consortiums (EIFU 1998; p.c. Interview Codes #101; #120; #101). Section 10.2 evaluates the success of industry associations in creating competitive advantage by facilitating linkages between domestic competitors.

7.2.3 Cultural affinity as competitive advantage

One of the revealing findings from this research is that cultural affinity with the client can be a source of competitive advantage. This factor is neither a cost nor a differentiation strategy. Cultural affinity in this context means that clients in the recipient country are attracted to perceived national cultural characteristics of the exporting country. This may seem odd given that export destinations in South East Asia are culturally dissimilar to Australia. Yet it appears that some Asian clients sometimes perceive a greater degree of affinity with Australian agents than with European or US counterparts. Australian contractors are regarded as amiable yet professional, with the nation lacking the colonial
legacy of Northern Hemisphere rivals. While there may be a difference between the perception and reality, of relevance here is that this translates into a competitive advantage that helps explain trade. This can happen even when the firm located in Australia has a French or UK parent company. Table 7.6 provides evidence of this assertion. The examples, however, contain sobering reminders that cultural affinity alone is not enough to ensure longevity in trade. For the 6 firms that cite cultural affinity, it is always in conjunction with other competitive factors (2 cases with cost; 4 cases with differentiation factors).

Table 7.6 Select quotations demonstrating cultural affinity as a competitive factor
(N = 6 firms; 1 organisation)

<table>
<thead>
<tr>
<th>Interview quote</th>
<th>Type of firm</th>
</tr>
</thead>
<tbody>
<tr>
<td>“We (Australians) are more at home in mixing with (Asian) locals than traditional European and US cultures, and have an ability to laugh at ourselves, which seems a positive attribute in South East Asia. There is a need to appreciate the importance of cultural difference. During the first meeting it is critical not to say or do something disrespectful” (p.c. Interview Code #98b).</td>
<td>Large consultancy/ design firm. French parent company.</td>
</tr>
<tr>
<td>“There is a degree of preference for Australian consultants over the US or European counterparts. The industry is not price driven, we (Australians) are perceived to have a higher level of expertise, and a better ability to get on with locals” (p.c. Interview Code #90).</td>
<td>Medium size consultancy/ design firm. UK parent company.</td>
</tr>
<tr>
<td>“Australian competitive advantage is from having a synergy between users, suppliers, and operators. Also there is a demonstrable feeling for South East Asia – Australians are prepared to listen. Australia has an excellent reputation in government administration such as a ‘clean’ public service” (p.c. Interview Code #108).</td>
<td>Large consultancy/ water testing firm. Commercialised arm of corporatised water utility.</td>
</tr>
<tr>
<td>“Australia brings engineering and project management. Australian engineers seem to fit better into cultures, and have a more egalitarian view. They are also cheaper” (p.c. Interview Code #94).</td>
<td>Medium size consultancy/ design firm. French parent company.</td>
</tr>
<tr>
<td>“(The Chinese) know the industry and prefer the ..... let’s call it the Australian experience ... they feel we are more part of their environment than European or US companies. However, there is huge amount of competition from French-German companies that have marketing mechanisms in China and are trying to pick up projects” (p.c. Interview Code #100a).</td>
<td>Medium size consultancy/ design firm. Australian owned (Sydney office).</td>
</tr>
<tr>
<td>“The nature, individuality, the characteristics of Australians probably suit Asian associates and clients in that we are a bit easier to deal with, little less bombastic perhaps. .... The fact that we have been a colonial part ourselves, (we are) not a threat, not seen as part of the British raj, for example, that has a historic and cultural taint to it. This gives us some advantage but at the end of the day people are a bit more commercially driven” (p.c. Interview Code #100b).</td>
<td>Medium size consultancy/ design firm. Australian owned (Melbourne office).</td>
</tr>
<tr>
<td>“Countries love US technology but there is tremendous historical baggage associated with the US. Australia does not have any of that baggage; it has English language and good technology. There is a significant opportunity. The problem is very few firms can afford the time and money that it takes to establish the relationships at those (international development) banks” (p.c. Interview Code #128).</td>
<td>Australian Government developmental aid organisation.</td>
</tr>
</tbody>
</table>

Cultural affinity is argued to be outside Porter’s framework, as it is neither exclusively a cost strategy nor a differentiation strategy. Lindahl and Beyers (1999) also claim that their research identifies additional dimensions of competitive advantage. As Section 3.2.2 indicates, however, Lindahl and Beyers (1999) do not justify why the dimensions they identify are distinct from Porter’s differentiation strategy. The difference with this finding from the water industry is that cultural affinity is sufficiently distinct to be considered outside of cost and differentiation factors. The creation of competitive advantage by cultural affinity it is not a conscious strategy developed by a firm but is an outcome of the firm having Australian personnel. In one respect cultural affinity is tantamount to a factor advantage. Porter (1990) considers a common language or similarity of consumer tastes between trading nations as factor advantages for the exporter. Van Bergeijk (1996) also notes that cultural similarity has a positive influence on trade. However, the uniqueness of the empirical finding is that recipients perceive an affinity with a culturally dissimilar country. Interestingly, there is a historical legacy of cultural affinity being a competitive advantage for domestic firms. Goldfinch (1986) comments that throughout the 1970s and 1980s, Australian aid programs were noted for demonstrating an appreciation of the moral and cultural sensitivities of the local culture in the recipient country.

Why might there be an affinity between some people in culturally dissimilar locations? As noted in Part Two, firms consist of people with their own individual agendas. It is people within firms that initiate and organise trade. Decision-makers have their own sense of self, personal and corporate aspirations, and motives (Granovetter 1985; Meyer 1996; Thrift and Olds 1996; Schoenberger 1997; Yeung 2000; 2001). Not all business decisions are entirely rational and based on transaction costs (Schoenberger 1997; McGrath-Champ 1999). For example, a business relationship might form because the decision-makers happen to share a common interest in playing golf. (This is an actual case from the empirical work [p.c. Interview Code #35].) If people from culturally dissimilar backgrounds share an interest outside immediate business concerns, then potentially bonds of trust can form. Network formation and trade contacts can then follow (Section 3.4.4; Section 9.2). Of course, this process takes time with much face-to-face contact required (p.c. Interview Codes #35; #64; #101).
Trust can also form because decision-makers perceive they are in a relatively equal power relationship. If representatives from the recipient country believe that arrogance is being displayed by representatives from the provider country - particularly if that country is a former colonial power - then this probably will cause disequilibrium in the relationship and stifle the development of trust. The quotations in Table 7.6 refer to Australian representatives being perceived as more ‘easy-going’, having an egalitarian view, and lacking a legacy as a colonial power. These factors are presumably conducive to forming equal power relationships with clients from developing countries. In support of this assertion, Porter (1990: 269) notes that Italian engineering firms have had success in Africa and the Middle East, partly because Italy was not viewed as a colonial nation.

Cultural affinity, however, is only a partial explanation. Other factors such as technical expertise and back-up service also need to be present. Although cost competitiveness is secondary, it still has some influence (Table 7.5). Moreover, the dominant global players originate from countries that have historically been significant colonial powers. The sheer size of some of the French and British firms, including their ability to collude as consortiums and involve local partners (Section 4.2), can surmount some of the cultural barriers in developing countries. Large multinationals likely have the resources to employ a number of local Asian decision-makers (e.g. managers, engineers or chief accountants) to negotiate directly with compatriot clients. Note also that the evidence in Table 7.6 is based on perceptions from the supply side. A more comprehensive analysis of cultural affinity would need to probe the demand side. To determine whether Australian business has a real competitive advantage in this factor would require investigating the experiences that Asian decision-makers have when dealing with representatives from a number of nations.

7.2.4 Relationships between competitive strategies and firm-performance

In this section, competitive strategies are compared to determine if they have a bearing on the performance of firms, and hence exports. In the process, arguments by Porter (1985; 1990) and Lindahl and Beyers (1999) are tested. This literature was reviewed in Sections 3.2.1 and 3.2.2. To recap: Porter asserts that firms pursuing both cost and differentiation
strategies (i.e. ‘stuck in the middle’) have inferior performance to firms pursuing one clear strategy. Conversely, Lindahl and Beyers argue that ‘stuck’ firms, at least in producer services, are not inferior in performance to other strategic groups.

Table 7.7 compares performance measures (i.e. turnover per employee and export proportion) for the broad strategic groupings identified in Table 7.5. Most of the firms in the selected sample would be considered producer services; hence the findings can be compared with the cited literature. While the raw figures suggest that turnover per employee and export proportion measures are lower for the cost group than for the others, statistically there is no detectable difference between any of the groups. For this sample at least, there appears to be support for Lindahl and Beyers’s ideas but not Porter’s. However, interpretations need to be treated with caution given the small sample size. Also, comparisons are restricted; for example, there are not enough non-exporters included to compare how strategies might differ from those of exporters.
### Table 7.7 Turnover per employee and export proportion by strategic group

(N = 28 firms) (25 exporters; 3 non-exporters) (sample includes 20 service providers; 8 manufacturers)

<table>
<thead>
<tr>
<th>Strategic Group ¹</th>
<th>Turnover per employee (A$ thousand) (Note: 2 unknown amounts)</th>
<th>Export proportion (Note: 10 unknown amounts)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N = 28</td>
<td>N = 15 (exporters only)</td>
</tr>
<tr>
<td></td>
<td>N = 26 (exporters &amp; non-exporters)</td>
<td>N = 15 (exporters only)</td>
</tr>
<tr>
<td>Focused differentiation</td>
<td>N = 15</td>
<td>N = 8</td>
</tr>
<tr>
<td></td>
<td>N = 14</td>
<td>Mean = 0.24</td>
</tr>
<tr>
<td></td>
<td>Mean = 430</td>
<td>(s.d. = 0.24)</td>
</tr>
<tr>
<td></td>
<td>(s.d. = 480)</td>
<td>Median = 0.15</td>
</tr>
<tr>
<td></td>
<td>Median = 220</td>
<td></td>
</tr>
<tr>
<td>Cost focus/ plus other differentiation factors (i.e. pursuing multiple strategies)</td>
<td>N = 8</td>
<td>N = 6</td>
</tr>
<tr>
<td></td>
<td>Mean = 230</td>
<td>Mean = 0.19</td>
</tr>
<tr>
<td></td>
<td>(s.d. = 180)</td>
<td>(s.d. = 0.22)</td>
</tr>
<tr>
<td></td>
<td>Median = 170</td>
<td>Median = 0.1</td>
</tr>
<tr>
<td>Multinational</td>
<td>N = 4</td>
<td>N = 1</td>
</tr>
<tr>
<td></td>
<td>Mean = 610</td>
<td>(n/a)</td>
</tr>
<tr>
<td></td>
<td>(s.d. = 780)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Median = 310</td>
<td></td>
</tr>
<tr>
<td>Statistical summary</td>
<td>Comparison of turnover per employee means between focused differentiation and cost focus group</td>
<td>Comparison of export proportion means between focused differentiation and cost focus group</td>
</tr>
<tr>
<td></td>
<td>T test (equal variance; log transformed) t (20) = 1.19</td>
<td>T test (equal variance; log transformed) t (12) = 0.24</td>
</tr>
<tr>
<td></td>
<td>p = 0.25 (two-tailed)</td>
<td>p = 0.81 (two-tailed)</td>
</tr>
<tr>
<td></td>
<td>Comparison of turnover per employee means between focused differentiation, cost focus and multinational group</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One-way ANOVA (log transformed) F (2, 23) = 0.76</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p = 0.48 (two-tailed)</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
1. The ‘no definite strategy’ grouping (e.g. cultural affinity, proximity) is not included as a strategic group because firms nominating these factors also use other factors that can be readily categorised into the three main classifications shown.
2. Mann-Whitney U test was run on the raw data (i.e. not log transformed) to compare turnover per employee means between focused differentiation and cost group. The result was not significant (U (20) = 43.50; p = 0.39 (two-tailed)).
3. Mann-Whitney U test was run on the raw data to compare export proportion means between focused differentiation and cost group. The result was not significant (U (12) = 22.0; p = 0.80 (two-tailed)).

**Source:** author’s interviews 1998 – 2000.
7.2.5 Explaining the lack of relationships with competitive strategies

The evidence in Table 7.7 suggests that there is no relationship between different competitive strategies and the performance measures of firms. In the sample, the cost-strategy group derives its competitive advantage mainly from competing on cost, as well as pursuing secondary differentiation factors. In this respect the group is pursuing multiple strategies (i.e. stuck in the middle). Yet Porter (1985; 1990) argues that such a strategy is likely to produce inferior performance. What accounts for the discrepancy? One reason is that Porter’s interpretation could be incorrect. Lindahl and Beyers (1999) claim this, arguing that in dynamic information-rich segments of the economy, successful firms pursue multiple strategies outside of Porter’s framework. A major criticism of Porter’s work is that no statistical evidence is presented to support some of the key ideas (Waverman 1995). Testing the performance of firms in different strategic groups across a range of industries would be required to test Porter’s ideas rigorously.

Another reason why no relationship is detected is that the sample is not large enough. The standard deviations shown in Table 7.7 are particularly large. Even with log transformations, large outliers can influence T tests and result in a Type 2 error (i.e. failing to reject the null hypothesis when there is actually a significant difference) (Wright 1997). The Mann-Whitney U tests are applied to cross-check findings. The U test is distribution-free that compares data by rank. However, small sample sizes still compromise the accuracy of determining differences in means (Wright 1997; Corston and Colman 2003). The raw values do suggest a difference in performance measures, with the cost focus/ multiple strategy group showing lower values. However, a larger sample size would be needed to robustly test for any differences.

Comparisons between strategic groups are restricted because no firm in the sample pursues exclusively a cost strategy. It is, however, possible that even a larger sample size would reveal few firms pursuing a cost strategy. This is because water industry firms - often being specialists - rely more on the quality of goods or services for competitiveness rather than competing on cost (Section 7.2.2; also p.c. Interview Codes #120; #122).
7.2.6 Summary of findings

The main finding of Section 7.2 is that competitive advantage is created by an array of factors, mainly within the classification of focused differentiation. A factor that has been revealed - distinct from both cost and differentiation strategies - is cultural affinity. This factor is interesting because competitive advantage can arise from buyers perceiving an affinity with providers from culturally dissimilar locations.

Another finding is that the type of competitive strategy is not a strong indicator of firm-performance. The result contends with Porter’s (1985; 1990) idea that firms pursuing multiple strategies have inferior performance. An intense study of one industry may reveal characteristics that challenge generalised assumptions, such as the ability of some small and young firms in the water industry to compete successfully with large established firms. A larger sample and longitudinal data for individual firms would ideally be required to rigorously test the relationships between different strategies and firm-performance, and if strategies change as firms grow.

7.3 Relating the empirical findings to Porter’s model

Porter’s (1990) ‘diamond’ model is a pivotal idea for explaining how competitive advantage is created (Sections 2.5; 3.2). The theoretical framework of this thesis uses a modified version of Porter’s model for explaining trade at the macro-level (Figure 2.2). At the micro-level, the determinants of the model influence the external and internal environment of the firm (Figures 3.1; 3.2). There is sufficient empirical material at this stage to address how the four determinants of the model relate to characteristics of the water industry. Section 7.3.5 concludes that the industry only partially conforms to some aspects of Porter’s model. The implication is that other aspects of competitiveness also need to be considered in developing an explanation of trade.

7.3.1 Factor Conditions

To assess the relevance of this determinant, this section considers how factor conditions - including factor disadvantage - create competitive advantage for water industry firms. As claimed by some reports (e.g. EDC 1995; EMIAA 1998), climatic and hydrological
conditions in Australia produce challenges for the industry that potentially can spur innovations in technology and management. Competitive advantage is assumed to be created because these innovations can be exported to countries with similar challenges. The South Australian Government’s desire to build an exporting water industry was partially motivated by the belief that the State’s arid climate has created a competitive advantage in water management (p.c. Interview codes #121; #122). As Section 2.2.1 explained, the limitation in a factor (i.e. factor disadvantage) is a possible explanation of trade in some circumstances.

The evidence from the water industry, however, is not compelling. Some respondents commented that expertise in groundwater management, developed as a result of an arid climate in parts of Australia, is not transferable to tropical climates in South East Asia where the challenge is not water quantity, but quality and delivery of the resource (p.c. Interview Codes #90; #98b; #120). Another example is the experience of an Australian monitoring equipment manufacturer that found the flow meters originally developed for Australian conditions were not suitable for South East Asian destinations where river flows are larger (p.c. Interview Code #27). While there is a theoretically plausible argument for factor disadvantage, there is insufficient empirical evidence to support the idea. Yet innovation through factor disadvantage may serve as an explanation relevant to the water industry in other countries. Bainbridge (1997) reports that firms in Israel export water-related goods and services to other countries with similar arid conditions.

Australia has a reputation for its strengths in multiculturalism (although national political developments since 2001 make this a debatable claim). Sheehan et al. (1991) contend that this reputation could be a competitive advantage in some sectors (e.g. consulting work, education services). Porter (1990: 257) identifies the ability to interact with different cultures as a factor advantage for some service industries, using the Swiss banking sector as an example. Cultural affinity in one respect is a factor advantage; however, the examples discussed in Section 7.2.3 are different from Porter’s perspective because the advantage arises not from similarity, but because of an affinity between decision-makers from disparate cultures.
There is some evidence to suggest that factor advantage in one industry can translate to a competitive advantage in another industry. For example, Australia’s factor advantage (or comparative advantage) in mining has influenced the water industry. The empirical work reveals three examples of firms that initially were involved in the mining industry: Geo2 Ltd., Occtech Engineering and Zeolite Ltd. Expertise gained from treating mine site wastewater has helped these firms produce innovations and specialist expertise in water pollution control.

7.3.2 Demand conditions

Porter argues that domestic demand conditions are often the most powerful determinant of national competitive advantage, particularly in service industries. There is empirical evidence to support this assertion. An important reason why French firms have international dominance in the water industry is the strong home demand conditions because of a history of franchising and private sector involvement (Finger and Lobina 1999; also Section 4.2). Demand conditions for the Australian water industry have arguably become stronger in the past decade since water industry reforms. Recall that Figure 6.6 shows an increase in exporting firms since the mid-1990s, the probable reason being stronger domestic demand conditions as a result of reforms and the drive for profits. The influence of reforms on firms is discussed further in Section 10.3.2. In addition, environmental protection expenditure for water and wastewater treatment has increased during the 1990s (ABS 1999 # 4603.0), reflecting changing demand conditions for water technology and management.

7.3.3 Related and supporting industries

In many of Porter’s examples of industries, geographic clustering of related and supporting industries is argued to be important for creating competitive advantage. Section 6.3 showed that linkages between related and supporting industries are not well developed for the Australian water industry. Porter’s interpretation would suggest that this is a hindrance to competitive advantage. It is hypothetical to speculate whether clustering would contribute to competitiveness in this industry, given that there are likely no international examples of water industry clustering (Section 6.4). To compensate for
the lack of local linkages, various corporate strategies are used. Australian firms rely on inputs of financial and knowledge capital from overseas parent firms. Some firms rely on inter-firm linkages; for example, alliances with research organisations and other firms (Sections 7.4 and 8.2 provide examples).

Strong linkages between manufacturing and complementary service firms create fertile conditions for competitive advantage (Porter 1990: 263). For the Australian water industry, there is little evidence of local manufacturers linking with exporting service firms (Table 6.7). Australian consulting firms working overseas do not often use Australian suppliers. European firms, on the other hand, are more likely to use compatriot firms in the international arena (p.c. Interview Codes #101; #120; #121). The French firms, in particular, are vertically integrated. For example, Vivendi designs, builds and operates water utilities worldwide, as well as having controlling interests in an array of firms that manufacturer water related equipment (Vivendi 2000). Given the dominance of European consortia in the industry, this suggests that strong inter-firm linkages can be a competitive advantage. Note that strong inter-firm linkages can occur without firms necessarily being in spatial proximity (Section 2.3.4).

7.3.4 Firm structure, strategy and rivalry

For this determinant, conditions in the national economy influence how firms are created, organised and managed. Conditions also influence domestic rivalry (Porter 1990). The reforms in the Australian water industry, due largely to COAG reforms and National Competition Policy, have created a more competitive domestic economy. This is reflected by utilities outsourcing functions, the opening up of market niches for small specialist firms, and the presence of international firms (Section 4.3.3). According to representatives of industry associations, domestic rivalry has increased (p.c. Interview Codes #120; #121; #123). Some domestic firms have had to radically restructure to survive, such as by alliances or mergers with other firms. Possibly not enough time has elapsed to produce an industry of internationally competitive firms. Alternatively, perhaps fundamental conditions - such as strong related and supporting industry and intense demand conditions - were not in place before the influx of international players.
As a consequence, the Australian industry is unlikely to become a global presence - although some individual firms may achieve prominence. This issue is discussed in Chapter 12.

7.3.5 Implications of the comparisons

The characteristics of the water industry only partially conform to the determinants of Porter’s model. Factor conditions are not a prominent source of competitive advantage, with the exception of cultural affinity. There is no evidence to support the creation of innovation through factor disadvantage. There is little evidence of strong linkages with local related and supporting industries. Conversely, some characteristics of the industry do conform to the determinants of domestic demand conditions and firm structure, strategy and rivalry. These determinants intensified after water industry reforms, resulting in the Australian industry becoming more competitive.

The overall assessment is that the diamond model does not strongly relate to the Australian water industry, mainly because of weak local linkages. It is doubtful Porter would use this industry as an example to reinforce points about his theory. Yet recall that a weakness of Porter’s work is that the best industry examples are chosen to fit the model, whereas the model itself is not rigorously tested (Sections 2.5.2; 3.2.2). Porter does not consider that competitive advantage might exist in industries that lie outside the model, for example resource-intensive industries. It would be too simplistic to conclude that the water industry is not competitive because it does not entirely conform to Porter’s model. Clearly, some firms are competitive since they export. Moreover, for a small industry in a small economy, export turnover is quite impressive (Section 6.1.5). Given the lack of conformity of the water industry to Porter’s model, what needs to be known is if there are other dimensions that explain competitiveness and trade. Subsequent chapters address this.
7.4 The function of corporate strategies

As Section 3.2.3 reviewed, firms can use a variety of corporate strategies to maintain or strengthen competitive positions. Strategies are used to transform the organisational structure so the firm can continue to meet the challenges of the market, including engaging in trade. Section 7.4.1 describes what strategies are common; Section 7.4.2 explains why these particular strategies are used. Multinational activity and intra-firm trade is discussed in Section 7.4.3.

7.4.1 Types of corporate strategies used

Table 7.8 lists some of the common corporate strategies used by this sample to improve competitive advantage. For the water industry, permanent alliances and multinational linkages are the common strategies. Temporary forms of alliances such as joint ventures and sub-contracting are also used.

Permanent alliances can take various forms; for example, by purchasing a share in a foreign firm, or establishing an office or subsidiary to source local contracts. The linkages between the different business units are often horizontal. Small and medium firms use horizontal alliances to compensate for the lack of multinational intra-firm networks. Forming an alliance or subsidiary also helps forge the relationships and trust that are necessary for doing business in Asian countries. Industry representatives stress the importance of alliances and collaborations for firms involved in the export of environmental goods and services (EDC 1995; EIDN 1996; Perkins 1997; EIFU 1998; 2002).

Being part of a MNC is a strategy that can lead to exports. A recent acquisition (e.g. in the previous 3 years) by a multinational can be an advantage for the acquired firm as access to export markets is improved. There is often an injection of capital and the benefits of a larger R & D network (p.c. Interview Codes #55; #112). The disadvantage is relinquishing control. While not reported in Table 7.8, an interesting alternative reason given by several firms for not exporting is that their function in a multinational link is to
concentrate on the domestic market (p.c. Interview Code #92; Survey Codes #3; #31; #63; #66).

Some smaller firms list on the stock exchange. A few innovative specialist manufacturers have used this strategy. The reason given is to gain access to capital. Often the original owners and senior management still retain a substantial share (p.c. Interview Code #61; #78). However, if the firm proves to be highly successful, as in the case of Memtec, foreign interests can eventually acquire it.

Strategies are frequently combined. Table 7.8 shows several cases where alliances are combined with other strategies such as multinational linkages and stock exchange floats. Some small and medium firms have linkages with a MNC and also maintain separate alliances with other firms (p.c. Interview Codes #79; #112). This combination allows some organisational flexibility, as well as the benefits of being associated with a larger firm.

Temporary forms of alliances are also used - one reason is that the firm still retains its legal entity and can separate itself more easily from a partnership if necessary. A common form of vertical alliance is sub-contracting (referred to as ‘piggybacking’ [p.c. Interview Codes #90; #121]). Some of the medium size engineering consultancies use this method, with a number of firms identifying their project management skills as a sub-contractor as a source of competitive advantage (Table 7.5).

There are other common corporate strategies not identified in the sample (e.g. mergers and diversification). There are no exclusive examples of firms acquiring other firms, although some alliances do involve purchasing some share in a foreign firm. A possible reason for the lack of acquirers is that the Australian industry is small and there is a substantial foreign presence (recall Figure 6.4). Another factor is that the sample is not large enough. (In hindsight, the issue of corporate strategies, as well as competitive advantage, should have been explored in survey questionnaires and not just confined to interviews.) Furthermore, the few firms identified in each category prevent statistical comparisons of firm-performance being made.
Table 7.8 Corporate strategies used by firms  \( N = 28 \) (26 exporters)  

<table>
<thead>
<tr>
<th>Corporate strategy</th>
<th>No. of firms</th>
<th>No. of cases by firm-size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L (large); M (medium); S (small)</td>
</tr>
<tr>
<td>Alliances (such as establishing foreign subsidiaries/partnership) (i.e. permanent horizontal alliance).</td>
<td>5</td>
<td>4 (M) 1 (S)</td>
</tr>
<tr>
<td>Being part of a MNC.</td>
<td>5</td>
<td>4 (M) 1 (S)</td>
</tr>
<tr>
<td>Alliances (permanent horizontal) and being part of a MNC.</td>
<td>4</td>
<td>4 (M)</td>
</tr>
<tr>
<td>Recent acquisition by a multinational and establishing joint ventures (temporary horizontal alliance).</td>
<td>3</td>
<td>2 (L) 1 (M)</td>
</tr>
<tr>
<td>Alliances (permanent horizontal) and stock exchange float.</td>
<td>3</td>
<td>1 (M) 2 (S)</td>
</tr>
<tr>
<td>Joint ventures/projects (temporary horizontal) and sub-contracting (i.e. temporary vertical alliances).</td>
<td>2</td>
<td>1 (L) 1 (M)</td>
</tr>
<tr>
<td>Alliance (permanent horizontal) and joint venture (temporary horizontal).</td>
<td>1</td>
<td>1 (M)</td>
</tr>
<tr>
<td>Acquisition by a larger (non-multinational) company.</td>
<td>1</td>
<td>1 (M)</td>
</tr>
<tr>
<td>Stock exchange float to raise capital.</td>
<td>1</td>
<td>1 (S)</td>
</tr>
<tr>
<td>Obtaining licensing agreement.</td>
<td>1</td>
<td>1 (S)</td>
</tr>
<tr>
<td>Acquisition by a MNC and alliances (permanent horizontal).</td>
<td>1</td>
<td>1 (L)</td>
</tr>
<tr>
<td>Stock exchange float and issuing licensing agreement.</td>
<td>1</td>
<td>1 (S)</td>
</tr>
</tbody>
</table>

Notes:
1. Branch offices of same firms are listed (2 cases)
2. There are not enough non-exporters to make any comparisons
3. If a firm uses a dominant strategy, as revealed in interviews, then only that strategy is mentioned. In some cases a clear single strategy does not prevail, so combinations are listed.


7.4.2 Explaining why certain corporate strategies are used

The general reason firms engage in corporate strategies is to gain some control over an uncertain and volatile external environment. The survival and prosperity of the firm is the main motive, and this may involve developing export markets (Section 3.2.3). For the water industry, permanent and temporary alliances, and multinational linkages are the common strategies identified. There are a number of reasons why these particular strategies prevail.
First, an alliance with a firm in the recipient nation is often necessary for gaining export access. This is often because of the uncertainty dealing with the local culture, as well as a stipulation of foreign investment and involvement with aid projects (p.c. Interview Codes #64; #98b). Second, alliances help networks and trust to develop. Rosenfeld (1996) observes that alliances function to formalise networks. Third, alliances are a preferred strategy because risks are spread between firms and scale economies can be achieved. The firm still retains its identity and can separate if necessary.

Porter (1990) argues that the best alliances are temporary and highly selective. The empirical work, however, reports that some Australian consulting engineering firms have maintained alliances with an Asian partner for over a decade (p.c. Interview Codes #95; #99b). Possibly these relationships endure because the underlying power relationships are symmetrical, given that the Australian firms are usually not large (relative to international rivals). Both parties are dependent on the other; for example, the Indonesian firm for expertise and capital, and the Australian firm for export access.

Another common strategy is for the firm to be part of a MNC. The acquired firm usually gains access to additional capital and knowledge resources, but loses its autonomy. This strategy is a stark example of asymmetrical power relations, as the parent firm is a large MNC that has a wide spatial choice for its operations.

Temporary alliances, such as joint ventures and subcontracting, are of minor importance. These are used because of flexibility (Dicken and Thrift 1992). Three of the four large firms in the sample exclusively pursue temporary alliances (p.c. Interview Codes #98a; #98b; #108). It could be that large firms do not need permanent alliances because they have sufficient capital and prefer the flexibility of this type of strategy. Alternatively, small and medium firms prefer permanent alliances because they require a longer commitment to develop export markets. Further conclusions are restricted because of the limited cases.

Overall, there is no clear evidence of a pattern in Table 7.8 between the type of corporate strategy used and the size of firms (other than large firms tending toward temporary
alliances). Both small and medium firms are represented in alliances (symmetrical power relationships) and multinational linkages (asymmetrical relationships). The characteristics of the industry could account for the lack of a pattern. Because small firms can be specialists with a differentiation focus, they have the flexibility to choose an alliance, stock exchange float or various combinations. Alternatively, a generalist cost-based small firm in another industry might be more restricted in the type of strategy. Bryson et al. (1993) assert that the more specialised a producer service firm is, the more symmetrical is the relationship between the supplier and the client. However, a larger sample and time series data would be required to establish relations between corporate strategy and firm-size.

7.4.3 Inward and outward FDI

A common strategy used by MNCs is intra-firm trade in the form of FDI (foreign direct investment). Section 2.4.2 reviewed Dunning’s ideas that explain why firms engage in FDI rather than direct exports. This section attempts to determine the relationship between inward FDI and exports. A characteristic of the Australian water industry is that inward flows of FDI from foreign firms are larger than outward FDI flows by domestic firms. Recall that Figure 6.4 shows that 60% of the aggregate Australian turnover is by foreign owned firms. Adding more detail, Table 7.9 depicts that there is a significant difference between the export turnover means for Australian owned and foreign owned firms (p = 0.05). Foreign owned firms export almost three times more in aggregate than Australian owned firms. It is not known how much of this is intra-firm transfer to the foreign parent. The data are unavailable to quantify this, as most of the branch firms are not ASX-listed.

What is more certain is that exports by Australian owned firms, although smaller in aggregate, contain a higher proportion of outward FDI than do exports by foreign owned firms in Australia. Although all 10 of the large foreign MNCs export, this is only a minor proportion of their turnover as the focus is the domestic market (p.c. Interview Codes #55; #98b; #105). Only one foreign MNC indicated that its purpose in Australia is as a “stepping stone into Asia” (p.c. Interview Code # 90). In contrast, Australian owned
exporters frequently use FDI - such as setting up branch offices - to access overseas markets (p.c. Interview Codes #95; #99a; 100a; 100b; also Section 9.1).

Table 7.9 Comparison of export turnover and export proportion between Australian owned and foreign owned firms

N = 68 (exporters only where amounts are known)

<table>
<thead>
<tr>
<th>Nationality</th>
<th>Australian owned</th>
<th>Foreign owned</th>
<th>Statistical summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export turnover</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggregate (A$ million)</td>
<td>N = 37</td>
<td>N = 29</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>175.2</td>
<td>451</td>
<td>Comparison of export turnover means between Australian and foreign owned firms</td>
</tr>
<tr>
<td>(s.d.)</td>
<td>4.7 (9.9)</td>
<td>15.6 (40.4)</td>
<td>T-test results (equal variance; log transformed)</td>
</tr>
<tr>
<td>Median</td>
<td>0.48</td>
<td>2.5</td>
<td>t (64) = -2.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>p = 0.05 (two-tailed)*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Export proportion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.22 (0.25)</td>
<td>0.18 (0.16)</td>
<td>Comparison of export proportion means between Australian and foreign owned firms</td>
</tr>
<tr>
<td>(s.d.)</td>
<td>0.1</td>
<td>0.13</td>
<td>T-test results (equal variance; log transformed)</td>
</tr>
<tr>
<td>Median</td>
<td>0.1</td>
<td>0.13</td>
<td>t (64) = -0.26</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>p = 0.80 (two-tailed)</td>
</tr>
</tbody>
</table>


There are conflicting views whether inward FDI creates or hinders competitive advantage in the recipient country. Porter (1990) stresses that the source of competitive advantage is the strength of domestic conditions, implying inward FDI plays no part. Conversely, Rugman (1991) and Rugman and Verbeke (1993; 1995) argue that inward FDI can also be important for creating competitive advantage (Section 2.5.2). The evidence from the water industry is ambiguous. For example, inward FDI for manufacturing does result in domestic production and exports. Yet because many important components are imported, often from the parent firm, linkages between domestic related and supporting industries remain weak (Section 6.3). With weak domestic linkages, the development of
competitive advantage is hindered. Inward FDI does have an influence on domestic exports, as foreign owned firms export a similar proportion compared with Australian owned rivals (Table 7.9). Overall, the net benefit to the Australian economy is unknown because some of the export revenue of foreign owned firms is returned to the parent firm.

7.5 Conclusion

This chapter has addressed questions concerning competitive advantage (Table 7.1), the overall purpose being to contribute to an explanation of trade for the water industry. The empirical findings do not strongly conform to theoretical expectations. There is scant evidence of relationships between productivity (i.e. competitiveness) and export performance. The variable of firm-size has an influence on productivity, suggesting economies of scale. Yet the size and age of firms do not appear to have an influence on export proportion. Furthermore, firms pursuing a multiple strategy do not display an inferior performance, contrary to Porter’s assertion. Another finding is that while some aspects of the water industry conform to Porter’s diamond model, other aspects do not. The lack of strong linkages between related and supporting industries and water industry firms are an example.

Corporate strategies are used by firms to extend competitiveness across space, with inter-firm alliances being common. Firm-size does not appear to have an influence on the type of strategy. Inward FDI has an influence on exports, whereas Porter’s ideas emphasise the strength of the domestic market and outward FDI. It remains unclear whether inward FDI creates sustainable competitive advantage.

One reason for some discrepancies with the literature is that the water industry has unique characteristics. Although there is some evidence of scale economies, small - and often young - specialist firms can still be competitive and export. There are opportunities for small specialist firms to develop international markets. Another characteristic is that there are determinants - such as cultural affinity by virtue of having Australian personnel - that lie outside Porter’s framework and are unrelated to firm-size and age.
There are possibly other reasons for the lack of empirical conformity to theoretical expectations. Ideally, a larger sample across several industries is needed before radically reassessing existing theories. The implications of empirical limitations are considered in Chapter 11. Another reason is that explanations by Porter (1985; 1990) and Dunning (1977; 1993b) are normative models representing the ideal conditions for competitiveness and multinational behaviour. The empirical work, on the other hand, delves into real world situations of one industry to uncover ‘what is’. In rethinking trade, part of the challenge is to explain findings that do not conform to idealised models of what should be. The next chapter continues the task by comparing empirical findings with theoretical ideas about innovation.
Chapter 8
Investigating innovation and the relationship with trade

This chapter analyses the role of innovation in determining the export behaviour of water industry firms. A relationship between innovation and export success is assumed in much of the literature (Sections 2.3; 3.3). The reasoning is that innovation (i.e. an improvement of a product, process or service) should result in greater productivity (i.e. higher turnover per employee, or greater output in value per unit of capital) because a larger quantity or better product is produced. This leads to firms being more competitive than rivals and having a better chance of accessing distant markets (i.e. to trade).

The following sections address research questions concerning innovation (Table 8.1). Section 8.1 tests some of these assumptions by investigating the relationships between proxies for innovation and export proportion. The influences of the size of firms and productivity on these proxies are also considered. Explanations for the results are proposed, with an emphasis on qualitative dimensions to explain relationships. Section 8.2 investigates how the creation and acquisition of innovation involve an array of sources that are internal and external to the firm and function at varying geographic scales. Section 8.3 highlights how the process of innovation creation and acquisition relates to the other theoretical strands and contributes to an understanding of trade.

Table 8.1 Research questions addressed in Chapter 8

<table>
<thead>
<tr>
<th>Questions from theoretical discussion (Table 3.3)</th>
<th>Relevant section in Chapter 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is there a relationship between innovation proxies and firm-performance? Why or why not?</td>
<td>8.1</td>
</tr>
<tr>
<td>What are the internal and external sources of innovation?</td>
<td>8.2.1</td>
</tr>
<tr>
<td></td>
<td>8.2.2</td>
</tr>
<tr>
<td>Are innovation sources spatially constrained? Why or why not?</td>
<td>8.2.3</td>
</tr>
<tr>
<td>How does the national innovation system influence this industry?</td>
<td>8.2.3</td>
</tr>
</tbody>
</table>

*Source: selected questions from Table 3.3*
8.1 Relationships between measures of innovation and firm-performance

It is useful to know whether there is a quantitative measure of innovation that is related to performance measures of firms (i.e. export proportion and turnover per employee). If one is found, then the variable (or variables) could form part of a predictive model of trade that applies to this industry. As discussed in Section 3.3.4, R & D (research and development)\(^1\) expenditure and the number of patents a firm has can serve as proxies for innovation, albeit with the limitations noted. R & D expenditure is a measure of an input flow over time, usually a designated year. Patents are an output measure that also measure stock because past innovations are taken into account. Using these proxies, Section 8.1.1 tests several hypotheses and proposes reasons for the findings. Section 8.1.2 argues that the results found are partly due to the limitations of innovation proxies and characteristics of the industry. Section 8.1.3 suggests that the concept of innovation needs to embrace qualitative dimensions.

8.1.1 Testing relationships

The literature (e.g. Porter 1990; Wakelin 1997; Industry Research and Development Board 1998) leads to several hypotheses to be empirically tested:

1. Exporters are more likely to have R & D expenditure and patent registrations than non-exporters. The relationship is:

   Exporting (1, 0) = \( f(\text{R} \& \text{D}; \text{patents}) \)

   where 1 and 0 denote exporter and non exporter.

2. Among exporting and non-exporting firms that do have R & D expenditure and patents, the exporting group has a greater proportional level of these proxies than the non-exporting group:

   \( \text{Non exporters (R & D %; patent %) < Exporters (R & D %; patent %)} \)

---

\(^{1}\) An official definition of R & D is systematic, investigative and experimental activities that involve innovation or high levels of technical risk with the purpose of acquiring new knowledge. New knowledge is interpreted as that which does not yet exist or if it does, it is not available on commercially acceptable terms (DISR 1998: 6).
3. Related to the above statement, there is a relationship between innovation proxies and export proportion:
   \[ \text{Export } \% = f(R \& D; \text{patents}) \]

4. There is a relationship between firm-size (expressed as turnover) and innovation proxies:
   \[ R \& D = f(\text{turnover}) \]
   \[ \text{Patents} = f(\text{turnover}) \]

5. There is a relationship between innovation proxies, firm-size and export proportion:
   \[ \text{Export } \% = f(R \& D; \text{patents}; \text{turnover}) \]

6. There is a relationship between innovation proxies and competitiveness (expressed as turnover/ employee):
   \[ \text{Turnover/ employee} = f(R \& D; \text{patents}) \]

Before proceeding with these tests, three provisos are noted. First, because R & D expenditure and patent registrations usually apply to product and process developments relating to tangible goods, the sample comprises manufacturers. Service providers are not included. Second, because the concern is whether innovation proxies influence export proportion, manufacturers with no R & D expenditure or no registered patents are still included in statistical tests. Third, in most of the tests using regression analysis, data is transformed into natural logarithms to make any underlying relationships linear (Wright 1997: 109-110). This procedure follows when tests on the raw data fail to uncover significant relationships, and is done to avoid a Type 2 error. The transformation is explicitly noted on each occasion.

**Hypothesis 1**

Table 8.2 shows the results from testing the first hypothesis. The exporting group has proportionally more firms with R & D expenditure and patent counts than non-exporters (the null hypotheses of no difference are rejected at \( p < 0.01 \)). The results conform to
expectations from the literature: exporters are more likely to have R & D expenditure and patent registrations than non-exporters.

**Table 8.2 Proportion of exporters and non-exporters with R & D expenditure and patents (N = 81)**

<table>
<thead>
<tr>
<th>Category</th>
<th>Exporters N = 58</th>
<th>Non-exporters N = 23</th>
<th>Statistical test of difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of firms with R &amp; D expenditure</td>
<td>46 (79%)</td>
<td>11 (48%)</td>
<td>Test for two proportions between R &amp; D expenditure for exporters and non-exporters: $z = 2.82$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$p &lt; 0.01$ (two-tailed)**</td>
</tr>
<tr>
<td>Number of firms with patents</td>
<td>29 (50%)</td>
<td>4 (17%)</td>
<td>Test for two proportions between patents for exporters and non-exporters: $z = 2.69$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$p &lt; 0.01$ (two-tailed)**</td>
</tr>
</tbody>
</table>

**Notes:**
1. Manufacturing firms only.
2. Patent counts for this table and subsequent tables refer to patents registered in Australia only.


**Hypothesis 2**

For the exporters and non-exporters that do have R & D expenditure and patent counts, there is a detectable difference between the two groups in their proportional use of innovation proxies (Table 8.3). Exporters have a higher proportion of R & D and patents. This result is expected because supposedly the more R & D expenditure and patents a firm has, the more innovative the firm is. Theoretically, innovation leads to competitive advantage which results in trade. Although larger samples would be required to confidently establish causation, the findings from this test support theoretical expectations.
### Table 8.3 Comparison of proportion of R & D expenditure and patent counts between manufacturing exporters and non-exporters (N = 80)

<table>
<thead>
<tr>
<th>Innovation proxy</th>
<th>Exporter</th>
<th>Non-exporter</th>
<th>Statistical summary</th>
</tr>
</thead>
</table>
| **R & D expenditure as proportion of turnover** (includes firms with zero R & D expenditure) | N = 57  
Mean = 0.07  
(s.d. = 0.15)  
Median = 0.02 | N = 23  
Mean = 0.04  
(s.d. = 0.08)  
Median = 0 | Mann-Whitney U test  
U (78) = 476.5  
p = 0.03* (one-tailed) |
| **No. of patents per A$ M (million) of turnover** (includes firms with no patents) | N = 55  
Mean = 0.54  
(s.d. = 1.24)  
Median = 0 | (with two outliers eliminated)  
N = 20  
Mean = 0.02  
(s.d. = 0.07)  
Median = 0 | Mann-Whitney U test  
U (73) = 319.5  
p < 0.01**(one-tailed) |

**Notes:**
1. Mann-Whitney U tests are used for two reasons: 1) Data are not normally distributed; 2) The tests intentionally include zero values for R & D expenditure and patent counts. If log transformed T tests are used, then zero values are eliminated by default.
2. One-tailed test (i.e. detecting difference in one direction) is used because the hypothesis is that exporters have a higher mean.
2. The outliers are two firms with unusually high numbers of patents for their size (Survey Codes #58 [51 patents]; #63 [27 patents]). The firms are branches of multinationals with registered patents in Australia, and concentrate on the domestic market. If the two outliers are included in calculations, then a significant result occurs but in the opposite direction with non-exporters having a higher mean than exporters (N = 22; Mean = 0.61; (s.d. = 2.22); Median = 0); (Mann-Whitney U test U (75) = 426.5; p = 0.023*). This anomaly is due to a small sample being unduly influenced by two extreme values.

**Source:** see Table 8.2.

**Hypothesis 3**
Regression analysis is used to test whether there is a direct relationship between and R & D proportion (i.e. R & D expenditure as a proportion of turnover) and number of patents (as a proportion of turnover), and export proportion (i.e. export revenue as a proportion of total turnover). The two proxies are the independent variables; export proportion is the dependent variable. The testing is done in three stages by using the two independent variables separately and then combining them.

**R & D proportion**
A regression analysis fails to reject the null hypothesis of no relationship between R & D proportion and export proportion (adjusted R² = 0.05; F (1, 48) = 3.64; p = 0.06; N = 50). Using a distribution-free correlation test, Spearman’s rho (ρ), also reveals no evidence of
a relationship ($r_s = 0.24; p = 0.09; N = 50$). A scatterplot of this (i.e. raw variables) is shown in Appendix E (Figure E.1). To lessen the likelihood of a Type 2 error, the variables are transformed into natural logarithms (Wright 1997: 76). This reveals a weak relationship, but still statistically significant ([log transformed] adjusted $R^2 = 0.15$; $F (1, 38) = 7.85; p < 0.01**; N = 40$). (Note that exporters with no R & D are eliminated in the transformation). However, the small adjusted $R^2$ value indicates that the relationship is not substantially significant. Figure 8.2 depicts the graphical relationship of the log transformed data.

**Figure 8.1 Relationship between R & D proportion and export proportion (N = 40)**

(exporters only) (log transformed)

$log Export proportion = – 1.05 + 0.41*(ln R & D proportion)$

Notes:
1. 40 cases of exporting manufacturing firms where both export proportion and R&D proportion are known.
2. Another correlation was performed on untransformed data (with zeros eliminated) using Spearman’s $\rho$. The result is significant ($r_s = 0.42; p < 0.01**; n = 40$).

**Patent proportion**

Substituting patent proportion as the independent variable results in a model with no predictive value. The scatterplot of the raw values is shown in Appendix E (Figure E.2) (adjusted $R^2 = -0.02$; $F(1,48) = 0.007$; $p = 0.93$; $N = 50$; ($r_s = 0.17$; $p = 0.23$). Log transformation of the data also reveals no evidence of a relationship ([log transformed] adjusted $R^2 = -0.04$; $F(1,22) = 0.03$; $p = 0.87$; $N = 24$), as Figure 8.2 starkly illustrates.

In the sample of manufacturing firms, twice as many firms have no patents, compared with firms that have no R & D expenditure (Table 8.1). The lower sample size produced after log transformation of patent proportion is a possibility why no relationship is evident between patent proportion and export proportion, whereas R & D proportion is revealed to have a weak relationship.

**Figure 8.2 Relationship between patent proportion and export proportion** $(N = 24)$

(exporters only) (log transformed)

\[ \ln \text{Export proportion} = -2.0 + 0.04 \times (\ln \text{patent proportion}) \]

Notes:

1. Includes exporting manufacturing firms where both patents/turnover is known and is not zero and export proportion is known.
2. Another correlation was performed on untransformed data using Spearman’s $\rho$. The result is non-significant ($r_s = 0.03$; $p = 0.89$; $n = 24$).

Source: see Table 8.2.
Combining R & D and patent proportion

Table 8.4 summarises the results of a regression analysis using the two innovation proxies to represent the independent variables. The variables are log transformed which eliminates zero values. No evidence of relationships between variables is detected. A separate regression analysis on the untransformed variables, including zero values for firms with no R & D or patents, confirms that there is no evidence of a relationship (adjusted $R^2 = 0.03$; $F (2, 47) = 1.87$; $p = 0.17$; $N = 50$) (see Appendix E (Table E.3).

There are two reasons identified for the lack of strong evidence of relationships. Firstly, a characteristic of the water industry is that small specialist firms can be active exporters (recall Section 7.1.2). Secondly, innovation proxies have limitations in what they measure (Section 3.3.4). Section 8.1.2 elaborates on these two reasons.

Table 8.4 Multiple regression analysis for export proportion (dependent variable) and R & D proportion and patent proportion (independent variables) ($N = 21$) (exporters only) (log transformed)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>adjusted $R^2 = 0.008$</td>
</tr>
<tr>
<td>$F (2,18)$ value = 1.08</td>
<td>$p = 0.36$</td>
</tr>
<tr>
<td>R &amp; D per turnover (log transformed)</td>
<td>$p = 0.17$</td>
</tr>
<tr>
<td>Patents per turnover (log transformed)</td>
<td>$p = 0.99$</td>
</tr>
</tbody>
</table>

Source: see Table 8.2.

Hypothesis 4

This test investigates if there is a relationship between the size of firms and innovation proxies. Firm-size is included because it might be expected that larger firms could commit proportionally more resources than smaller firms to R & D and the development of patents (Wakelin 1997). It is also assumed that in absolute terms, larger firms spend more on R & D and have more patents than smaller firms. Firm-size might thus be indirectly related to export proportion, given that exporters have proportionally more R & D expenditure and patents (Hypothesis 1). Turnover (A$ M [million]) is used as a proxy for firm-size and is the independent variable. (Non-exporters are also included because the concern is size and innovation proxies.) The dependent variables are R & D proportion, R & D expenditure, patent proportion and patent expenditure. Appendix E
(Figures E.4 – E.7) shows scatterplots using the four dependent variables. Regression analysis and Spearman’s correlation (rho) accompany the graphs.

No relationships are evident when using the dependent variables of R & D proportion and patents proportion (Appendix E; Figures E.4a; E.4b; E.6). This is because a characteristic of the water industry is that both small and large firms are likely to be specialists (Sections 7.1.2; 7.2.2). Indeed in some industries, small domestic manufacturing firms can have higher proportional levels of expenditure on innovation than large firms (McKinsey et al. 1993; DISR 1999). The findings from the water industry indicate that some of the small specialist manufacturers, in proportion to their turnover, invest heavily in R & D and patents. There is, however, a suggestion of a relationship with turnover and R & D expenditure (Appendix E [Figures E.5a; E.5b]) (adjusted $R^2 = 0.62$; $F (1, 75)$ value $= 126.9$; $p < 0.01^*$; $N = 77$). There is also evidence of a relationship with turnover and number of patents (Appendix E [Figure E.7]) (adjusted $R^2 = 0.16$; $F (1, 73)$ value $= 15.19$; $p < 0.01^*$; $N = 75$). These findings are expected. Larger firms spend more on R & D and have the resource to develop and register more patents than smaller firms. Figures E.5a and E.5b also suggests that as turnover becomes larger, expenditure on R & D increases, but at a decreasing rate. This implies decreasing returns to scale. For some large firms, a threshold is possibly reached where additional expenditure on R & D does not translate into a proportional increase in profits.

**Hypothesis 5**

Does the interaction of the proportion of innovation proxies and firm-size (i.e. turnover) explain export proportion? Table 8.5 shows the results. The regression model has little explanatory power. Yet R & D proportion still emerges as an independent variable of significance. This concurs with the testing of Hypothesis 3 and suggests that for manufacturing firms, R & D proportion has a significant (but not substantive) influence on export proportion. Firm-size does not have an influence because small specialist firms can invest heavily in innovation. Running the same test using log transformed variables produces a non-significant result (Appendix E; Table E.8). Eliminating patent counts produces a significant result, with R & D having a significant influence (Appendix E; Table E.9). This is because of the large numbers of firms with zero patent counts. When
the patent variable is eliminated, a larger sample size is produced which increases statistical reliability.

**Table 8.5 Multiple regression analysis for export proportion (dependent variable) and innovation proxies and turnover (independent variables) (N = 49) (exporters only)**

Export proportion = 0.17 + 0.30*(R&D proportion) – 0.07*(patent proportion) + 0.01*(turnover)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>adjusted $R^2 = 0.02$</td>
</tr>
<tr>
<td>F (3, 45) value = 1.39</td>
<td>$p = 0.26$</td>
</tr>
<tr>
<td>R &amp; D per turnover</td>
<td>$p = 0.05*$</td>
</tr>
<tr>
<td>Patents per turnover</td>
<td>$p = 0.62$</td>
</tr>
<tr>
<td>Turnover (M)</td>
<td>$p = 0.94$</td>
</tr>
</tbody>
</table>

*Source:* see Table 8.2.

**Hypothesis 6**

The final hypothesis tested is to determine if there is a relationship between innovation proxies and turnover (i.e. firm-size), and competitiveness (or productivity). Turnover per employee (as a proxy for competitiveness) represents the dependent variable; R & D proportion, patent proportion, and turnover represent the independent variables. Non-exporters are included because the concern is with competitiveness and innovation proxies. No evidence is found of a correlation between the dependent and independent variables (Table 8.6). The null hypothesis cannot be rejected. Eliminating firm-size, but keeping the two innovation proxies as independent variables, leads to a non-significant result (Appendix E (Table E.10). Using log transformed variables still produces a non-significant result, whether firm-size is included or not (Appendix E (Tables E.11; E.12).

A reason for the findings could be that a high turnover per employee for a firm is not the result of a new innovative product with embedded R & D, but rather other factors such as corporate strategies, improved marketing or back-up service, or the result of upgrading the skills of employees. Such improvements are not captured by proxies that only reflect technical change. Also, some new firms with a high expenditure on R & D could have a low turnover per employee because markets are only becoming established.
Table 8.6 Multiple regression analysis for turnover per employee (dependent variable) and innovation proxies and turnover (independent variables) (N = 75) (exporters and non-exporters)

Turnover per employee = 0.33 + 0.14*(patent proportion) + 0.10*(turnover) – 0.09*(R&D proportion)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>adjusted R² = – 0.007</td>
</tr>
<tr>
<td>F (3, 71) value = 0.83</td>
<td>p = 0.48</td>
</tr>
<tr>
<td>Patents per turnover</td>
<td>p = 0.25</td>
</tr>
<tr>
<td>Turnover (A$ M)</td>
<td>p = 0.40</td>
</tr>
<tr>
<td>R &amp; D per turnover</td>
<td>p = 0.47</td>
</tr>
</tbody>
</table>

Source: see Table 8.2.

The summary of the six tests in Section 8.1.1 is:

Hypothesis 1: Exporting firms are more likely than non-exporters to have R & D expenditure and patent registrations.

Hypothesis 2: There is a statistically significant difference between exporters and non-exporters in R & D and patent proportion. Exporters are more likely to have higher proportions of innovation proxies.

Hypothesis 3: There is evidence of a weak relationship between R & D expenditure and export proportion. There is no evidence of a relationship between patent proportion and export proportion.

Hypothesis 4: No relationship is evident with firm-size and the proportion of innovation proxies. Firm-size, however, appears to influence the amount of R & D expenditure and number of patents.

Hypothesis 5: Combining innovation proxies and firm-size (i.e. turnover) does not lead to a model that explains export proportion.

Hypothesis 6: No statistically significant relationship is detected between innovation proxies and the proxy for competitiveness (turnover per employee).
The general conclusion is that for manufacturing firms in the water industry, R & D expenditure and patent registrations increase the propensity to export (Hypotheses 1 and 2). Yet there is not enough evidence to establish that once the threshold of zero is passed (i.e. a firm has some R & D expenditure or registered patents), then an increase in these innovation proxies leads to a proportional increase in exports. There is evidence to suggest that R & D proportion has some influence on export proportion, but the effect is not substantial.

8.1.2 Explaining the findings

The theoretical link between innovation, competitiveness and trade has been explained at several points in this thesis. Yet the empirical findings only suggest a weak relationship. It is argued that there is a stronger relationship between innovation and trade than what has been uncovered in Section 8.1.1. However, the innovation proxies used are not sensitive enough to detect this. This is because proxies have inherent limitations, and that innovation in the water industry is not necessarily expressed by R & D expenditure and patent counts.

Section 3.3.4 reviewed the limitations of innovation proxies. One issue is that the proportion of R & D expenditure is an input measure that may not translate into a proportional output of innovations. Patents are argued to be a more accurate measure than R & D expenditure because patents are the result of innovations actually realised (Ceh 1996; Wakelin 1997). But not all innovations, especially if they are incremental, translate into patents. Even when patented innovations are produced, this may not necessarily lead to greater productivity for the firm, or result in higher exports. The innovations might not be commercially successful. Furthermore, these proxies only measure innovation created within the firm, whereas external acquisition of knowledge for innovation is also common (Section 8.2.1). Stronger evidence of relationships between variables might emerge if better measures of innovation proxies are used. For example, Wakelin (1997; 1998) establishes relationships using the innovation history of firms (compiled by an UK government agency) as a suitable proxy. This type of data, however, is not available for the Australian water industry.
Yet even with improved proxies, innovations by service providers - such as in design, management or operations of water treatment plants - are usually not quantified by proxies (p.c. Interview Codes #98b; #112). This is because R & D expenditure, registered patents, and even innovation history, are more relevant to technological change embedded within physical products. Innovations by service firms are overlooked by conventional innovation proxies.

A weak relationship is detected between R & D proportion and export proportion (Figure 8.1). Possibly a larger sample would establish a stronger relationship between these variables. Only some of the categories within the tables in Section 8.1.1, however, are small (e.g. less than 20 firms). A few categories have more than 40 firms. The size of the sample is probably adequate for statistically valid tests. Yet even if strong relationships were uncovered at the level of the firm, the proxies used only capture one narrow aspect of innovation. Importantly, strong correlation does not imply causation (Wright 1997). Expenditure on R & D or patent registrations by a firm may not be a cause, but rather a consequence of exporting. This is because firms become exposed to international competition and so have an incentive to innovate (Wakelin 1997).

The characteristics of the industry provide another reason for the lack of relationships. Technological change in the water industry is characterised more by incremental innovations, rather than ‘hi-tech’ breakthroughs (Davis 1996; Bainbridge 1997; Smith 1998). Several respondents emphasised this industry characteristic (p.c. Interview Codes #106; #109; #120: #123). For example: “With the water sector, it is very slow in the uptake of new ideas. There is about a twenty-year uptake period. …Overall it still uses very basic technology. Although management systems and telemetry have changed, in general there have not been enormous breakthroughs in technology” (p.c. Interview Code #106). There are some manufacturing activities in the water industry that do rely on adapting knowledge from ‘high-tech’ industries; for example, water testing equipment uses techniques adapted from biotechnology, and automated process and control devices make extensive use of information technology. One firm has used established technology to instigate an on-line monitoring system to assess the in situ performance of its products.
The firm can do real-time monitoring of equipment hundreds of kilometres away (p.c. Interview Code #79). This innovation, however, comes from the adaptation of existing technology, without the firm needing to secure its own patents.

The general consensus amongst industry representatives is that the water industry is a medium technology industry. Section 3.3.1 notes that low and medium technology industries can still be innovative. The implication is that for medium technology industries such as water, innovation contributes to competitiveness. In these industries technological change is often incremental, whereas in high technology industries, gaining competitiveness over rivals is dependent on often radical technological change that is represented better by innovation proxies (Noponen et al. 1993; Angel 1994).

In conclusion, the weak relationships found between innovation proxies, firm-size and firm-performance are because of: 1) limitations of proxies, and 2) the characteristics of a medium technology industry. Yet these findings do not discount the argument that innovation is related to competitiveness and trade. Numerous studies at the macro-level support this relationship (e.g. Hirsch and Bijaoui 1985; Buxton et al. 1991; Fagerberg 1988; 1994). At the micro-level, innovation remains a fundamental strand in an explanation of trade. What is required is a rethinking of the concept of innovation beyond that measured by limited innovation proxies of technical change. Section 8.1.3 tackles this issue.

8.1.3 Using qualitative evidence to establish a relationship between innovation and trade

Section 8.1.3 uses qualitative examples to demonstrate that innovation can be expressed as a broader concept than technical change measured by quantifiable values. The qualitative interpretation of innovation is still linked to competitive advantage and trade because the improved product or service extends the spatial reach of the market. Relevant to the water industry, innovative can mean simplifying a product or process where necessary so it will be reliable and appropriate in its geographic setting, often a developing country in the Asia Pacific region. Some R & D expenditure may still be required, although it would be quite minimal compared with a ‘high-tech’ product.
Interestingly, the concept of appropriate technology for developing countries is not a recent realisation. For example, Bishop (1986) notes that the success of technology transfer in water technology depends on appreciating local cultural, economic and technological conditions.

Table 8.7 presents comments that demonstrate how competitive advantage can result from developing products that utilise ‘appropriate technology’. One example of innovation by applying simplicity is the development of an oil/water separator for an industrial complex in China. This version has lower maintenance requirements and is easier to use than more complicated products that require specialised training to operate, as well as imported replacement parts (p.c. Interview Code #78). The simpler product is arguably innovative because it is an improvement over a more complicated design if it achieves the desired goal. Appropriate technology can also embrace a cost competitiveness approach by keeping the product simple. In a sense, firms using appropriate technology are pursuing a multiple strategy of differentiation and cost competitiveness. Simplifying a design is also a form of specialisation if rivals are still adhering to more complex designs. Specialisation, as noted in Section 7.2.2, results in trade because the market is spatially extended.

A disadvantage for firms that produce simplified appropriate technology is the vulnerability to being copied by a competitor. A solution taken by the firm in this example was to use encrypted software, as well as involving local entrepreneurs with an incentive to protect the patents on the product. Other firms have also used a similar solution (p.c. Interview Codes #64; #79; also McGaughey et al. 2000).
Table 8.7 Select quotations demonstrating appropriate technology as a competitive factor (N = 3 firms)

<table>
<thead>
<tr>
<th>Interview quotation</th>
<th>Type of firm (size and ownership)</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Every water system in the world is run differently, different legislation, and</td>
<td>Medium size operator/ asset management firm. (Commercialised arm of</td>
</tr>
<tr>
<td>different systems. What we do is develop a product based on simple packages that</td>
<td>corporatised water utility.)</td>
</tr>
<tr>
<td>can easily be installed rather than developing computer software from scratch and</td>
<td></td>
</tr>
<tr>
<td>hard coding it, because the first thing you will be doing is rewriting 20% of it for</td>
<td></td>
</tr>
<tr>
<td>the first sale” (Interview Code #106).</td>
<td></td>
</tr>
<tr>
<td>“One of the things that became clear after doing market research was that high-tech</td>
<td>Small wastewater specialist. (ASX listed firm; Australian owned.)</td>
</tr>
<tr>
<td>becomes part of the cost because you can’t sell these countries a lot of the cost</td>
<td></td>
</tr>
<tr>
<td>of high-tech components in your plants. The plants are still computerised but built</td>
<td></td>
</tr>
<tr>
<td>with simplified components. ....Our products are more efficient and less complicated</td>
<td></td>
</tr>
<tr>
<td>than our competitor’s” (p.c. Interview Code #78).</td>
<td></td>
</tr>
<tr>
<td>“We found selling products to China, someone has to be trained to run the plant.</td>
<td>Small wastewater specialist. (ASX listed firm; Australian owned.)</td>
</tr>
<tr>
<td>(With our products) everything is simplified so the person doesn’t have to do an</td>
<td></td>
</tr>
<tr>
<td>extensive training course to operate and maintain it. This gives us competitive</td>
<td></td>
</tr>
<tr>
<td>advantage” (p.c. Interview Code #78).</td>
<td></td>
</tr>
<tr>
<td>“Often they (Asian clients) want the best high technology which is above their</td>
<td>Large consultancy/ design firm. (French parent company.)</td>
</tr>
<tr>
<td>operational skills. Part of our job is to talk them out of it. This gives us export</td>
<td></td>
</tr>
<tr>
<td>success in the long-run. The reason is because if you are providing things which are</td>
<td></td>
</tr>
<tr>
<td>over-engineered then you get a bad name” (p.c. Interview Code #98b [1st respondent]).</td>
<td></td>
</tr>
<tr>
<td>“In many cases, particularly for agency work, the implementation priorities are</td>
<td>Large consultancy/ design firm. (French parent company.)</td>
</tr>
<tr>
<td>simplicity, reliability and affordability…. Product innovation is not always relevant</td>
<td></td>
</tr>
<tr>
<td>but the context always is” (p.c. Interview Code #98b [2nd respondent]).</td>
<td></td>
</tr>
</tbody>
</table>


8.2 Innovation creation and acquisition

Regardless of the level of technology used by an industry, firms gain the knowledge required for innovation from a variety of sources, including internal creation, external acquisition and diffusion (Sections 3.3.2; 3.3.3). Investigating these sources contributes to an understanding of the process of innovation, which in turn helps explain how and why trade develops for an industry. The sources are described in Section 8.2.1. Section 8.2.2 explains why combinations of internal and external sources prevail. The limitations of the empirical categorisation are also discussed. Section 8.2.3 maintains that linkages between firms and external innovation sources can remain effective over space.
8.2.1 The sources of innovation

To investigate the different sources of innovation, different categories of firms are used to organise the variety of responses. Manufacturers and service providers are used to distinguish sources, followed by exporters and non-exporters.

8.2.1.1 Manufacturers and service providers

The firm-activity category is used because service providers usually do not have R & D and patents, so their sources of innovation are assumed to be different from manufacturers. There is evidence that sources of innovation are different for the two categories. Figures 8.3 and 8.4 show that manufacturers mainly rely on internal R & D (often a specialised unit within the firm), and external sources such as product testing with leading clients. Product testing allows market intelligence to feedback into the innovation process. Collaborations with research organisations are also common. Service providers predominantly use staff expertise for gaining innovation. The expertise can be sourced internally, or recruited externally to the firm. Other external sources include knowledge from the overseas parent company, in addition to corporate strategies such as joint ventures with other firms. A reason why innovation proxies are poor measures is that external sources are neglected. One way to quantify external sources would be to count the number of licensing agreements, although this only captures one type of external source that is usually restricted to manufacturers.

Although the individual combinations of sources are different between manufacturers and service providers, at a coarser level of resolution both groups use a combination of internal and external sources of innovation. For manufacturers 9% of firms rely exclusively on internal sources, as compared with 7% for the service providers. An exclusive reliance on external sources is displayed by 13% of manufacturing firms and 9% of service providers (Table 8.8). For both manufacturers and service providers, the majority of firms rely on a combination of internal and external sources.

In general, for service providers R & D is less defined and formalised (i.e. less likely to be a specific expenditure or carried out by a distinct unit within a firm) than for manufacturing firms. As noted by one service provider: “Some first-off jobs, and early
parts of the job could be considered R & D” (p.c. Interview Code #98b). Another consulting engineering firm mentioned: “Our R & D is in attendance at seminars and workshops and reading of the literature. What emits out of this is R & D” (p.c. Interview Code #100b). A similar firm observed: “The need for R & D is probably lost in this grey area of what experience is gained on jobs and what sort of experience one buys with people” (p.c. Interview Code #101).

Table 8.8 Classification of knowledge sources for manufacturers and service firms (N = 124) (exporters and non-exporters)

<table>
<thead>
<tr>
<th>Type of knowledge source</th>
<th>Manufacturing firms</th>
<th>Service firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal</td>
<td>9%</td>
<td>7%</td>
</tr>
<tr>
<td>External</td>
<td>13%</td>
<td>9%</td>
</tr>
<tr>
<td>Combination</td>
<td>71%</td>
<td>82%</td>
</tr>
<tr>
<td>Unknown</td>
<td>7%</td>
<td>2%</td>
</tr>
</tbody>
</table>

**Note:**
1. See Figures 8.3 and 8.4 for details of these sources.

**Source:** author’s surveys and interviews 1998 – 2000.
Figure 8.3 Sources of knowledge/innovation acquisition for manufacturing firms (N = 81)

Key (for Figures 8.3–8.6):
(I) Internal source (e.g. in-house staff; internal R & D unit)
(E) External source (e.g. product testing; overseas parent company; licensing agreement; corporate strategy such as joint venture or collaboration)
(I, E) Combination of internal and external sources

Note (for Figures 8.3–8.6):
1. Knowledge and innovation are used as interchangeable terms in verbal interview settings. However, in the reporting of this research ‘innovation’ is preferred because it has a specific meaning of knowledge directed toward a goal of an improved product, service, or delivery for commercial benefits.

Because manufacturers and service providers each use distinct combinations of sources, the hypothesis is tested of whether there is a quantitative difference in firm-performance measures between the two categories. Table 8.9 shows the results from testing this hypothesis. A significant difference is detected between manufacturing and service firms for turnover per employee. A probable reason is that manufacturing firms are more capital-intensive so have fewer employees for the same unit of turnover when compared with service-providers. A more speculative reason is that intense internal R & D might also contribute to a higher turnover per employee for manufacturers. Yet there is no significant difference between the two groups for the proportion of exporters or the proportion of export revenue. This suggests that the different groups muster the
innovation sources appropriate to their requirements. Whether the source of innovation is from the use of external staff expertise or an internal R & D unit, the conclusion is that the type of source is unrelated to a firm’s export performance. The difference in turnover per employee is only because manufacturers are capital-intensive.

**Table 8.9 Comparison of firm-performance measures between manufacturers and service firms** (N = 106) (exporters & non-exporters)

<table>
<thead>
<tr>
<th>Category</th>
<th>Manufacturing firms</th>
<th>Service firms</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total no. of firms</td>
<td>81</td>
<td>38</td>
<td>-</td>
</tr>
<tr>
<td>Turnover per employee (A$ thousand)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (s.d.)</td>
<td>N = 75 (6 unknown)</td>
<td>N = 31 (7 unknown)</td>
<td>T test (equal variance; log transformed)</td>
</tr>
<tr>
<td>Median</td>
<td>345 (283)</td>
<td>275 (334)</td>
<td>t (104) = 2.40 p = 0.02 (two tailed) *</td>
</tr>
<tr>
<td>No. of exporters</td>
<td>N = 58 72% of manufacturing group</td>
<td>N = 28 74% of service firm group</td>
<td>-</td>
</tr>
<tr>
<td>Export proportion (exports as % of turnover)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (s.d.)</td>
<td>N = 51 (7 unknown)</td>
<td>N = 15 (13 unknown)</td>
<td>T test (equal variance; log transformed)</td>
</tr>
<tr>
<td>Median</td>
<td>0.19 (0.20)</td>
<td>0.22 (0.28)</td>
<td>t (64) = 0.09 p = 0.93 (two tailed)</td>
</tr>
</tbody>
</table>

*Note:*
1. Branch offices not included.


**8.2.1.2 Exporters and non-exporters**

Figures 8.5 and 8.6 compare sources of innovation between exporters and non-exporters. This is done because Table 8.3 reveals a difference in the proportion of innovation proxies between the two groups. As these figures and Table 8.10 show, using qualitative factors also uncovers a distinction. The starkest contrast is that 4% of exporters rely solely on external knowledge, compared with 18% of non-exporters. One reason is that several non-exporters are MNC branch firms established to concentrate on the domestic market (p.e. Interview Code #92; Survey Codes #2; #13; #22). Branch plants would be more likely to import this knowledge than generate it internally. According to Caves
MNCs generally undertake the majority of R & D in their home country. This is explained by the internalisation strategy identified in Dunning’s model (Section 2.4.2).

The direction of causality between external sources and being a non-exporter is not clear. Does a reliance on external knowledge mean that a firm is more likely to be a non-exporter, or is it simply a consequence of being a non-exporter in the first place? The latter proposal is possibly correct because a number of non-exporters also use the same combinations of sources (e.g. internal R & D and product testing) as exporters. If external sources alone resulted in firms not exporting, then more non-exporters than shown would be relying exclusively on external sources and not on combinations.

**Figure 8.5 Sources of knowledge/ innovation acquisition for exporting firms**

(N = 91)  *Note:* Percentages do not add up to one hundred due to rounding.
**Figure 8.6 Sources of knowledge/innovation acquisition for non-exporting firms**
(N = 33)

![Bar chart showing sources of knowledge/innovation acquisition for non-exporting firms.](chart)


**Table 8.10 Classification of knowledge sources for exporting and non-exporting firms**
(N = 124)

<table>
<thead>
<tr>
<th>Category of firm</th>
<th>Exporter</th>
<th>Non-exporter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of knowledge source</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal</td>
<td>8%</td>
<td>6%</td>
</tr>
<tr>
<td>External</td>
<td>4%</td>
<td>18%</td>
</tr>
<tr>
<td>Combination</td>
<td>84%</td>
<td>67%</td>
</tr>
<tr>
<td>Unknown</td>
<td>4%</td>
<td>9%</td>
</tr>
</tbody>
</table>

*Note:*
1. See Figures 8.5 and 8.6 for details of these sources.

8.2.2 Explaining the findings

The main finding is that the creation of innovation for firms is a combination of internal and external sources. This concurs with the literature (Pavitt 1984; von Hippel 1988; Cornish 1997a; 1997b; Oerlemans et al. 1998). Table 8.11 uses ideas from these researchers to categorise the empirical examples.

Table 8.11 Classification of internal and external sources of innovation

<table>
<thead>
<tr>
<th>Classification</th>
<th>Empirical examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal sources</strong></td>
<td></td>
</tr>
<tr>
<td>Transformation functions (R &amp; D units, production units i.e. learning by doing)</td>
<td>Internal R &amp; D units, internal staff</td>
</tr>
<tr>
<td>Transaction functions (market intelligence input)</td>
<td>Product testing</td>
</tr>
<tr>
<td><strong>External sources</strong></td>
<td></td>
</tr>
<tr>
<td>Public knowledge infrastructure (universities, technical colleges)</td>
<td>Research collaborations with universities, CRCs (Cooperative Research Centres)</td>
</tr>
<tr>
<td>Private knowledge infrastructure (trade organisations, consultants)</td>
<td>Use of consultants as external staff</td>
</tr>
<tr>
<td>Industrial column (suppliers, buyers, other firms)</td>
<td>Licensing agreements, joint ventures</td>
</tr>
<tr>
<td>Intermediaries (includes information brokers such as chambers of commerce, industry associations), technology policy (implemented through economic and industry development bureaucracies).</td>
<td>Industry associations such as AWA (Australian Water Association), also government innovation programs (see Chapter 10)</td>
</tr>
</tbody>
</table>

Source: Column 1 adapted from Hakansson (1987); Oerlemans et al. (1998); Column 2 from author’s surveys and interviews 1998 – 2000.

Why do firms use combinations of internal and external sources of innovation, rather than a reliance on one form? By using several sources, firms are more likely to gather the necessary knowledge to innovate, rather than relying solely, for example, on internal R & D. The lack of internal resources or specific expertise motivates the search for external sources. Yet some firms maintain reliance on internal sources - even if not exclusively - to better protect proprietary knowledge. The empirical work shows that a number of
manufacturing firms use an internal R & D unit, in addition to external sources of innovation (Figure 8.3). Because a tangible product is capable of being copied more readily than a service, it makes sense to protect some designs in-house (p.c. Interview Code #79).

Underlying the processes of acquiring and creating knowledge are corporate strategies. The empirical findings reveal that external sources of innovation involve common corporate strategies such as joint ventures and collaborations. Corporate strategies are manifestations of firms extending their boundaries of influence; likewise, sourcing innovation will involve decision-makers interacting at the fluid interface between the internal and external environment of the firm. In addition, the intra and inter-firm linkages associated with corporate strategies also contribute to innovation diffusion.

The limitation of this investigation of innovation sources is that characteristics of the water industry restrict the types of comparisons. For instance, the majority of firms are incremental innovators - depending on both internal and external sources. There are not enough radical innovators in the sample to compare how innovation sources might differ. Hence competing claims by Maillat (1991) and Oerlemans et al. (1998) cannot be tested about whether incremental innovators are more dependent on internal sources compared with radical innovators (see Section 3.3.2.3). Yet in reality, it would likely be difficult to find firms - outside of select ‘high-tech’ sectors - that are strictly radical innovators. Another issue not explored in this analysis is the rate of diffusion of innovation. To investigate diffusion would require time-series data on the use of overseas patents by domestic firms.

8.2.3 Innovation and geographic linkages

Innovation creation has an inherent geographic component because internal and external sources are spatially separate. Table 8.12 shows that innovation sources are associated with different types of geographic linkages. Internal creation is important, as are regional or national collaborations with institutions. International sources such as R & D from a multinational parent are also prevalent. Local sources of innovation are only a secondary resource used by some firms. Furthermore, no cases were found of direct linkages
between firms and nearby relevant research institutions. For example, located within 5 km of the Cooperative Research Centre (CRC) for Catchment Hydrology (Clayton, VIC) are four firms that possibly would use similar hydrological knowledge, yet none of these indicated any linkages (p.c. Interview Codes #105; #109; Survey Codes #50; #111). However, the CRC for Catchment Hydrology itself has geographically dispersed linkages with other commercial firms located in other parts of Melbourne and inter-state (p.c. Interview Code #124). Another example is the CRC for Waste Management and Pollution Control that has widespread national linkages with firms, yet none of these are located near its location in Kensington, NSW (p.c. Interview Code #126).

There is no evidence from the interviews to suggest that spatial separation adversely affects the relevance and currency of knowledge that leads to innovation. Once linkages are in place then the sources of innovation are not spatially confined. In fact, there are four examples of specialist manufacturers of products renowned for innovative designs that are located in mainly semi-peripheral locations (p.c. Interview Codes #55; #61; #71; Survey Code #29). Three of these examples are on urban fringes. Research on the US metal working industry by Harrison et al. (1996) also identifies this zone as having a high proportion of innovators.

There are a number of reasons why spatial separation may not be detrimental to innovation: 1) the widespread use of electronic communication technology means that current and relevant knowledge is readily obtainable; 2) senior managers - especially of larger firms - are geographically mobile, resulting in a regular ‘cross-fertilisation’ of overseas and local knowledge; 3) the water industry is not as dependent on ‘breakthrough’ latest technologies as compared to some high technology industries that require face-to-face interactions (Angel 1994); and 4) intra-firm linkages (e.g. through FDI) and inter-firm linkages (e.g. joint ventures and collaborations) can abrogate distance. These reasons also reinforce an earlier argument (Sections 6.4.; 7.3.5) that localised linkages are not necessary for the water industry to be competitive. Contrary to assertions by Lundvall (1988; 1992), Gertler (1993; 1995) and van Bergeijk (1996) of a distance decay effect with sources of innovation, the empirical findings are that the
knowledge that spawns innovations can remain relevant over space once linkages are in place. These linkages are established by networks (discussed in Section 9.2).

**Table 8.12 Sources of innovation and types of geographic linkages** (N = 28 firms)  
(Interviews only) (26 exporters; 2 non-exporters) ¹

<table>
<thead>
<tr>
<th>Source of innovation acquisition/ creation</th>
<th>Frequency</th>
<th>Geographic linkage identified for particular method</th>
</tr>
</thead>
<tbody>
<tr>
<td>In house R &amp; D</td>
<td>9</td>
<td>I</td>
</tr>
<tr>
<td>Collaborations with CSIRO and CRCs</td>
<td>8</td>
<td>R</td>
</tr>
<tr>
<td>Exclusively collective expertise within the organisation</td>
<td>8</td>
<td>I</td>
</tr>
<tr>
<td>Through assembling internal and external teams</td>
<td>5</td>
<td>I, L, R ³</td>
</tr>
<tr>
<td>R &amp; D from multinational parent</td>
<td>5</td>
<td>O</td>
</tr>
<tr>
<td>Technical knowledge through internal staff</td>
<td>2</td>
<td>I</td>
</tr>
<tr>
<td>Individual invention with later collaboration with CRCs/CSIRO</td>
<td>2</td>
<td>I, L, R ³</td>
</tr>
<tr>
<td>From associated university department (as a result of being a spin-off firm)</td>
<td>2</td>
<td>L, R ³</td>
</tr>
<tr>
<td>Graduate recruitment program</td>
<td>2</td>
<td>R</td>
</tr>
<tr>
<td>From lead users (as market intelligence)</td>
<td>1</td>
<td>R, O</td>
</tr>
</tbody>
</table>

**Notes:**
1. There are not enough non-exporters to make comparisons with exports.
2. An individual firm may mention more than one source. Thus total responses exceed the number of firms.
3. The distinction between local and regional is not always clear-cut. These labels are only intended to reflect particular cases identified from the interviews.

**Source:** author’s interviews 1998 – 2000.

The linkages that firms have with external sources of innovation within the nation state comprise the national innovation system (Sections 2.3.2.2; 3.3.2). Examples include collaborations between firms and research institutions. Staff expertise is partly a product of the educational institutions that also form innovation systems. The effectiveness of the national innovation system in creating competitive advantage depends on the interaction between institutions and the private sector (Nelson 1993a). There is evidence of interactions between institutions and water industry firms (Figures 8.3 - 8.6; Table 8.11). However, without cross-country comparisons it is not known how developed these linkages are. One report, for example, argues that Australia’s national innovation system remains highly fragmented because it has too few linkages or active coordination.
between public and private agencies (DISR 1999). Section 10.2.5 discusses the effectiveness of the national innovation system for the water industry.

### 8.3 Conclusion

Chapter 8 has discussed innovation in the context of explaining how trade develops in the Australian water industry. The first section found that quantitative relationships between innovation proxies and firm-performance measures are fairly weak. Manufacturing firms that export do have a higher proportion of R & D and patents. There is a weak but significant relationship between R & D proportion and export proportion, but no evidence of a relationship between patent proportion and export proportion. It is argued that the innovation proxies used only reflect a narrow concept of innovation confined to technical change. A broader concept of innovation that encompasses appropriate technology offers a better explanation of how trade develops.

Section 8.2 investigated innovation sources. The results reveal a variety of internal and external sources. This reinforces an earlier assertion (e.g. Section 3.1) that an explanation of trade involves processes internal and external to the firm. The findings also show that firms often use geographically disperse innovation sources. If intra- and inter-firm linkages are in place, then innovation creation and acquisition by firms is not spatially constrained.

The implication for the theoretical framework is that while innovation is considered a separate strand of investigation, the process involving innovation creation and acquisition is inextricably linked with other the strands. Several cases from the empirical findings illustrate this. For instance, understanding why firms choose certain sources of innovation involves knowing why particular corporate strategies are used. Understanding why appropriate technology is linked with trade requires appreciating that competitive advantage can be created in numerous ways. The ability to develop appropriate technology, for example, is related to having a cultural affinity with clients. A further example of the connection between strands is that influences by the state and institutions create national innovation systems where the knowledge feedbacks to the firm. Firms...
also mobilise and link internal and external innovation sources by using networks. This strand is explored next.
Chapter 9
How competitiveness extends across space: accessing export markets and the function of networks

The previous chapters provide empirical evidence to demonstrate how firms in the water industry create competitive advantage and innovation. Competitive firms have a larger spatial influence in the market than less competitive rivals. Yet what still needs to be known is how competitive advantage and innovation, once established, extends across space. There is a dialectical relationship between competitiveness and space because competitiveness possessed by firms only becomes influential when it is transmitted across space from producers to buyers. This chapter explains this process of transmission by investigating how firms with competitive goods or services connect with distant buyers. As Part One reviewed, there are several ideas about how firms access export markets. Dunning’s eclectic paradigm explains why multinational corporations choose foreign direct investment (FDI) over direct export of goods or services. Protecting proprietary knowledge and minimising transaction costs are main reasons for FDI. An alternative theory is that inter-firm corporate strategies such as alliances are used by some firms to minimise risk in export markets. Network theory provides additional insights into how decision-makers, internal and external to the firm, make contact. Using these insights, Chapter 9 finds out how firms of different types and sizes within an industry access export markets. Possibly one idea may emerge as more applicable than the others for explaining export access. Alternatively, several explanations may have to be combined.

Chapter 9 begins by investigating the methods firms use to access export markets. The method of access is partly determined by the size and activity of the firm. In Section 9.2, interview material is used to show how networks between decision-making individuals (i.e. the actors) function as the actual mechanism of connection between buyers and sellers. Formal and informal networks are distinguished. The importance of trust and the influence of space on the process of network formation are also considered. Section 9.3 uses insights from actor network theory to explain how networks reach over space, and what holds them together. Section 9.4 concludes that networks between individual
decision-makers are an essential component of explaining trade. However, networks also need to be considered within the wider context of structural influences. Throughout the chapter several research questions are addressed (Table 9.1). These questions are underpinned by the argument that a comprehensive explanation of trade includes investigating how competitiveness that is embedded in goods, services and capital extends across space.

Table 9.1 Research questions addressed in Chapter 9

<table>
<thead>
<tr>
<th>Questions from theoretical discussion (Table 3.3)</th>
<th>Relevant section in Chapter 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>How are export markets accessed?</td>
<td>9.1</td>
</tr>
<tr>
<td>Why are particular methods used?</td>
<td>9.1</td>
</tr>
<tr>
<td>Does the size and type of firm influence the method used?</td>
<td>9.1.3; 9.1.4</td>
</tr>
<tr>
<td>Is there a dominant theory explaining export access, or are several explanations required?</td>
<td>9.1.5</td>
</tr>
<tr>
<td>How are networks formed?</td>
<td>9.2</td>
</tr>
<tr>
<td>Are there spatial barriers to forming networks and trust?</td>
<td>9.2.2</td>
</tr>
<tr>
<td>How do networks reach over space?</td>
<td>9.3.1</td>
</tr>
<tr>
<td>How can network theory inform an analysis of trade?</td>
<td>9.3</td>
</tr>
</tbody>
</table>

Source: selected questions from Table 3.3.

9.1 Methods of accessing export markets

The methods of accessing export markets for intermediate goods and producer services are fundamentally different from those of consumer goods and services. Intermediate goods and services are usually relatively more expensive than consumer goods and services, and the decision-makers tend to be a group rather than an individual consumer (Hart 1994; Lynch 1994). Personal contact between producer and customer increases proportionally with the cost and extent of customisation of the product and is therefore more prevalent in industrial product markets than for mass consumption markets (Gertler 1995). Furthermore, there is a body of literature that advocates a network approach for understanding intermediate (or industrial) markets because of on-going relationships between decision-makers (Mahin 1991; Axelsson and Johanson 1992; Easton 1992). An expectation from the literature (e.g. Wright 1994) is that face-to-face methods such as word-of-mouth (i.e. being recommended) and active targeting (i.e. the firm approaching potential clients by setting up an overseas office, forming alliances, or the use of
marketing agents) are more common than methods used to access final consumer markets, such as by mass media advertising or e-commerce.

Section 9.1.1 investigates the types of export access used by water industry firms. The role of web-sites is evaluated in Section 9.1.2. Although a useful tool for firms in gaining and disseminating information, web-sites and E mails are certainly not a substitute for initial face-to-face contact. Sections 9.1.3 and 9.1.4 reveal that export methods vary depending on the size and type of firm. A variety of intra-firm and inter-firm strategies are used. Reasons are suggested for the findings. Section 9.1.5 discusses the theoretical significance of these results. What is found is that the theoretical explanation needs to be malleable according to the size and type of firm.

**9.1.1 Common methods of access**

The empirical approach used is to ask representatives of firms how exports develop and aggregate the individual experiences until commonalities emerge. Table 9.2 reveals that word-of-mouth (i.e. recommendations from third parties) and active targeting are dominant. This conforms to expectations from the industrial marketing literature (see above). Accessing markets through developmental aid organisations is frequently cited because of the nature of the water industry (Section 4.3.1). Corporate strategies such as joint ventures and alliances are also common. Strategies such as horizontal alliances allow the firm to expand its boundaries by sharing resources with the other collaborator. Risks are shared, making alliances a viable option, especially for smaller firms.

The reason why firms decide to export was asked in some interviews. Common answers include the requirement to increase profits and market expansion due to a limited domestic sector (p.c. Interview Codes #51; 81; 98b). (The actual underlying personal motives behind the reason ‘why’ were not explored, as an intense corporate interview was not the intention.)
Table 9.2 Frequency of different methods firms use to access export markets
(N = 91 firms \(^1\); 239 citations \(^2\) ) (exporters only)

<table>
<thead>
<tr>
<th>Method of export access (^3)</th>
<th>Frequency of citation</th>
<th>Percentage of total citations (^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active targeting (e.g. setting up overseas office; sales representatives visiting clients)</td>
<td>48</td>
<td>20%</td>
</tr>
<tr>
<td>Word-of-mouth</td>
<td>46</td>
<td>19%</td>
</tr>
<tr>
<td>Australian government agencies (e.g. AusAID)</td>
<td>39</td>
<td>16%</td>
</tr>
<tr>
<td>Joint ventures/ alliances (^5) (temporary vertical subcontracting arrangements or horizontal joint ventures; permanent horizontal alliances such as establishing foreign subsidiaries/ partnership)</td>
<td>27</td>
<td>11%</td>
</tr>
<tr>
<td>International Development Organisations (e.g. World Bank, Asian Development Bank)</td>
<td>17</td>
<td>7%</td>
</tr>
<tr>
<td>Multinational group</td>
<td>17</td>
<td>7%</td>
</tr>
<tr>
<td>Industry intelligence (e.g. contacts through colleagues)</td>
<td>16</td>
<td>6.5%</td>
</tr>
<tr>
<td>Attendance at trade shows</td>
<td>11</td>
<td>5%</td>
</tr>
<tr>
<td>Foreign government agencies (e.g. JICA)</td>
<td>9</td>
<td>4%</td>
</tr>
<tr>
<td>Web-sites</td>
<td>9</td>
<td>4%</td>
</tr>
</tbody>
</table>

Notes:
1. Sample includes branch offices of the same firms (5 cases).
2. Most firms use a combination of methods so total frequency of citations is greater than the number of firms.
3. Methods have been created from surveys and interviews by tabulating responses until definite categories start to emerge. Categories are artificially imposed, whereas in reality there might be some crossovers (e.g. active targeting and joint ventures might be the same thing to some firms). Nevertheless, the varieties of methods and frequency of usage are still apparent.
4. Percentages do not add up to 100% due to rounding.
5. The answers do not adequately distinguish the difference between temporary and permanent alliances.


The question of why some firms do not export was also explored. Table 9.3 describes the responses. The lack of capital experienced by small firms is an important factor. Yet other small firms are active exporters, suggesting that it is possible to overcome capital constraints by using various corporate strategies and networks. A notable finding from Table 9.3 is that being part of a MNC may be a disincentive for some firms to pursue exporting. These branch offices are primarily focused on the domestic market.
Table 9.3 Reasons why firms do not export
N = 33 firms (non-exporting group)

<table>
<thead>
<tr>
<th>Reason for non-export activity</th>
<th>No. of firms</th>
<th>Percentage of non-exporting group</th>
</tr>
</thead>
<tbody>
<tr>
<td>No answer/ not applicable</td>
<td>12</td>
<td>36%</td>
</tr>
<tr>
<td>Too small/ still expanding in domestic market.</td>
<td>9</td>
<td>28%</td>
</tr>
<tr>
<td>Part of MNC group (firm is represented internationally).</td>
<td>6</td>
<td>18%</td>
</tr>
<tr>
<td>Distributor of products only.</td>
<td>4</td>
<td>12%</td>
</tr>
<tr>
<td>Inadequate government assistance.</td>
<td>1</td>
<td>3%</td>
</tr>
<tr>
<td>Political/ economic uncertainty in importing location.</td>
<td>1</td>
<td>3%</td>
</tr>
</tbody>
</table>


9.1.2 How useful are web-sites?

This research was conducted during the period when the majority of firms and organisations had recently established web-sites. It is useful to see what role electronic means of commerce play in establishing trade linkages for this industry. Table 9.2 shows that there is a small number of citations for web-sites. Moreover, this method was always mentioned in combination with other more prominent ones. Interviews reveal that websites on their own are not sufficient to secure an export contract (p.c. Interview Codes #64; #98a; #100a; 100b; #105). This is because of the level of personal contact and negotiation needed, particularly with engineering consultancy work. A respondent noted: “If general (web-based) documents are used, it is too late to put in a good tender by the time we get it” (p.c. Interview Code #100b). Another respondent mentioned that face-to-face contact remains essential. Nevertheless: “The web is becoming more common for aid type projects” (p.c. Interview Code #GHD Sydney). A representative from an environmental industry association, however, was enthusiastic about the potential of the Internet: “I would argue web-sites are crucial. You can often learn more in your office using a computer than by visiting sites. I’d argue strongly on-site visits are very much over-blown - a professional person would be better doing a desktop study. The people with real commercial interests will spend a lot more time accessing information than they will travelling around” (p.c. Interview Code #123).
It is possible that the use of web-sites for export access has increased since the fieldwork was complete. However, the Internet is unlikely to replace other traditional methods of forming export contacts. Its likely role is as a useful adjunct communication tool. Because the water industry is an intermediate goods and services industry, products and services are generally more complex and expensive than for consumer markets. Hence a high degree of personal contact is required between the actors.

9.1.3 Export methods and the size of firms

The combination of methods used to access export markets can differ depending on the size of the firm. Comparing Figures 9.1, 9.2 and 9.3 reveals both similarities and differences. The main similarity is that for all sizes, contracts through developmental aid organisations are important. Aid organisations tender out work for international water management projects. The media used to convey the information are advertisements in national newspapers, regular newsletters and increasingly, web-sites. There is fierce competition between firms to win contracts. A representative from AusAID illustrates this: “The more proactive firms probably would have been following the development of projects from the feasibility stage to the design and implementation so they are ready. It is obviously a huge investment to prepare a bid on a project so they are watching it. They may even have someone on the ground in the (recipient) country to gather information on the activity to strengthen their bid” (p.c. Interview Code #128). AusAID contracts are a major source of access for all firms, with medium and large firms also using other international development organisations (e.g. World Bank, Asian Development Bank). Larger firms generally have the resources to compete for contracts from wider sources compared with smaller firms.

The main differences highlighted in the three displays are that small firms depend on word-of-mouth, with active targeting being secondary. This could be because relying on word-of-mouth is one of the few options available to small firms, which often lack the capital to actively target or to instigate alliances. Word-of-mouth allows small firms to establish a reputation, although this can take considerable time to develop (Harvey 1983). For medium size firms, export access is a mixture of word-of-mouth and active targeting.
The importance of active targeting, which can take forms such as visiting clients or setting up an office, is reflected in this response: “In Asia, it takes a large number of meetings to find out what they really want. ..you can’t do it remotely, so it is very expensive, it takes a lot of time and effort. If you’ve got a local office that helps because you are not spending a lot of money sending people back and forth all the time” (p.c. Interview Code #101). Medium size firms usually have the resources to visit potential clients or to set up a small foreign office. Unlike large firms, however, medium size firms lack the extensive linkages and large resources required to establish multiple foreign branch offices. Figure 9.2 also indicates that multinational linkages begin to emerge as a form of access for some medium size firms.

**Figure 9.1 Main methods \(^1\) of export access for small firms**

N = 24 (62\% of exporting small firms \(^2\))

![Bar Chart]

**Notes:**
1. The combinations do not indicate relative importance of each method. (Section 11.3.2 discusses this limitation.)
2. For the remaining 38\% of exporting small firms, there was only one firm per different combination of methods. The combinations of methods for these firms are variations of the categories shown in Figure 9.1. To include all the exporting small firms would clutter the figure and not add much new information. This condition applies to the proportions shown in other figures in this chapter.

**Source:** author’s surveys and interviews 1998 – 2000.
Figure 9.2 Main methods of export access for medium size firms
N = 18 (60% of exporting medium-size firms)

Figure 9.3 Main methods of export access for large firms
N = 16 (73% of exporting large firms)


For export contacts, large firms make use of Australian and international development organisations, in addition to multinational connections (Figure 9.3). The use of aid agencies is common for large firms, due to having the resources and reputation to successfully tender. Several representatives of multinational engineering consultancies reported that their firm’s high profile name was a major reason for obtaining overseas contracts. As one participant said: “Even if projects are not large, clients still like the parent company guarantee” (p.c. Interview Code #94). So although word-of-mouth is not a common response for large firms, this method would be implicit for many large firms where reputation is built on recommendations from previous clients.
For small and medium firms the necessity of having a local partner or alliance arrangement for developing exports was noted specifically in 9 interviews (p.c. Interview Codes #64; #78; #79; #95; #99a; #99b; #100a; #100b; #106) (2 small firms; 7 medium size firms). Smaller firms can ‘piggyback’, for example, enter licensing agreements or joint ventures with a local partner. This is consistent with the findings in Table 7.8 that identified permanent horizontal alliances as important corporate strategies for competitive advantage. In these examples, local contacts in recipient countries often substitute for the long-distance networks of interaction that multinational firms possess. By developing alliances, small firms extend their influence by externalising activities. As O’Farrell and Wood (1998) note, small firms do not have the resources to internalise activities and embark on FDI (foreign direct investment), so have little option but to externalise. The practical importance of partnering with people who have local experience and contacts is encapsulated in this quote from a representative of a small firm: “Quite frankly it (doing business in China) would be a nightmare without the particular Chinese individual we employ. He is bilingual – has significant influence and friends in high levels of regional government. Because everything is based on relationships you need that level of influence - so if you haven’t got those things in place it would be unbelievably difficult” (p.c. Interview Code #78).

9.1.4 Comparing manufacturers and service providers

Figures 9.4 and 9.5 compare methods of export access for manufacturers and service providers. Manufacturers use word-of-mouth and active targeting. Active targeting involves actions such as directly approaching clients and setting up branch offices in the recipient country. Service providers are different as they depend on Australian and foreign government aid programs. Manufacturing firms are less likely to be directly involved in aid work. Recall from Section 6.3 that Australian supplier firms are not generally used for overseas aid projects; this contributes to weak supplier linkages.

In general terms, manufacturing firms rely on the internal resources of the firm (e.g. active targeting, word-of-mouth). Alternatively, service providers use resources external to the firm, with more reliance on inter-firm relationships (e.g. aid agencies, joint
ventures and alliances). This is a generalised difference as some manufacturers use external methods such as alliances, and some service providers use internal methods.

**Figure 9.4 Main methods of export access for manufacturing firms**

N = 40 (69% of exporting group of manufacturing firms)

*Source: author’s surveys and interviews 1998 – 2000.*
To explain the difference between the two groups, two ideas are drawn from the literature. Buckley and Casson (1976) claim that firm-specific propriety knowledge creates an incentive to internalise and protect knowledge. Knowledge intensive activities are more likely to be conveyed abroad through investment in branch offices, rather than by direct export or exchange with foreign collaborators. Because a manufactured product is a tangible object, it can be copied by competitors and so internal methods of export access are used to protect proprietary knowledge. An alternative explanation by O’Farrell and Wood (1998) is that for business services, the uncertainty and higher risks of operating knowledge-intense services do not generally favour FDI (foreign direct investment), despite having generally lower capital requirements to set up a foreign establishment compared with manufacturing firms. Moreover, services are harder to
emulate by competitors so there is not as much risk to the firm when entering partnerships. Therefore, contractual arrangements (i.e. relying on external resources) to enter export markets should be more common that branch office investments (i.e. internal resources). Co-production with collaborators is preferred as it lowers uncertainty.

The empirical findings lend support to O’Farrell and Wood’s argument. Inter-firm linkages (e.g. joint ventures, alliances or the use of aid agencies) are a common method of export access for service providers (Figure 9.5). In these cases, firms are drawing on resources external to their boundaries. Buckley and Casson’s proposal is not as convincing for explaining exports by manufacturing firms. Active targeting and being part of an MNC are common for manufacturers, suggesting the internalisation of knowledge (Figure 9.4). Yet alliances with other firms are also used, indicating that protecting proprietary knowledge is not the only motive. Firms in the water industry often do not rely exclusively on high-technology for competitiveness, but rather the application of appropriate technology (Section 8.1.3). Protecting knowledge, while important for some firms, is not as critical for maintaining competitive advantage as in high-technology industries.

9.1.5 What is the significance of the findings?

What the results show is that export markets are accessed by several methods. The different methods listed in Table 9.2 involve processes internal and external to the firm. For instance, active targeting relies on a firm’s internal resources. Alternatively, joint ventures, multinational linkages, and gaining contracts from aid organisations involve using resources external to the firm. The methods of accessing export markets depend on the size of the firm and whether it is a manufacturer or service provider. There is a mixture of inter-firm corporate strategies and intra-firm linkages.

In these examples from the water industry, only a few manufacturing firms actually export physical products. Similarly, only some service-providers export by sending staff overseas for projects. The reality of exporting is more complex because often multiple parties are involved, rather than simply a producer and buyer. Some large firms engage in intra-firm trade by using FDI to establish a manufacturing plant or overseas consultancy.
Other firms export goods and services by using inter-firm alliances. For example, medium size Australian consulting firms often form alliances with smaller Asian firms to access markets in Asia. In addition, procurement by the state (such as recruiting tenders for developmental aid projects) acts as an avenue of export access for the private sector.

The theoretical significance is that no single explanation adequately identifies why firms use particular methods of export access. This is particularly so in industries - such as water - comprising a diversity of firm-sizes and activities. Buckley and Casson’s work (1976), in parallel with Dunning’s (1977; 1993b) eclectic model, explain the motives for FDI by multinationals. There are advantages in keeping resources (including knowledge) internalised by the firm, as well as locational advantages by setting up in foreign countries. Yet this explanation does not work for smaller firms that lack resources to internalise production and to establish branch operations. Furthermore, being part of a multinational group can be a reason not to export if the branch firm has an exclusive domestic focus (Table 9.3). For small producer service firms, O’Farrell and Wood (1998) offer a more convincing explanation of internationalisation by emphasising the lowering of uncertainty by collaboration.

A further insight from the results is that for firms of all sizes, networks underlie the processes of trade. Murdoch (1995), for instance, observes that multinationals consist of long networks. The empirical findings show that large firms rely on multinational networks, in the form of overseas branch offices and connections with parent companies. The use of word-of-mouth by smaller firms also suggests the influence of networks. Bryson et al. (1993) and O’Farrell and Wood (1998) argue that inter-firm networks enable small and medium size (SMEs) to reduce reliance on internal resources, leading to increased competitiveness. Through network relationships, SMEs are able to overcome the size-related constraints of their growth (Rialp and Rialp 2001). Given their inherent importance, networks require further analysis.
9.2 The functions of networks and trust

The common methods of accessing export markets (e.g. word-of-mouth, active targeting and multinational links) do not detail how the actors transact resources between exporting and importing localities. Understanding the function of networks helps illuminate the process involved. Section 9.2.1 identifies two types of networks from the empirical work: formal and informal. Specific examples are used to show how these networks operate and facilitate trade. In Section 9.2.2, the interrelation of trust with networks is explained.

9.2.1 Formal and informal networks

Table 9.4 categorises networks as formal (e.g. business joint venture agreements), and informal (e.g. ‘soft’ networks of non-legally binding arrangements between firms where information is disseminated). Informal arrangements can result from chance meetings that may eventually develop into formalised agreements. Serendipitous events that lead to trade contacts suggest that networks create opportunities at random. With long chains of specific interdependencies between actors in the network and relationships continually in flux, Axelsson and Johanson (1992) note that opportunities will appear at irregular intervals.

Firms that contain key actors with an abundance of strong and weak social ties have a greater probability of involvement in both types of networks than rival firms where the actors possess a few strong ties (Section 3.4.3). Large firms, more so than small firms, are assumed to comprise numerous individuals with weak and strong ties (for example, globally mobile business executives). This in turn leads to greater exposure of useful information for innovation and trade.

The extent of weak and strong ties is not tested here, although some of the examples described in Tables 9.4 and 9.5 would probably have originated from the numerous weak ties possessed by key actors. Note that terms such as strong and weak ties, and formal and informal networks, were not used in interviews. The approach was to let the respondent’s own words describe how exports have developed.
Table 9.4 Examples of types of network formation (N = 28 firms)

<table>
<thead>
<tr>
<th>Description of type of network</th>
<th>Frequency of citation</th>
<th>Classification of network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Through joint ventures with firm’s own subsidiary or overseas branch office.</td>
<td>13</td>
<td>Formal</td>
</tr>
<tr>
<td>Joint ventures/ alliances with other firms.</td>
<td>9</td>
<td>Formal</td>
</tr>
<tr>
<td>Networks through developmental aid agency contacts.</td>
<td>8</td>
<td>Formal</td>
</tr>
<tr>
<td>Through weak-tie contacts.</td>
<td>6</td>
<td>Informal</td>
</tr>
<tr>
<td>Meeting with government-sponsored trade delegation.</td>
<td>2</td>
<td>Formal</td>
</tr>
</tbody>
</table>

**Notes:**
1. Some firms noted more than one type so total frequency is greater than the number of firms.

**Source:** author’s interviews 1998 – 2000.

### 9.2.1.1 Formal networks

Formal network structures take the form of various corporate strategies (Sections 3.2.3; 7.4). For example, alliances and joint ventures come into existence by the interactions of individuals representing different firms and interests. Networks can function in a paradoxical way that can promote cooperation amongst competitors, particularly on international projects. A representative from a multinational engineering firm articulates this: “There is a network with Australian consultants who work through AusAID. Because we work together so much a network forms, such as a team from one consulting group recruiting an expert from another. … There can be a head-to-head battle to be short-listed on a project. However, if one is successful (in getting the contract) the other will sometimes ask if they could provide something specialised” (p.c. Interview Code #98b). Australian firms, however, are not as developed with consortiums as European counterparts.

Networks can be formalised by intentional actions of the state and institutions. This represents an indirect influence of the state on trade (Section 10.3). A good example is that of CRCs formalising networks through international research collaborations. Even if not initially for a commercial objective, collaborations can indirectly result in trade. The approval by respected scientists in an Asian country is extremely effective for initiating trust and building networks. A representative of a CRC (Cooperative Research Centre)
explains why: “The East Asian university structure reflects the Confucian structure in a culture where the academic is top of the list of the ones to trust and go back to for checks, testing or review. The participation of an Asian academic (on collaborative projects between universities and industry) signifies a degree of trust in the knowledge an Australian firm or organisation that is attempting to export” (p.c. Interview Code #126). Another example of a direct approach to create networks - specifically to promote water industry exports - has been undertaken by the South Australian government through the formation of the Water Industry Association (WIA). The examples demonstrate that the development of networks is not just the result of atomised individuals interacting in the absence of structural factors, as is sometimes implied in the literature (see Section 3.4.5). The development of networks - and the nurturing of trust - can require some form of catalyst, often as an initiative by an institution.

9.2.1.2 Informal networks

Informal networks are also evident in the water industry. Several respondents noted that having the right contacts, often through informal arrangements via social networks, are an important part of winning contracts. As a representative noted: “Within the engineering business in Australia, it is knowing who you know rather than what is coming up (e.g. potential tendering job). You get jobs through friends basically. It is still very relevant in this type of industry” (p.c. Interview Code #119).

Some examples of informal networks are reported in Table 9.5. Note that the sample is confined to small manufacturing firms. According to the literature (Section 3.4.3), small firms are less likely than larger firms to have personnel with the extensive weak ties conducive to informal networks. Yet the examples in Table 9.5 suggest that the internationalisation activities of small firms also rely on the weak ties of key personnel. Interestingly when interviewed, representatives from large firms did not allude to examples of weak ties or serendipitous events leading to export contracts, whereas small firms did. This does not mean, however, that large firms do not have informal networks. Quite the contrary: large firms have abundant informal networks due to multinational connections. Informal network events are not recalled by representatives from large firms because these events are considered a mundane occurrence and therefore not memorable.
enough to be mentioned. However, representatives from small firms discuss events that represent the manifestation of informal networks, as the events are more memorable from the small firm’s perspective.

**Table 9.5 Specific examples of how informal networks can initiate trade**  
(N = 4 firms)

<table>
<thead>
<tr>
<th>Description of event leading to trade contact</th>
<th>Type of firm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serendipitous meeting of a visiting Korean delegation at an AWA conference resulted in sale of units to a Korean paper and pulp manufacturer (p.c. Interview Code #79).</td>
<td>Small ASX-listed (Australian Stock Exchange) industrial wastewater treatment equipment manufacturer.</td>
</tr>
<tr>
<td>Brother in Arabia played golf with a highly connected brigadier, resulting in exports of desalination equipment from Perth to the United Arab Emirates (p.c. Interview Code #35).</td>
<td>Small private desalination equipment manufacturer.</td>
</tr>
<tr>
<td>A contact in London resulted in export orders of units to a UN aid project for Kurdish refugees in Iran (p.c. Interview Code #37).</td>
<td>Small private water treatment equipment manufacturer.</td>
</tr>
<tr>
<td>Initially met a group in China that was interested in technology for a water-bottling plant in southern China. This project did not eventuate as it was considered too high risk. However, contacts led to other people who were interested in the technology for contaminated industrial wastewater. This resulted in export sales (p.c. Interview Code #78).</td>
<td>Small ASX-listed water treatment equipment manufacturer.</td>
</tr>
</tbody>
</table>


**9.2.2 Trust and its role in facilitating trade contacts**

As Section 3.4.4 reviewed, trust is a critical element in network formation. Some of the previous empirical examples have alluded to trust, such as the discussion of cultural affinity (Section 7.2.3). Networks and trust are interrelated: networks help establish trust; trust helps maintain networks (Granovetter 1985; Murdoch 1995; Park 1996). Of course, trust is intrinsic in both formal and informal types of network arrangements, although informal types would presumably require more demonstrable examples of trust before they are formalised.

For the water industry, the building of trust is arguably as important to explaining trade as other factors such as competitive advantage and acquiring innovation. As exemplified in one comment: “Service industries are built on relationships, (it has) very little to do with
the price of the product. Trust is the key” (p.c. Interview Code #79). Another interviewee made clear the importance of trust, giving the example of firms not closing Asian branch offices in the wake of the Asian financial crisis: “You can’t withdraw from those offices completely because this would signify a lack of trust. If you are seen as deserting them, there go all your relationships. We maintain a presence but at a reduced level” (Interview Code #90).

The importance of trust is further emphasised by noting that the absence of trust - evident by patent and copyright violations - is an impediment to trade (p.c. Interview Codes #55; #100a; #108). One participant explained: “What happens sometimes is that the first set of drawings is paid for, and then they duplicate that all over China” (p.c. Interview Code #100a). Being asked for bribes (“palm greasing”) is sometimes encountered by firms when doing business in Asia (p.c. Interview Codes #64; #105). Representatives denied that their firms indulge in such practices, although European competitors were claimed to be sometimes guilty. However, at the coalface of Asian business negotiation where trust is being forged, the distinction between bribes and gifts (e.g. as in sightseeing tours and restaurants) is probably murky.

Spatial proximity is necessary in the formation of trust, at least initially while the relationship is being nurtured. For example, a respondent from a wastewater equipment manufacturer stressed that it is essential to travel to the recipient country on a regular basis so effective business relationships can be built and maintained. When the initial partnership with an Indonesian firm was being developed, a firm representative visited at least every six weeks (p.c. Interview Code #64). Another respondent from an engineering consultancy also noted that spatial contact needs to be sustained over time: “In Da Nang (Vietnam) we’ve been in and out for 4 years and now have an outstanding relationship with local associates. This has taken a long time” (p.c. Interview Code #100b).

Key actors in spatial proximity can form friendships long prior to establishing business relationships. This can function as a conduit for trust, which in turn can eventually initiate trade. As one respondent from an engineering consultancy observed: “A lot of professionals have been educated in Australia - young people - and they very quickly
become senior in Asia due to skill shortages. Student friendships may become future business links. Personal contacts are important” (p.c. Interview Code #90).

9.3 Insights offered by actor network theory

Actor network theory can provide additional insights into how networks are sustained. Section 3.4.2 reviewed how the recognition of non-human agency explains how networks reach over space, and how power relationships act to hold networks together. These concepts are explored in the context of the water industry.

9.3.1 Non-human agency: explaining how networks reach over space

Both actors and non-human agency bring networks into existence. Examples include people using the Internet and fax machines, and decision-makers travelling between locations by jet aircraft. The interaction of humans with non-human agency (i.e. technologies and text) allows networks to transmit over distance. The empirical work supports theorists such as Callon (1991) and Law (1994; 1999) who advocate that technologies form crucial parts of networks by bridging spatial separation. Three consulting engineering firms specifically mentioned that by utilising electronic communication methods (e.g. faxes, E-mails, telephones), staff can still do work for overseas projects while based in Australia (p.c. Interview Codes #90; #100a; #108). As one respondent explained: “The overseas office (e.g. in Manila or Saigon) gets work for various projects then sends it over to Australia. We send it back electronically. It means we don’t have to have a huge office there; we just need to have good marketing people on the ground to procure projects. The staff would be less than 10” (p.c. Interview Code #100a).

These findings do not contradict the earlier assertion that electronic communication alone (e.g. web-sites) is insufficient to initiate trade. Once face-to-face contacts between decision-makers are established, then technological artefacts - conferred with the power of non-human agency (Callon 1991) - can sustain networks. One respondent noted: “You need face-to-face to initiate projects. The engine room can be somewhere else as long as you then keep in contact with people” (p.c. Interview Code #90).
Tools that allow communication over space are crucial for global business, but only after networks and trust are firmly in place. O'Farrell and Wood (1998) argue that for advanced producer services, interaction cannot usually be sustained through telecommunications alone but depends on close institutional relations of familiarity and trust. However, this view does not consider the role of telecommunications once networks are established. As Cornish (1997b) concludes, the benefits often attributed to proximity can be readily stretched over space and time (via technology and travel), once a communication channel is established between individuals.

9.3.2 Power

Power relationships within networks help explain what holds networks together (Section 3.4.2.2). Power differentials between firms also determine the type of corporate strategy a firm pursues (Sections 3.2.3; 7.4.2). An important analytical question, in Axelsson and Johanson’s (1992) view, is determining where the power resides in networks between trading partners. As Australia is a relatively small global player in many industries - including the water industry - the relationship with larger industrialised economies will be asymmetrical. For small Australian firms, MNCs from France, Britain and the US have the upper hand of power. Multinational acquisitions of small firms are stark expressions of asymmetrical power relationships. Yet even though the bargaining position is unequal, the small firm in some cases may be better off under new ownership, particularly with access to capital.

Because the global water industry is competitive, Asian clients usually are in a powerful negotiating position and can play off one competitor against another (p.c. Interview Codes #78; #98b; #105; #118). Asymmetrical power relations also manifest between exporting Australian firms and developmental aid organisations. AusAID has the control when dealing with Australian firms, with the power axis shifted when AusAID deals with larger organisations such as the Asian Development Bank and the World Bank (p.c. Interview Code #127). The interaction of three parties - exporting firms, developmental organisations and recipient governments - creates complex power relationships where networks are constantly in flux.
9.4 Conclusion

Chapter 9 has explained how competitiveness is extended across space. This involves investigating how export markets are accessed and the role of networks. Accessing export markets is linked to intra- and inter-firm corporate strategies, involving processes internal and external to the firm. The size of firms influences the method of export access: large firms tend to use multinational networks and smaller firms tend to enter licensing agreements or joint ventures with a local partner. Explaining the different methods of access between manufacturers and service providers requires different theoretical perspectives. Some firms embark on internalisation to protect knowledge; other firms gain synergies through collaboration.

Networks, and the interrelation of trust, are the means by which decision-makers actually form and maintain contacts that result in trade. Trade does not occur in isolation to social contacts between decision-makers in the exporting and importing locations. Decision-making individuals within firms have numerous strong and weak ties between key actors in other firms and organisations. A reason for the fluid boundaries of the firm is because of the dynamic relationships its actors have with external actors. Networks explain how firms can exploit fluid boundaries. By using networks, geographic clusters of localisation economies are not essential for innovation and trade (see Sections 2.3.4; 6.3; 6.4).

An important revelation is that once contacts between actors are established - with the proviso that networks and trust are firmly in place - spatial separation may not necessarily diminish the prospects for trade. Non-human agency, for example in the form of telecommunications, helps explain how networks reach over space. While the technological artefacts of non-human agency are important adjunct tools, this does not replace the initial face-to-face contact that is essential between decision-makers.

What has also been shown is how structural determinants, in the form of organisations such as AusAID and CRCs, formalise the process of network creation. The task of the next chapter is to investigate how the determinants of the state and institutional support influence trade.
Chapter 10
State and institutional influences on trade

The influences that state and institutional organisations have on trade are discussed in earlier chapters. Chapter 2 argues that the role of the state ought to be included in a broad conception of competitive advantage and trade; Chapter 3 discusses the direct and indirect ways in which state and institutions are important for understanding trade at the level of the firm. The empirical work in Chapter 10 examines how state and related institutions are involved in initiating and sustaining trade for water industry firms.

Several research questions are addressed in the process (Table 10.1). The effectiveness of direct initiatives by the state is evaluated in Section 10.1. Direct initiatives include export facilitation programs and sponsoring trade delegations. The discussion considers the normative question of whether industry targeting would be beneficial. Section 10.2 assesses institutional influence and discusses the effectiveness of existing institutional capacity relevant to the Australian water industry. The indirect influences of the state are described in Section 10.3 and argued to affect trade as much as direct influences. Section 10.4 concludes by reinforcing the argument made in Part One that state and institutional influence is an integral strand in an explanation of trade.

Table 10.1 Research questions addressed in Chapter 10

<table>
<thead>
<tr>
<th>Questions from theoretical discussion (Table 3.3)</th>
<th>Relevant section in Chapter 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>How does the state directly and indirectly influence trade for firms in this industry (e.g. export facilitation and</td>
<td>10.1.1</td>
</tr>
</tbody>
</table>
| innovation programs, water industry reforms, foreign aid procurement practices, environmental and public health legislation)? | 10.3
| How effective are direct initiatives and why?                                                                     | 10.1.1                         |
| Is targeting feasible for this industry?                                                                          | 10.1.2                         |
| How effective are industry associations in facilitating trade?                                                     | 10.2
| Is the institutional capacity sufficient?                                                                        | 10.2.5                         |
| How do different tiers of government create competitive advantage and influence trade?                           | 10.3.3                         |
| Why is the state a necessary theoretical strand to explain trade?                                                 | 2.6.1; 3.5.2; 10.4             |

Source: selected questions from Table 3.3
10.1 Effectiveness of direct initiatives by the state

The export facilitation programs relevant to the Australian water industry are described in Table 4.5. These are examples of direct involvement by the state. Section 10.1.1 evaluates the effectiveness of some of these programs, offering reasons for the findings. Section 10.1.2 builds on the accumulated knowledge about the industry to assess whether direct initiatives in the form of industry targeting would be effective.

10.1.1 How effective are direct initiatives?

10.1.1.1 Export facilitation programs

Table 10.2 reports how many firms (by size and type) use export facilitation programs (EFPs). Respondents nominated a satisfaction rating of the effectiveness of programs (using a Likert scale of 1 to 5). Medium size firms have a higher proportion of users of EFPs and a slightly higher median satisfaction rating than other categories. Because medium size firms use these programs more than other sizes, the average satisfaction level is higher than for less frequent users (Table 10.2). Not having the access to capital of large firms creates a propensity for medium firms to use these programs. Medium size firms also use programs more frequently than small firms. Several small firms mentioned that they do not have the staff (i.e. resources) to do the necessary paper work required to access EFPs (p.c. Interview Code #46; Survey Codes #47; #77; #88).

Interestingly, 45% of the firms overall do not use a program. A common reason was “too much paper work” (p.c. Interview Code #109; Survey Codes #47; #54; #62; #70; #107). Another reason is that some smaller firms believe that export assistance programs are only of benefit to established larger firms (Survey Codes #30; #49; #70; #76). A decade ago McKinsey et al. (1993) identified that many domestic “small and medium size firms (SMEs) do not have the resources to sift through a myriad of individual ad hoc (industry development) programs for themselves” (ibid.: p. iv). For the water industry, this problem was still hindering SMEs in the late 1990s.
Table 10.2 Export facilitation programs (EFPs) \(^1\) used by water industry firms
N = 91 (exporting firms only)

<table>
<thead>
<tr>
<th>Usage by categories of firm</th>
<th>Total</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
<th>Manufacturers</th>
<th>Service providers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number using EFPs (% of category total)</td>
<td>50 (55%)</td>
<td>16 (41%)</td>
<td>22 (73%)</td>
<td>12 (54.5%)</td>
<td>33 (57%)</td>
<td>17 (51.5%)</td>
</tr>
<tr>
<td>Satisfaction rating (only includes users of program with rating of 1 {unsatisfactory} to 5 {very satisfactory}) (^2)</td>
<td>N = 41</td>
<td>N = 14</td>
<td>N = 18</td>
<td>N = 9</td>
<td>N = 28</td>
<td>N = 13</td>
</tr>
<tr>
<td></td>
<td>Median = 3</td>
<td>Median = 3</td>
<td>Median = 4</td>
<td>Median = 3</td>
<td>Median = 3</td>
<td>Median = 3</td>
</tr>
<tr>
<td></td>
<td>Mode = 3</td>
<td>Mode = 3</td>
<td>Mode = 4</td>
<td>Mode = 3</td>
<td>Mode = 3</td>
<td>Mode = 3</td>
</tr>
<tr>
<td>No. of unknown ratings for program users</td>
<td>9</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

Notes:
1. EFPs are mainly administered by Federal Government departments (Austrade and DFAT) and include Export Market Development Assistance; Export Access Programs; and the now defunct Development Import Finance Facility [DIFF] (Table 4.5). There are also minor programs administered by economic development departments of various State Governments.
2. A rating of 1 assumes the program was used but its usefulness was considered unsatisfactory. A non-response, coded by 0, assumes the program was not used. Despite a clearly worded instruction to only rate those the firm actually used, there might some cases where a rating of 1 mistakenly meant the program was not used, rather than a low satisfaction. The number of instances is not known.
3. Mean is not taken because this data is ordinal and not interval (see Wright 1997: 5-7).

Table 10.3 reports that EFPs have an influence on trade. There is a significant difference between the means of exports as a proportion of turnover for program users and non-users (p = 0.02). The grants and concessions help some firms establish a presence in a foreign market. However, the use of a program may not necessarily be a causal factor leading to higher export proportions. It is possible that firms already actively exporting are familiar with the processes involved and so more readily use these programs.

To be effective, EFPs should be used by the majority of eligible firms. For firms that use these programs, export proportions should be significantly higher (DIST 1996). Just over half the exporting firms use export facilitation programs, suggesting some firms have problems with accessibility of programs. For users of programs export proportions are significantly higher (Table 10.3), suggesting that programs possibly are effective. Yet it is also possible that the use of a program is a consequence of the firm already being an active exporter.

### Table 10.3 Comparison of export proportions between users and non-users of EFPs

<table>
<thead>
<tr>
<th>Results</th>
<th>Users of export facilitation programs</th>
<th>Non- users of export facilitation programs</th>
<th>Statistical summaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of exporting firms N = 91</td>
<td>N = 50 (55%)</td>
<td>N = 41 (45%)</td>
<td></td>
</tr>
</tbody>
</table>
| Export proportion (as proportion of turnover) | N = 38  
Mean = 0.25  
(s.d. = 0.25)  
Median = 0.14  
(12 users with unknown export proportion) | N = 32  
Mean = 0.13  
(s.d. = 0.15)  
Median = 0.09  
(9 non-users with unknown export proportion) | T-test results (equal variance; log transformed)  
t (68 ) = 2.3  
p = 0.02 (two-tailed)*  

*Note:
1. Mann-Whitney U test using raw data also produces a significant result:  U (68) = 418.0; p = 0.03 (two-tailed).*

**10.1.1.2 Sponsoring trade delegations**

There are other ways governments directly facilitate exports. One way is by an agency such as AusTrade hosting international trade shows for various industries. However, the success of these endeavours is dubious (p.c. Interview Codes #123; #126; Survey Code #71). This is because industry representatives and potential clients are passing through a space designated for a trade show, with little time to establish real contacts. The meetings between decision-makers are usually transitory. This is not conducive to developing trade, particularly in intermediate goods and services industries (Axelsson and Johanson 1992). As one representative from a CRC observed: “People take glossy brochures but the points of contact are very difficult to make and expand” (p.c. Interview Code #126).

The EIFU (Environment Industries Focus Unit) has the purpose of facilitating exports for the environmental industry (including water) (see Table 4.5). Presumably, Federal government departments have the advantage of accessing the resources of other departments. A representative from the EIFU noted: “We work very closely with DFAT (Department of Foreign Affairs and Trade) and Austrade on these issues (of identifying commercial opportunities in overseas markets). For example, if there are in-coming foreign delegations that have a business focus we then try and get the message out to industry… We try to bring the various players together and facilitate the process”. Furthermore: “We have the access to government resources and politicians that industry organisations (e.g. AWA; EIDN) don’t have access to” (p.c. Interview Code #127).

However, the EIFU does not specifically focus on individual firms. The success of the EIFU is uncertain. No private sector firm in the sample mentioned the work of the EIFU (e.g. its EnviroNet database of active firms) as instrumental for gaining export contacts.

**10.1.2 Would targeting be feasible for this industry?**

The direct export facilitation programs relevant to the Australian water industry have some influence on the propensity of firms to export. Although many firms have not embraced the programs, for those that do average export proportions are higher. A question raised is whether industry programs specifically targeting the water industry
would result in higher export proportions and more firms exporting. The following discussion considers this.

Recall that Table 2.3 listed the types of industry conditions necessary for strategic trade policy to be effective. In summary, the ideal recipients for targeting assistance are domestically owned firms in an industry where there are barriers to entry and competition from foreign owned oligopolies. The domestic industry should be more, or at least equally, concentrated as the rival foreign industry. The industry should be still relatively early in the product cycle before foreign firms have established a reputation. Two further conditions are that firms produce homogenous products, and externalities through R & D subsidies do not spill over to foreign rivals (Brander and Spencer 1984; 1985; Brander 1986; Spencer 1986).

The Australian water industry conforms to some of the conditions for targeting; for others it does not. There are barriers to entry but the degree across the industry is inconsistent. Barriers are present for some manufacturing firms but probably no more so than for other firms in medium technology industries. The water industry also comprises a large number of producer service firms of different sizes (Section 6.1). For producer services, entry barriers are generally lower than for manufacturers (Lindahl and Beyers 1999). Yet for some small specialist consultancies, entry barriers still exist in the form of scarce resource such as specialised skilled staff (p.c. Interview Code #85).

The industry partly conforms in that there is a domestic component facing foreign competition from major oligopolies. For some activities, the foreign competition is intense (e.g. water management and operation, BOOT projects); for other activities, foreign competition is less intense (e.g. manufacturing monitoring equipment). Overall, the domestic industry is not an ideal structure for effective targeting because it comprises a large numbers of small firms competing against concentrated foreign rivals.

The water industry differs from the stipulation that the industry be in an early product cycle phase. As noted, the water industry is generally considered a mature industry (Sections 8.1.3; 7.2.5). The industry also differs from the ideal model because production
is not homogenous but encompasses a diverse range of activities (Sections 4.1; 5.3.3). Another assumption of ideal targeting conditions is that R & D subsidies do not spill over and benefit foreign competitors. For the Australian water industry, there are some cases (e.g. Memtec) where domestic firms that are recipients of such subsidies eventually became foreign owned, demonstrating that spill-overs to foreign competitors do occur.

A major factor casting doubt on the effectiveness of domestic targeting is the complexity of ownership models. The simplistic theoretical assumption is that there is delineation between foreign and domestic owned firms (see Section 2.6.3). Reality is more complex. For the Australian water industry the tendency is for successful domestic firms to evolve from full domestic ownership into arrangements with foreign partners. Memtec is a prime example; because of international success Memtec were acquired by first US, and then French interests. The firm’s R & D is still largely carried out in Australia; this undoubtedly benefits foreign interests. Another example is Jetfloate, a manufacturer of specialised water pollution control equipment. To seek equity capital, Jetfloate became part of the conglomerate - the Environment Group (p.c. Interview Code #79). The Environment Group has a substantial foreign interest. Arguably, important factors in the success of these firms have been R & D subsidies and tax concessions. The foreign shareholders obtain benefit from this expenditure of public money which has created knowledge capital.

The conclusion is that targeting firms in the water industry would be unlikely to benefit the industry’s exporting prospects. The characteristics of the industry do not widely conform to the conditions discussed in Section 2.6.3. Ownership arrangements within firms are complicated, as often there is a connection with foreign parent companies. The industry is generally mature, and entry barriers are variable depending on the type of activity within the industry. Targeting at the level of the industry at best might produce ambiguous results; at worst it could be tantamount to a gift to foreign MNCs. Yet this does not preclude some type of assistance. A better understanding of the processes underlying trade at the level of the firm can help in formulating more effective policies. Section 12.3 suggests some ideas.
10.2 Institutional support and its influence on trade

Industry associations and research institutions contribute to the institutional capacity of regions, and for industries within these. Institutional capacity can be in the form of innovation exchange and collaborative networks that enhance the exporting prospects of local firms (Section 3.5.3). A background to the main organisations relevant to the institutional capacity of the Australian water industry is given in Section 4.4.2. Section 10.2 assesses the effectiveness of these organisations. Section 10.2.1 demonstrates that the recent establishment of some organisations is an attempt to redress the limitations of a small domestic industry. Section 10.2.2 presents empirical evidence of the use and effectiveness of the main industry organisations for facilitating trade. Whether there is a geographic constraint to their effectiveness is tested in Section 10.2.3. The function of CRCs is discussed in Section 10.2.4. Section 10.2.5 argues that there is enough institutional capacity for this industry; however, the quality of linkages needs improving.

10.2.1 Purpose of support

The recent formation of some organisations arose from impediments identified by the environmental management industry. Since clients are often looking for integrated solutions, strategic alliances between specialist firms are important (Garman and Borton 1997). However, the Australian industry has been identified as fragmented and lacking linkages between supplier firms and service providers. Forming networks is seen as a solution to this (Bergman 1997; Garman and Borton 1997; EIFU 1998; EIDN 1999). There are various ways organisations attempt to achieve this. The EIDN, for example, acts as a facilitator by using existing science and technology agreements between Australia and other countries to set up demonstration sites. One example is the sale of Australian environmental monitoring equipment to China and Korea. As explained: “We link the research institutions within universities and CSIRO with industry funding. We are using our international program to try and make those linkages. … What we do is set up collaborative activities, and focus on projects with institutions linking in with a firm. Primarily we are focused on information flows and making the information effortlessly available to people” (p.c. Interview Code #123).
The Water Industry Alliance (WIA) in South Australia was formed because local firms were not being involved with international projects, which was part of the contractual agreement with the multinational operators of the State’s water services (Section 4.3.3). A representative provides a background: “It was realised that some sort of alliance was necessary because of the realisation that Asian export markets rely on building trust. The WIA was formed so local firms could network with each other, and hopefully join forces and use complementary skills and share resources. The WIA has been formed to glue and pull all those infrastructure areas together, to form a community, and to build trust – this is very important” (p.c. Interview Code #121). The challenge of creating cooperation amongst competitors is recognised: “We have come up a very steep learning curve. You just can’t say to companies ‘why don’t you work together’ and the next day expect that they will win an order. It takes 2 to 5 years for this sort of community to evolve into a community that’s keen to open their books to each other” (ibid.).

### 10.2.2 Evidence of usefulness

The ratings by respondents of the usefulness (i.e. as sources of contacts) for three industry associations, including the EIDN, are reported in Table 10.4. (Note that the WIA is not assessed because of its recent establishment [1998]. In addition, its interests are confined to South Australian firms.) The EIDN and the EMIAA - organisations intentionally set up to facilitate exports by providing overseas market information and encouraging networks - both rate low in their usefulness for domestic and international contacts. The AWA receives markedly higher ratings than these other two organisations, especially for its usefulness to firms for establishing domestic contacts. A reason for the difference is that the EIDN and EMIAA have a broad interest of promoting environmental management and technology industries. Because of the wide range of industries included, the organisations appear to lack focus (p.c. Interview Code #123). In contrast, the AWA is focused on the water industry, with a specific role to disseminate information through publications and seminars. AWA’s modest rating for international contacts is expected given that its objectives have a domestic focus, with no current intention to be involved in direct export facilitation (p.c. Interview Code #120). There are, however, two cases revealed in interviews of firms forming trade contacts with foreign...
delegates at AWA conferences, although these were more serendipitous events rather than the main purpose of the conferences (p.c. Interview Codes #44; #79).

There are only minor differences when comparing the use of industry associations and usefulness ratings by exporting and non-exporting firms. When averaged over the three organisations, 47% of exporters and 46.5% of non-exporters use these organisations as a source of domestic contacts. For international contacts, a modest 44% of the exporting group have approached these associations. Moreover, the usefulness ratings are low: the aggregated results for both groups are a median of 2 and mode of 1.

Table 10.4 Number of users and usefulness ratings of main industry associations
N = 124 ¹ (exporters and non-exporters)

<table>
<thead>
<tr>
<th>Organisation &amp; ratings</th>
<th>Australian Water Association (AWA)</th>
<th>Environmental Management Institute of Australia (EMIAA)</th>
<th>Environmental Industry Development Network (EIDN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All firms</td>
<td>Domestic contacts</td>
<td>Domestic contacts</td>
<td>Domestic Contacts</td>
</tr>
<tr>
<td></td>
<td>International contacts</td>
<td>International contacts</td>
<td>International contacts</td>
</tr>
<tr>
<td>No. of users (as % of total firms) ²</td>
<td>95 (77%)</td>
<td>44 (36%)</td>
<td>36 (29%)</td>
</tr>
<tr>
<td></td>
<td>76 (61%)</td>
<td>43 (35%)</td>
<td>33 (27%)</td>
</tr>
<tr>
<td>Usefulness rating ³</td>
<td>Median (out of 5)</td>
<td>Mode</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Notes:
1. Includes all commercial entities including branch offices. Does not include research organisations.
2. In surveys and interviews firms were asked to rate only those organisations they had experience with (see Table10.2, footnote 2 for caveat on this).
3. Number of counts for descriptive statistics matches the number of users for each group. Non-users are coded 0 and not counted in calculating the descriptive statistics.


The conclusion is that industry associations are not an essential catalyst for initiating exports. The information offered by these organisations often serves as an adjunct to information already possessed by exporting firms. A general problem is the currency of information distributed by industry organisations. As succinctly put by a respondent from an engineering consultancy: “Once it is printed, it is old news” (p.c. Interview Code #100a). A representative from an industry organisation noted that firms that actively
pursue exports often have full time staff maintaining and accessing databases, who are “keeping on top of World Bank contracts to find out the information the day it was released” (p.c. Interview Code #123). A now defunct government initiative - AUSTEMEX (see Table 4.5) - failed in the respondent’s view because: “AUSTEMEX had no such system, it tended to rely on out of date information” (ibid.). The implication is that the most current useful information is possessed by firms – industry associations only provide generalised information.

10.2.3 Spatial influence

The head offices of the industry associations (with the exception of the WIA, which is not rated as it is specifically for South Australian firms) are based in NSW and the ACT. Research by Bennett (1998) suggests that voluntary business associations (including industry organisations) are more effective if their spatial reach is confined to small geographic areas (see Section 3.5.3). Based on this, the expectation is that firms located in the peripheral States of Australian industrial organisation (WA, SA, and QLD) would make less use of industry organisations than firms located in the core States (NSW, VIC).

The findings in Table 10.5 suggest that this is not the case. The proportion of firms in the periphery that use these associations is not significantly different from the proportion of firms in the core States. Neither is there a significant difference when comparing satisfaction ratings between firms in the core and periphery. Firms in both peripheral and core States rate the AWA’s usefulness as satisfactory for domestic contacts. This is because the AWA has developed a network of State branch offices, with long experience in disseminating information. In contrast to Bennett (1998), Bryson and Daniels (1998) suggest that industry support organisations are more effective with well-developed national linkages (like the AWA), rather than a few strong ties with local entities. The AWA is rated less favourably for international contacts by both groups of firms. This is expected given that the AWA has a domestic focus (p.c. Interview Code #120). The other associations - EMIAA and EIDN - generally rate low for usefulness (median 1 or 2), whether user firms are in Sydney or Perth. Spatial separation is not likely a major reason for their ineffectiveness, but rather a lack of focus. These associations have an objective
to be export facilitators but remain ineffective because they attempt to serve too many firms that are loosely defined as part of the ‘environmental industry’ (p.c. Interview Codes #118; #120).

**Table 10.5 Comparison of the use and satisfaction ratings of industry associations between firms located in ‘core’ and ‘peripheral’ Australian States**

(\(N = 124\)) (exporters and non-exporters)

| Location of firms | Variables | Firms in core (NSW, VIC)
N = 88
68 exporters (77% of this group) | Firms in periphery (WA, SA, QLD)
N = 36
23 exporters (64% of this group) | Statistical comparisons |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Firms using AWA for domestic contacts</td>
<td>65 (74%)</td>
<td>30 (83%)</td>
<td>Test for two proportions of AWA domestic contact use between core and periphery (z = 1.13; p = 0.26) (two-tailed)</td>
</tr>
<tr>
<td>Satisfaction rating</td>
<td></td>
<td></td>
<td>Mann-Whitney U test (^1)</td>
</tr>
<tr>
<td>Median</td>
<td>4</td>
<td>3</td>
<td>U (93) = 810.5</td>
</tr>
<tr>
<td>Mode</td>
<td>4</td>
<td>5</td>
<td>(p = 0.17) (two-tailed)</td>
</tr>
<tr>
<td>Firms using AWA for international contacts</td>
<td>52 (59%)</td>
<td>24 (67%)</td>
<td>Test for two proportions of AWA international contact use between core and periphery (z = 0.78; p = 0.44) (two-tailed)</td>
</tr>
<tr>
<td>Satisfaction rating</td>
<td></td>
<td></td>
<td>Mann-Whitney U test</td>
</tr>
<tr>
<td>Median</td>
<td>2</td>
<td>1</td>
<td>U (74) = 482.5</td>
</tr>
<tr>
<td>Mode</td>
<td>1</td>
<td>1</td>
<td>(p = 0.09) (two-tailed)</td>
</tr>
<tr>
<td>Average proportion of firms using EMIAA &amp; EIDN for domestic &amp; international contacts.</td>
<td>42%</td>
<td>49.5%</td>
<td>Test for two proportions of overall organisation use between core and periphery (z = 0.76; p = 0.45) (two-tailed)</td>
</tr>
<tr>
<td>Satisfaction rating (domestic &amp; international contacts combined)</td>
<td></td>
<td></td>
<td>Mann-Whitney U test</td>
</tr>
<tr>
<td>Median</td>
<td>3</td>
<td>2</td>
<td>U (154) = 2284</td>
</tr>
<tr>
<td>Mode</td>
<td>1</td>
<td>1</td>
<td>(p = 0.07) (two-tailed)</td>
</tr>
</tbody>
</table>

*Note:*

1. Mann-Whitney U test is used because the data is ordinal and it is not normally distributed (Wright 1997).

10.2.4 CRCs and institutional capacity

Cooperative Research Centres (CRCs) also form part of the institutional capacity of regions. They influence trade for water industry firms indirectly as an important source of information dissemination and network facilitation (also see Section 4.4.2). The direct influence of CRCs on trade is more confined. Out of the three water-focused CRCs interviewed, only the CRCWMPC (Cooperative Research Centre for Waste Management and Pollution Control) actively seeks exports. The organisation has developed a formula for export access: 1) establish government to government memorandums of understanding (MOUs); 2) run focused workshops about the technology; 3) discuss with clients what the priority areas are; 4) set up a physical demonstration of the plant; 5) negotiate licensing and commercial agreements (p.c. Interview Code #126; also Garman and Borton 1997). As a representative explained: “The idea is to utilise a government-to-government MOUs – get that government structure as the umbrella – and then seek some funding support, often through the Department of Industry and Science, with funding for very specific workshop symposiums or seminars” (p.c. Interview Code #126). “By taking our stepped approach, we’ve able to do things on a very cheap budget, very select part of the market. We are not trying to sell everything to everyone. Australia only has some niche parts of the market it can offer” (ibid.). Export success has been gained with monitoring equipment and artificial wetland design (Ridge 1999).

Representatives of the other two CRCs (CRC for Catchment Hydrology and CRC for Freshwater Ecology) were adamant that their organisation’s function should be as knowledge brokers and information disseminators, with knowledge of water issues to be treated as a public good and not as commercial property (p.c. Interview Codes #124; #125). The decision to commercialise has the potential to detract from core research functions of CRCs. As a representative explained: “When an individual consulting opportunity comes up, the CRC board has to determine whether the request is compatible with what they do. We don’t want to spread our researchers too thin. Consulting work has to be complimentary. There would be concern if high level consulting was running down intellectual capital” (p.c. Interview Code #124).
CRCs have an important function as a link between industry and research. Yet not all CRCs aspire, nor should be expected, to become heavily involved in the commercialisation and internationalisation of knowledge and products. The CRCWMPC is unusual in that it has an export focus. To minimise exposure to financial risk, the CRCWMPC has formed subsidiary companies. For other CRCs, the most appropriate indirect facilitation of trade is to bring together research organisations and commercial firms. By creating these linkages, institutional capacity is enhanced.

### 10.2.5 Is there enough institutional capacity?

Business and economics commentators frequently lament Australia’s low levels of industry R & D expenditure and the legacy of Australian innovations being developed by foreign firms because of the lack of domestic venture capital (e.g. Jones 1989; Colebatch 1998; Brain 1999; Baldwin 2000). The solutions suggested often relate to increasing institutional capacity. These include more funding for CRCs, and better industry access to research programs (Cullen 1997; Lowe 1997). Evidence by the ABS shows that government R & D in Australia is a high ratio compared with other OECD countries; however, business expenditure on R & D has been in marked decline (ABS 2000 # 8104.0; #8109.0).

It is argued that at least for the water industry, there is enough institutional capacity. There is no significant difference between core and peripheral States in the use and satisfaction with industry associations (Table 10.5). Furthermore, there are numerous government programs available (Table 4.5). There are several CRCs involved in water research and industry collaboration (Cullen 1997; Mein 1997). The AWA is active and well regarded (Table 10.4). Moreover, the inclusion of water as a subsector of environmental technology and management has provided access to other industry associations. In addition, many firms would be members of engineering associations and local chambers of commerce. The EIDN is of the view that capacity is sufficient: “Australian competitive advantage (in environmental industries) comes from a big investment over the past 40 years into the CSIRO and universities in terms of fundamental research strengths. We are well regarded internationally in fundamental
research, in terms of what is happening at the molecular level - for example, with wastewater treatment and air pollution” (p.c. Interview Code #123).

Based on these factors, institutional capacity relevant to the water industry is argued to be adequate. The issue is improving the quality of linkages. As Gibbs et al. (2001) observe, the literature on institutional thickness (or capacity) has tended to emphasise the quantity of intra-regional institutions and the frequency of transactions, rather than the quality of institutions and their inter-relationships.

The empirical evidence suggests that the quality of linkages is lacking. The majority of firms do not access the services offered by the EMIAA or EIDN (Table 10.4). These associations lack focus because they attempt to represent a nebulous ‘environmental industry’ that does not directly relate to the specific needs of supplier firms in the water industry. Some firms even claimed they were not aware of these organisations (e.g. Interview Codes #85; #109; Survey Codes #32; #54). Organisations such as EIDN and WIA attempt to build networks; the success - as yet - is limited, and likely to remain so as there is a perpetual struggle for adequate funding. The AWA is highly regarded for domestic contacts, indicating that it is an important element in institutional capacity. It does, however, only rate modestly for its usefulness for international contacts. The organisation has no intention of being an export facilitator (p.c. Interview Code #120).

Given the small size of the domestic industry, it is uncertain how effective increased institutional capacity would be. Rosenfeld (1996) notes the difficulties of trying to recreate a specific institutional capacity that has proved successful in another location. For instance, what works in Denmark may not work in Australia because historic circumstances, abilities to adapt innovations and business cultures are different (Nelson 1993a; Jepma and Rhoen 1996). Furthermore, Scott (1998) argues that too much institutional capacity can ‘lock’ firms into regions and create inflexible attitudes.

If an exporting industry is an objective for policy-makers, then improving on existing linkages that have generated some export success is more effective than state investment in new programs or institutions. For example, the development of research collaborations
can lead to commercial agreements (p.c. Interview Code #126). Funding CRCs is an illustration of how the state can facilitate informal (or soft) networks, creating the conditions to encourage collaborations amongst small firms. These collaborations may eventuate into formalised business agreements (i.e. hard networks). The overall effect is a strengthening of the linkages between public institutions and the private sector. The existing institutional capacity becomes more effective, without necessarily being ‘thicker’ by the establishment of a new program or organisation.

10. 3 Indirect influences of the state on trade

The state can influence trade for firms in many indirect ways (Section 3.5.2). Supporting institutions such as CRCs is one way of facilitating innovation creation. Section 10.3 discusses three indirect influences identified in the empirical work. The aim is to demonstrate how the state exerts both subtle and overt influences on trade.

10.3.1 Water industry reforms

The extensive water reforms during the 1990s would be expected to have had some indirect impact on trade, creating both opportunities and constraints for firms. The tenets of reform are steeped in ideas (of which Porter [1990] is prominent) that vigorous domestic competition is a positive stimulus. The empirical finding is that a number of firms have obtained more domestic work, thereby gaining additional experience and becoming more competitive. However, a minority have found that exposure to foreign competition makes it difficult to be cost-competitive. The findings are summarised in Table 10.6. The sample size is small but there are no noticeable differences between exporters and non-exporters - over 80% in both groups have found reforms to be positive. Yet industry associations appear to have differing views. The WIA believes reforms have had a positive impact by encouraging competition. Conversely, a representative from the AWA claims opportunities for domestic firms have been eroded because of uncoordinated approaches between State Governments. There is also the rivalry from larger international water consortiums that have a greater ability to be more cost-competitive than domestic counterparts (p.c. Interview Codes #121; #120). The EIDN (1996) also reports that since the reforms, utilities are less likely to be involved in
multiple partner R & D. There is evidence that the number of spillovers from R & D has declined since utility reform (ASTEC 1998).

**Table 10.6 Positive and negative outcomes of Australian water industry reforms**
(N = 20 firms)¹ (exporters and non-exporters)

<table>
<thead>
<tr>
<th>Positive Outcomes (as noted by firms ²,³)</th>
<th>Exporting firms</th>
<th>Non-exporting firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>More domestic demand created/ more clients.</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>Demand creates skills required by overseas utilities.</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td><strong>Negative outcomes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More price driven (low margins/short-term contracts).</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Foreign dominance of knowledge.</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes:
1. Does not include research organisations or industry bodies. Includes two corporatised utilities.
2. One response category per firm.
3. Information is based mainly interviews but some survey comments also provided additional information.


The impact of COAG water reforms on the demand for products and services was sought in the third batch of surveys (Section 5.2.5). A Likert scale was used, with 1 representing no influence and 5 representing an extreme influence on a firm’s strategy. The results indicate a moderate impact (median 3; mode 3; N = 18). This is expected, as some firms would likely experience the impact of reforms. The sample size is small, which limits interpretation.

Reforms have also resulted in some corporatised utilities pursuing international contracts (Section 4.3.3). Interviews and surveys conducted with the commercialised arms of five water utilities - ACTEW Corporation (ACT Electricity and Water), Australian Water Technologies (Sydney Water), Hunter Water Australia Pty Ltd, Australia Asia Water Centre/ SA Water International (South Australia Water), and the Water Corporation of Western Australia - reveal fledgling export activity where international contracts are sporadic (Interview Codes #116; #108; #106; #122; Survey Code #115). Internationalisation activities are largely an adjunct to the more important domestic operations. A few respondents noted the inherent contradiction of remaining a domestic public service utility (even with a commercialised arm), yet operating in a competitive

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international arena where public money could be exposed to high risk (p.c. Interview Codes # 106; #108; #120).

10.3.2 Influences of regulations and industry initiatives

Section 3.5.2.2 explained how stringent environmental and public health regulations and ‘cleaner production’ initiatives can theoretically lead to competitive advantage in some sectors. One sector expected to benefit would be producers of environmental goods and services, such as the water technology and management industry. This section assesses whether environmental regulations and objectives drive demand and innovation for this industry.

The findings shown in Table 10.7 suggest that there has been some influence, mainly due to regulations. For example, the introduction of licensing agreements for dischargers of effluent has created demand for more sophisticated wastewater treatment and monitoring equipment (p.c. Interview Codes #64; #27). The findings are consistent with the observation that, “across all states and territories, environmental regulations are the main driving force behind investment in wastewater treatment” (AWWA 1998: 26). An alternative view is that if regulation is too strict, then this creates unrealistic standards that might not stimulate innovation (p.c. Interview Code #114). The 1998 Cryptosporidium scare experienced by Sydney Water was cited as an example that could trigger unrealistic standards (p.c. Interview Codes #112; #114). Also, stricter conditions for discharging treated effluent to the environment require more complicated technology, necessitating water authorities to often involve large international firms (Tolhurst 1999). Yet in Australia, reuse technologies have not been fully exploited - in 1997 only 2.7 % of treated effluent and 4.1 % of raw effluent was reused or recycled (WSAA 1998). This suggests that standards are not technically unrealistic and could be even more stringent, creating domestic demand for specialist technologies.

Contrary to what some of the literature claims (e.g. OECD 1996), there is little evidence from this research of demand being created because of a shift from ‘end-of-the-pipe’ devices to cleaner production processes, including ISO 14001 compliance (i.e. the use of environmental management and auditing systems in the production process). As one
respondent commented: “ISO 14001 is just a process people wrap around their procedures – it is seen to be a nicety. I don’t know how seriously people take it” (p.c. Interview Code #106). Another participant mentioned: “Because ISO 14001 does not put regulatory pressure on clients, I don’t think it would by itself create a need, specifically, for extra treatments” (p.c. Interview Code #55).

When comparing the influence of regulation and industry initiatives on exporters and non-exporters, both groups are similar (Table 10.7). About a third of the firms from each group report that regulations have influenced how they approach innovation and marketing. This finding concurs with the literature that argues environmental regulation can positively benefit competitiveness (Section 3.5.2.2). The causal link between regulations and exports, however, remains ambiguous because of the similarity of responses between exporters and non-exporters.

### Table 10.7 Influences of regulations and industry initiatives on the development and demand for water industry products and services (N = 124) (exporters and non-exporters)

<table>
<thead>
<tr>
<th>Main influence cited</th>
<th>Exporters N = 91</th>
<th>Non-exporters N = 33</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of firms (%)</td>
<td>Main influence cited</td>
</tr>
<tr>
<td>Environmental / public health regulation</td>
<td>32 (35%)</td>
<td>Combination of environmental / public health regulation; and cleaner production / environmental auditing</td>
</tr>
<tr>
<td>Combination of environmental / public health regulation; and cleaner production / environmental auditing/ ISO 14001</td>
<td>26 (28%)</td>
<td>Environmental / public health regulation</td>
</tr>
<tr>
<td>Cleaner production/ environmental auditing</td>
<td>17 (19%)</td>
<td>Cleaner production/ environmental auditing</td>
</tr>
<tr>
<td>No answer</td>
<td>14 (15%)</td>
<td>No answer</td>
</tr>
<tr>
<td>No influence (explicitly stated)</td>
<td>6 (7%)</td>
<td>No influence (explicitly stated)</td>
</tr>
</tbody>
</table>

**Notes:**
1. Includes all commercial entities including branch plants. Does not include research institutions or industry organisations.
2. Percentages do not add up to 100% due to rounding.

**Source:** author’s surveys and interviews 1998-2000.
Although this research does not investigate how demand develops in importing locations, three respondents did note that new environmental standards in South East Asia have stimulated demand. One Australian firm gained export orders because of a requirement by authorities in Malaysia to implement industrial wastewater recycling on new industrial estates (p.c. Interview Code #55). Other firms have benefited from being involved in consultancy work with the Indonesian Department of Environment’s BAPEDAL program (p.c. Interview Codes #95; #98b). These firms have gained the necessary expertise because of previous experience with Australian regulations. Interestingly, several respondents commented that in South East Asia environmental legislation is rapidly becoming just as stringent as in Western OECD countries, with clients demanding the latest technology (p.c. Interview Codes #100b; #105; also Towns 1994). In theory, this should benefit innovative Australian firms. Building on Porter’s (1990) ideas, O’Connor and Daniels (2001) demonstrate that trade of advanced producer services generally occurs between countries with similar home demand conditions. Initiatives such as AusAID assistance to the BAPEDAL program in Indonesia are an example where state support can help create similar demand conditions in the host (i.e. importing) country, potentially bringing opportunities for Australian firms.

In this sample, regulatory change often emits from the level of Local Government, sometimes under the directives of State Governments. Three firms noted this specifically with stormwater management (p.c. Interview Codes #61; #94; #96). As one respondent commented: “Most of the impetus for legislation comes from local government (e.g. load based licensing), with opportunities from local government creating work” (p.c. Interview Code #96). Yet the influence of Local Government can also create impediments for innovation; for example, some Local Governments have a reluctance to implement ‘grey-water’ reuse (p.c. Interview Codes #106; #123). A representative from an industry association noted local governments’ conservative stance: “They like to think it has been done somewhere else before so it is proven technology. Problem is that regulatory bodies - SA water - are reluctant to lead the way in grey water recycling. They are worried about what might go wrong” (p.c. Interview Code #121).
This finding has implications for the theoretical interpretation of state influence. Different tiers of government have distinct functional roles. Local Government, while not involved with direct export facilitation, can still influence demand conditions and thus innovative activity by firms. This influence can occur through environmental and public health legislation. The water industry is an example where an analysis of the function of the state in relation to trade should consider this tier of government. The empirical material demonstrates how the influence of local government manifests. Indeed, Smith (1998: 270) concludes that, “the success of many of the water-related policies will depend on the willingness and ability of local government to implement policies formulated by higher tiers of government”. Porter (1990: 622-3) also mentions that regional and local governments can influence competitive advantage. However, Porter (1990) uncharacteristically does not elaborate on this idea.

10.3.3 Procurement by government agencies

The procurement of services by government agencies responsible for developmental aid is an important way for firms to gain access to international markets (Section 9.1) One representative from a development consultancy articulates the benefits: “AusAID provides consultancy firms with opportunities for getting into the international market and develop competitiveness. When we are competing on the international field with the World Bank or Asian Development Bank, our AusAID work gives us credibility. We get short-listed. However, an overdependence on AusAID funding would be counter-productive in the long-term” (p.c. Interview Code #118).

Aid programs have been revised to emphasise untied bilateral assistance to reduce poverty, rather than foster commercial interests of the donor country (Section 4.3.1). The impact of reforms remains to be seen. One of Porter’s (1990) ideas is that tied aid creates captive markets that lack suitable demand conditions for developing global competitiveness (Section 3.5.2.3). However, this point is contentious. The results from the water industry show that aid projects have been important for Australian firms. The policy of tied aid has helped some domestic firms develop competitiveness. For example, domestic engineering consultancy firms such as Sinclair Knight Merz and GHD have
benefited from involvement with AusAID (p.c. Interview Codes #99a; #100a). Because of the dominance of global water MNCs, using temporary tied aid can bolster the competitiveness of Australian firms.

10.3.4 What is the significance of these findings?

The empirical work shows that indirect influences of the state can create competitive advantage, leading to trade. For some firms, COAG water reforms have led to increased domestic demand for their goods and services. There is evidence that environmental regulations stimulate demand and influence innovation creation. Procurement practices by governments can influence trade. These examples demonstrate the different ways the state creates conditions to nurture competitive advantage.

Yet indirect influences are overlooked in the literature. When the role of the state in relation to trade is discussed, macro-level influences such as WTO agreements and regional trading blocs dominate the agenda (e.g. Noponen et al. 1993; Grant 1994). As shown, indirect ways can have a considerable influence. Different industry studies would reveal different manifestations of indirect influence by the state. Indirect methods, probably more starkly than direct, demonstrate that the influence of the state is omnipresent. This reinforces an earlier argument (Section 2.6.1) that even if the prevailing policies are stepped in neo-liberalism with limited scope for action, the state and its related institutions still have a prevailing influence on trade.

Another significance of the findings is that the state is not a monolithic entity - different tiers of governments have different functions. As demonstrated, Local Government has an important role because legislation at this level creates incentive for some firms to innovate. Some of these innovations are sold internationally. The influence of particular tiers of government is contingent on the industry. For example, if the aerospace industry was being studied, Local Government would be expected to have less influence than Federal or State tiers. For the water industry, Australian legislative structures result in Local Government being responsible for implementing certain environmental and health policies.
10.4 Conclusion

This chapter has used empirical findings from the water industry to show how the state directly and indirectly influences trade. The discussions have complemented the earlier theoretical argument of why the role of the state is important in an explanation. What has been found is that direct assistance programs are used by about half the sample, one reason being that these programs are not suited to small exporters and are cumbersome. There is evidence that users are generally satisfied with the effectiveness of programs, and have a greater proportion of export turnover than non-users. There is less satisfaction expressed with government attempts at sponsoring trade delegations. Based on characteristics of the industry discussed in previous chapters, it is argued that the industry would not be a suitable candidate for direct targeting. Industry associations play a minor role in export development. Interestingly, there does not appear to be a spatial restraint on the influence of industry associations as usage and usefulness ratings are similar for firms in core and peripheral States.

There are strong indirect influences of the state on trade. COAG water reforms have increased domestic demand for water industry goods and services and are widely believed to have been positive. However, corporatised water utilities have not been transformed into major exporting firms, due partly to the risk of exposing public money in a highly competitive export market. There is evidence that environmental and public health regulations have driven innovation. Overall, the impact of indirect influences does not appear to differ between exporters and non-exporters. This suggests that indirect influences facilitate trade, yet are not essential to the causation of trade.

The implications of these findings are that a comprehensive explanation of trade must consider the role of state and institutional support. The theoretical discussion in Part One argued this; the findings from the water industry demonstrate this. By contributing to factor creation (e.g. the funding of educational and research institutions) and influencing demand conditions (e.g. environmental regulation), the state inevitably influences spatial flows of goods and services (as well as flows of capital, people and ideas). State and institutional influence will vary for different geographies, industries and firms, but the
implication for an explanation of trade is that direct and indirect influences need to be considered. An insight from this work is that state influence is not restricted to the national or supranational level – the local level can also have an effect on innovation and trade.

These findings help illuminate the debate over whether the state should be an active initiator or passive facilitator of trade. Active initiation (e.g. targeting) is wrought with practical difficulties. Besides, the existing direct assistance programs are used by only about half the firms in the sample. Increasing direct assistance may not translate into improved results. For the water industry, there is enough indirect influence that can be harnessed to positively benefit trade. Building on this, Section 12.3 outlines some ideas of what the state ought to do as a passive facilitator of trade.
Chapter 11
Reconciling and appraising the theoretical and empirical work

Part Three analysed empirical findings from the Australian water technology and management industry, using the four theoretical strands identified in Part One. Numerous supporting questions were addressed to develop an answer to the main question: how does trade develop for this industry? Cumulatively, a detailed understanding has been formed of the processes that explain how trade develops and why certain findings prevail.

The purpose of Part Four (Chapters 11 and 12) is to summarise, reconcile and appraise the empirical and theoretical work. The contributions and implications of the research are then discussed. In the process, several of the remaining research questions are addressed (Table 11.1). Chapter 11 begins by summarising the empirical findings and tying together the determinants that explain trade (Section 11.1). In Section 11.2 the theoretical framework is assessed and reconciled in light of the empirical material. Certain aspects of the theory need to be emphasised; other aspects should be considered secondary. It is argued that discrepancies occur because of unique characteristics of the industry, rather than limitations in the theory and evidence. The theoretical framework is claimed to be flexible enough to be applied to other industries. Section 11.3 appraises the research method. The contribution of critical realism is discussed. This leads into an assessment of the limitations of the research and suggestions for improvement. Section 11.4 considers how the findings should now direct interpretation of the literature on trade. This provides a platform for the concluding chapter that highlights the theoretical contributions and practical implications of the research.
Table 11.1 Research questions addressed in Chapter 11

<table>
<thead>
<tr>
<th>Questions from theoretical discussion (Table 3.3)</th>
<th>Relevant section in Chapter 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>For this industry, how do exporting and non-exporting firms differ in terms of structure, size, competitive strategy, and the use of institutional support?</td>
<td>11.1.2 (Tables 11.2; 11.3)</td>
</tr>
<tr>
<td>How can the theoretical framework and the empirical findings be reconciled and limitations redressed?</td>
<td>11.2</td>
</tr>
<tr>
<td>Can the explanation be applied to other industries?</td>
<td>11.2.8 (Figure 11.1)</td>
</tr>
</tbody>
</table>

Source: selected questions from Table 3.3.

11.1 Review of findings

The empirical chapters have presented material to support, test and challenge various aspects of the four explanatory strands. Section 11.1.1 integrates the findings with the theoretical framework to distil an explanation of trade in the water industry. Section 11.1.2 summarises the differences and similarities between exporters and non-exporters. Regression analysis and factor analysis is conducted on the quantitative variables that use ratio measurements. This leads to the conclusion that qualitative characteristics offer a more satisfactory explanation of differences. Exporters are distinguished by an ability to derive competitive advantage through appropriate technology and specialisation, and the extensive use of networks in the form of numerous strong and weak ties. Section 11.1.3 proposes a formula for the propensity of a firm to export, based on what is now known.

11.1.1 Distilling the findings

The process of trade is understood by using ideas from four theoretical strands: competitive advantage, innovation, networks and state and institutional support. Firms gain competitive advantage when they produce a good or service that is cheaper or better in quality than rival firms. Competitive advantage extends spatial influence in the market and increases propensity to export goods, services or capital. Competitive advantage is created by determinants that are internal and external to the firm. Internal determinants involve a firm pursuing a cost or differentiation focus. In the water industry, competitive advantage usually manifests as a differentiation focus by a firm having a specialised product or service. The empirical work reveals factors that are
outside this framework, such as cultural affinity where bonds of trust have developed between decision-makers. The age of firms does not determine competitiveness, whereas size has some influence due to economies of scale. Theoretically, external determinants of competitive advantage involve factor conditions, supplier linkages and competitive rivalry from other firms, operating in spatial proximity. Yet the empirical work finds that localised linkages between related and supporting industries are not well developed. Competitiveness can occur where clusters of related activity are not apparent. Corporate strategies - such as inter-firm alliances and intra-firm multinational linkages - extend the influence of the firm. The strategy chosen depends on the degree of power possessed by the firm. Also, inter-firm strategies, such as alliances and collaborations, are frequently used to enter foreign markets.

Competitive advantage itself is a corollary of innovation. Innovation is generated internally, and also acquired externally by the firm. An empirical finding is that innovation proxies used by manufacturing firms increase propensity to export; however, there is little relationship between the proportion of innovation proxy and export proportion. Innovation in the form of appropriate technology offers a more convincing explanation of export activity than technical change expressed as R & D expenditure or patent registrations. Also, service providers depend on inter-firm collaborations and expertise from external staff for innovation, and not technical change. The knowledge required for innovation is not spatially constrained.

Networks between decision-makers extend competitiveness across space, and explain how export contacts are actually made. Once networks and trust are established, spatial separation is not detrimental to sustaining relationships between key actors. Personal relationships between decision-makers in exporting and importing locations are important. The role of state and institutional support is argued to be important because it can amplify competitive advantage and facilitate networks. The empirical work has uncovered numerous cases of indirect influence by the state on trade.
11.1.2 Comparing exporters and non-exporters

To summarise the various findings, the following tables compare the characteristics of exporters and non-exporters. Table 11.2 shows that there are quantitative differences between the groups for firm-size and the use of innovation proxies. Yet overall, quantitative variables are generally unsatisfactory in distinguishing between exporters and non-exporters. For instance, exporters do not necessarily have a higher turnover per employee than non-exporters. Also, although manufacturers that export have greater proportions of R & D and patents than non-exporting counterparts, there is little evidence to suggest that the proportion per turnover of these proxies is related to export proportion.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Exporters N = 86</th>
<th>Non-exporters N = 33</th>
<th>Statistical summary</th>
<th>Comments on differences or lack of difference.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turnover (A$ million)</td>
<td></td>
<td></td>
<td>T test (equal variance; log transformed)</td>
<td>On average, exporters are larger firms. However, many small firms are also exporters (Sections 6.1.4; 7.1.2).</td>
</tr>
<tr>
<td>Mean</td>
<td>40.8</td>
<td>16.8</td>
<td>t (106) = 2.19</td>
<td></td>
</tr>
<tr>
<td>(s.d.)</td>
<td>82.3</td>
<td>28.4</td>
<td>p = 0.02 (one-tailed)*</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>6.5</td>
<td>5.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turnover per employee (A$ 1000)</td>
<td></td>
<td></td>
<td>T test (equal variance; log transformed)</td>
<td>No difference. Exporting firms are not distinguished by this measure of productivity (Section 6.1.4).</td>
</tr>
<tr>
<td>Mean</td>
<td>325</td>
<td>320</td>
<td>t (104) = 1.01</td>
<td></td>
</tr>
<tr>
<td>(s.d.)</td>
<td>301</td>
<td>299</td>
<td>p = 0.16 (one-tailed)</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>250</td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm-size</td>
<td></td>
<td></td>
<td>Mann-Whitney U test</td>
<td>Exporters are larger because developing export markets usually requires capital. Exports can also lead to firm-growth.</td>
</tr>
<tr>
<td>Median</td>
<td>Medium size</td>
<td>Small size</td>
<td>U (117) = 1115.5</td>
<td></td>
</tr>
<tr>
<td>Mode</td>
<td>Small size</td>
<td>Small size</td>
<td>p = 0.02 (one-tailed)*</td>
<td></td>
</tr>
<tr>
<td>Age (years old in 2000)</td>
<td></td>
<td></td>
<td>T test (equal variance; log transformed)</td>
<td>No difference. Young firms can comprise experienced personnel with export experience.</td>
</tr>
<tr>
<td>Mean</td>
<td>17.8</td>
<td>15.8</td>
<td>t (106) = 1.07</td>
<td></td>
</tr>
<tr>
<td>(s.d.)</td>
<td>(9.0)</td>
<td>(9.1)</td>
<td>p = 0.14 (one-tailed)</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>18</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Establishment time range</td>
<td>1980-84</td>
<td>1985-89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of firms with R &amp; D expenditure</td>
<td>N = 46 (79% of exporting group)</td>
<td>N = 11 (48% of non-exporting group)</td>
<td>Test for two proportions between R &amp; D for exporters and non-exporters</td>
<td>Exporters are more likely to have R &amp; D expenditure but the causation is unclear. Possibly firms that are already exporters maintain R &amp; D expenditure to remain competitive. Section 8.1.1)</td>
</tr>
<tr>
<td>No. of firms with registered patents</td>
<td>N = 29 (50% of exporting group)</td>
<td>N = 4 (11% of non-exporting group)</td>
<td>Test for two proportions between patents for exporters and non-exporters</td>
<td>Exporters are more likely to have patents. Suggests that proxies increase the propensity of a firm to export.</td>
</tr>
<tr>
<td>R &amp; D expenditure as proportion of turnover (includes firms with zero R &amp; D expenditure)</td>
<td>N = 57</td>
<td>N = 23</td>
<td>Mann-Whitney U test</td>
<td>Significant result suggests that R &amp; D expenditure has some influence on exports. However, higher R&amp;D proportion is not strongly correlated with export proportion.</td>
</tr>
<tr>
<td>Mean</td>
<td>0.07</td>
<td>Mean</td>
<td>U (78) = 476.5</td>
<td></td>
</tr>
<tr>
<td>(s.d.)</td>
<td>(0.15)</td>
<td>(s.d.)</td>
<td>p = 0.03* (one-tailed)</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>0.02</td>
<td>Median</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of patents per A$ M (million) of turnover (includes firms with no patents)</td>
<td>N = 55</td>
<td>N = 20</td>
<td>Mann-Whitney U test</td>
<td>As above. However, caution is applied in this interpretation because of number of firms with no patents. Also, the causation is unclear because higher patent proportion is not related to higher export proportions.</td>
</tr>
<tr>
<td>Mean</td>
<td>0.54</td>
<td>Mean</td>
<td>U (73) = 319.5</td>
<td></td>
</tr>
<tr>
<td>(s.d.)</td>
<td>(1.24)</td>
<td>(s.d.)</td>
<td>p &lt; 0.01**(one-tailed)</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>0</td>
<td>Median</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: selected results from Tables 6.3; 8.2; 8.3.
As a further summary, Table 11.3 reports the results of multiple regression analysis using variables that use ratio data. All exporters (manufacturers and service providers) are included. Export proportion is the dependent variable; turnover (as a proxy for size), age, R & D proportion, and turnover per employee (as a proxy for competitiveness) are the independent variables. (Patent proportion is not included because of the large number of firms with zero values). The relationship between the variables is weakly significant ([log transformed] p = 0.04; adjusted $R^2 = 0.15$). The significant coefficient is R & D proportion (p = 0.02). This result is consistent with the findings in Section 8.1 that reveal this innovation proxy having a significant (but not substantive) influence on export proportion. Yet as Section 8.2 explains, this innovation proxy is more suitable to manufacturing firms and only captures a narrow aspect of innovation. The argument still stands that quantitative variables are not good predictors of export proportion in this industry. As evident in Table 11.3, only 15% of the variance in export proportion is explained by the independent variables. Furthermore, as Appendix F (Tables F.1 and F.2) demonstrates, the untransformed variables suggest no relationship.

**Table 11.3 Multiple regression analysis for export proportion (dependent variable); turnover, age, turnover per employee and R & D proportion (independent variables) (N = 43)** (log transformed)

\[
\ln \text{Export proportion} = -0.79 + 0.39*(\ln \text{R&D proportion}) - 0.20*(\ln \text{age}) - 0.19*(\ln \text{turnover/employee}) + 0.17*(\ln \text{turnover})
\]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>adjusted $R^2 = 0.15$</td>
</tr>
<tr>
<td>F (4, 38) value = 2.82</td>
<td>p = 0.04 *</td>
</tr>
<tr>
<td>R &amp; D proportion (log transformed)</td>
<td>p = 0.02 *</td>
</tr>
<tr>
<td>Age (log transformed)</td>
<td>p = 0.25</td>
</tr>
<tr>
<td>Turnover per employee (log transformed)</td>
<td>p = 0.21</td>
</tr>
<tr>
<td>Turnover A $ M (log transformed)</td>
<td>p = 0.31</td>
</tr>
</tbody>
</table>


To ensure any possible relationships are not obscured, factor analysis is conducted on all variables that use ratio data. This is to investigate if correlations between the variables can be reduced to a small number of underlying factors. The analysis is conducted on three groupings: all firms in the sample, exporters and non-exporters.
However, the tests are inconclusive. Bartlett’s test of sphericity fails to reject the hypothesis that there are insufficient intercorrelations between the variables. The results are no more reliable when log transformations are applied to the raw variables. Appendix F provides details. In short, none of the variables emerge as sufficient factors in explaining variances.

These tests support the empirical findings that, overall, quantitative evidence does not reveal significant relationships between innovation, competitiveness and trade. Qualitative characteristics offer a better explanation of the causation of trade. Cultural affinity, differentiation strategies (specialisation and back-up services), appropriate technology and networks enable firms to develop competitive advantage and trade. Table 11.4 describes the qualitative differences between exporters and non-exporters.

**Table 11.4 Comparison of qualitative characteristics between exporting and non-exporting firms** (N = 119 firms)

<table>
<thead>
<tr>
<th>Theoretical Strand</th>
<th>What the literature reports</th>
<th>Empirical findings</th>
<th>Empirical findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitive advantage and corporate strategy</td>
<td>Competitive advantage is linked with productivity. Firms that are more productive gain competitive advantage. This can lead to exports. Competitive strategy is usually pursued by either lower price or higher quality. Explanations for FDI by MNCs rely on locational advantage and internalisation. Small firms likely to use inter-firm strategies (e.g. collaborations) to minimise risk.</td>
<td>Productivity proxies do not strongly correlate with export proportion. Competitive strategy is more complex. Firms do not exclusively pursue one strategy over another. Differentiation dominates but price is also a minor influence. Also other factors such as cultural affinity. MNCs use collaborations as a means of exporting. This suggests that internalisation of proprietary knowledge is not always relevant. Variety of corporate strategies used, partly depending on power structures. No clear pattern of firm-size being associated with particular strategies.</td>
<td>Non-exporters can have high productivity proxies (Table 6.3). Cultural affinity not reported. MNC linkages are also a reason not to export. Small non-exporters usually have ownerships structures consisting of manger-owners. Also, small firms have limited funds for risk taking.</td>
</tr>
</tbody>
</table>
Table 11.4 (continued)

<table>
<thead>
<tr>
<th>Theoretical Strand</th>
<th>What the literature reports</th>
<th>Empirical findings Exporters</th>
<th>Empirical findings Non-exporters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation</td>
<td>Internal and external resources of the firm are involved in innovation creation.</td>
<td>Findings support that firms depend on internal and external sources.</td>
<td>Non-exporters have more dependence than exporters on external knowledge sources (e.g. MNC parent). High technology not apparent.</td>
</tr>
<tr>
<td></td>
<td>Studies of innovation often use unreliable proxies.</td>
<td>Appropriate technology cited as important for competitive advantage.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Literature tends to emphasise technological change in manufacturing industries to the neglect of service providers.</td>
<td>High technology (e.g. high levels of R &amp; D) is not a crucial condition for the industry.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>There is spatial constraint with transferring tacit knowledge, hence propensity for firms in related industries to cluster.</td>
<td>Service providers and manufacturers have different sources of innovation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Innovation creation is found to be not spatially constrained.</td>
<td></td>
</tr>
<tr>
<td>The function of</td>
<td>The marketing of industrial products and producer services is different from that of consumer products.</td>
<td>Findings conform to expectations. Market access for firms is based on building relationships and trust.</td>
<td>Non-exporters still require on-going relationships with clients to survive in the domestic market.</td>
</tr>
<tr>
<td>markets and networks</td>
<td>Networks are power structures and underlie corporate strategies, external innovation acquisition and export market access.</td>
<td>Provided there is initial face-to-face contact and trust, then networks do not suffer spatial restraints in effectiveness.</td>
<td>Possibly a lack of networks and having few strong &amp; weak social ties is a reason for non-export. Note, however, that the type of networks used by non-exporters was not empirically explored.</td>
</tr>
<tr>
<td></td>
<td>Non-human agency helps networks have influence over space.</td>
<td>Results demonstrate the function of non-human agency (electronic communication devices, jet aircraft).</td>
<td>Small firms have less social ties between decision-makers than larger firms, making it harder to break into export markets.</td>
</tr>
<tr>
<td>State and institutional</td>
<td>In trade theory, state influence is usually considered only at the macro-level. It is often neglected at the micro-level.</td>
<td>State &amp; institutional influences are important at the micro-level.</td>
<td>Indirect influences of the state are still apparent for non-exporters.</td>
</tr>
<tr>
<td>influence</td>
<td></td>
<td>Both groups experience the influence that environmental and health legislation has on innovation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indirect influences are more important in explaining trade than direct influences.</td>
<td></td>
</tr>
</tbody>
</table>

Source: summarised from theory and empirical work (Parts One and Three).
11.1.3 Attempting a formula

According to the literature (see Sections 3.2; 3.3), variables such as productivity, firm-size, firm-age, R & D expenditure and patent numbers influence the propensity (i.e. the tendency) to export. The variables could be incorporated into a mathematical model to predict export behaviour. A simplified expression is as follows:

\[ \text{Propensity to export for a firm} = f(\text{productivity}) \]

where \( \text{Productivity} = f(\text{R & D expenditure; patents; exogenous technical change; firm-size; firm-age; labour skills}) \)

Productivity is measured as labour costs per unit of output, or capital expenditure per unit of output. This leads to a better product (higher price per unit of output) or cheaper product (lower cost per unit of output).

Yet as Tables 11.2 and 11.3 report, quantifiable variables do not produce a satisfactory model of propensity to export. Based on what is known about the water industry, a different expression is required. The propensity of a firm to export may be expressed as a function of the number of social networks, capacity to innovate, and state influence. A possible expression is as follows:

\[
\begin{align*}
\text{Propensity to export} & \quad \rightarrow \quad \text{No. of networks (strong & weak ties)} \rightarrow \text{size/ ownership} \\
& \quad \rightarrow \quad \text{Innovation capacity} \rightarrow \text{R&D; patents; staff expertise; ties with research institutions} \\
& \quad \rightarrow \quad \text{State} \rightarrow \text{programs; creation of factor conditions} \\
& \quad \rightarrow \quad \text{Demand} \rightarrow \text{domestic & international conditions}
\end{align*}
\]

The number of networks includes the number of strong and weak ties. This variable is influenced by firm-size, the state and institutional capacity. Multinational corporations are expected to have more networks than smaller domestic firms. The capacity to innovate is not only related to internal expenditure on R & D and the patents generated, but also to the number of staff with specialised expertise and the number of ties with research institutions. Innovation leads to higher productivity for the firm, which in principle increases spatial reach of the market and hence the propensity to export. The strength of state influence is related to the number of programs that the firm uses and
finds satisfactory. State influence also creates favourable factor conditions, which in turn influence innovation capacity (e.g. skilled workforce through education). The strength of demand is determined by domestic demand, and demand in the importing locality for the firm’s goods or services. The state also has some influence on demand conditions, such as through environmental legislation. For the individual firm, state influence on factor conditions and demand conditions are exogenous determinants.

Because the research is not an econometric study, testing and refining mathematical expressions is not attempted. It is also acknowledged that some of these variables would be difficult to quantify in practice. Nevertheless, this idea sketches a possible research opportunity for a more rigorous expression of the prerequisite conditions that influence the propensity of a firm to export. In a similar vein, O’Farrell and Wood (1998) conclude that the likelihood of firms to enter foreign markets is influenced by demand-side and supply-side externalities, including the range of specialised market niches, the quality of local supply infrastructure, the intensity of competition, the availability of potential network associates, and cyclic trends in demand. Their research, however, does not attempt to tie these variables together.

11.2 Reconciling the evidence with the theory

Part One develops a framework of how trade *should* in theory occur. The empirical work in Part Three investigates how trade *does* occur for an industry, using the theoretical framework to analyse the findings. Explanations are offered for conformities, and more frequently, the discrepancies found between theory and evidence. The purpose of Section 11.2 is to reconcile the discrepancies by arguing that rethinking trade requires reinterpretation of some aspects of the existing literature. Empirical findings inform the theoretical development, the converse to the approach in Part Three. Seven areas of the literature are identified for modification - each is discussed in the following subsections. Although the overall focus is on the firm, macro-level perspectives are woven into the discussion to aid the analysis. Section 11.1.8 concludes by reinterpreting the theoretical framework developed in Part One.
11.2.1 Justifying the demotion of traditional explanations

Chapter 2 argues that traditional explanations (factor endowment theory, Linder demand and product cycle) have major limitations and are unlikely to be satisfactory explanations of trade for the water industry. The Linder demand model (Section 2.2.2) is not considered as a theoretical strand because this thesis concentrates on the supply side. A demand side study, however, would probably adopt a modified form of this explanation. Product cycle theory is argued to be not relevant for this particular empirical study. The water industry is a mature industry with a large number of service providers, contrary to the standard model of the product cycle.

The focus is not on a resource industry so factor endowment theory is not tested. The empirical work, however, reveals some limited influence of factor advantage. Cultural affinity is partly a manifestation of a factor advantage because it is an outcome of national characteristics (Section 7.2.3). Furthermore, factor advantage in the mining industry has influenced competitive advantage in wastewater treatment. No evidence is found to support the antithesis of this theory - factor disadvantage - despite claims in some government publications that Australia’s largely arid climate has induced particular innovations (Section 7.3.1).

Yet it would be misguided to totally dismiss factor endowment theory as part of a general explanation of trade. Although Porter considers factor conditions as one determinant of competitive advantage, his work relegates this determinant to secondary importance because resource-intensive industries are not considered. Rugman (1991; 1993), for example, critiques this as a serious oversight.

In a macro-level model (Figure 2.2), factor conditions - either as a factor in abundance or as a scarcity - need to be included. Moreover, the importance of this determinant largely depends on the industry being studied. For example, if the internationalisation of the Australian wine industry was the case study rather than water, then factor endowment (e.g. climatic conditions, soils, skilled viticulturists) would likely be stressed as important to an explanation.
11.2.2 Shifting Dunning’s paradigm to secondary importance

The ubiquity of multinational corporations (MNCs) in most industries means that theories of MNC behaviour should be considered in an explanation of trade. Dunning’s proposal is useful for explaining why MNCs choose FDI (foreign direct investment) as an avenue of trade, rather than direct export (Section 2.4). As explained, MNCs are motivated by the need to internalise activities to lower costs and protect firm-specific knowledge. The limitation of Dunning’s paradigm is that FDI is only one type of corporate strategy. To comprehensively explain trade, a broader concept encompassing both intra and inter-firm strategies is required, in addition to an explanation of what makes firms competitive in the first place. An over-reliance on theories of multinational activity can obscure the variety of control and ownership methods that firms exercise (Section 2.4.3). Also, despite supportive claims by Clegg (1993) and Braunerhjelm and Exholm (1998), Dunning’s explanation does not adequately explain service industry internationalisation. There is no evidence from the sample that seeking low cost locations is the main motivation behind European water MNCs operating in Australia, or for establishing branch plants in Asia. The reasons for seeking new locations often rest on being closer to new market opportunities (p.c. Interview Codes #90; #101).

Large firms tend to enter markets through collaborations. Internalisation motives are not evident. There is not a pressing need with service MNCs to protect proprietary knowledge. Being part of a MNC is only one method of entering export markets. O’Farrell and Wood’s (1998) reason - that production with collaborators is preferred because it lowers risk - is more credible, particularly for smaller producer service firms.

The theoretical framework does not require a separate strand to explain MNC behaviour, but needs to acknowledge that intra-firm linkages are an important corporate strategy used to gain competitive advantage. Dunning’s ideas can be drawn upon if necessary, such as explaining why a MNC might shift manufacturing offshore. The concepts of competitive advantage and corporate strategies can accommodate ideas about how MNC’s become competitive and why they choose FDI.
11.2.3 De-emphasis of clustering

The rethinking of trade argues for a de-emphasis of the assertion that geographic clustering of related and supporting industries drive trade (Section 2.3.4). The empirical work lends support to the alternative view of de-emphasis. Many firms export, despite weak localised linkages. Furthermore, innovative firms are found that have no localised linkages with research institutions or nearby suppliers. Networks and corporate strategies substitute for the lack of localised linkages.

This critique is not intended to undermine arguments by Porter (1990), Krugman (1991), Baptista (1998) and Swann et al. (1998), but rather claim that there are alternative ways for innovation to develop that do not depend on externalities generated by clusters. Because international comparisons of the water industry have not been made, this claim remains cautious. Based on literature searches confined to the English language (see Section 6.4), there appears to be no evidence of water industry clusters in other OECD countries.

11.2.4 Rethinking innovation

The theory considers innovation as an essential determinant that contributes to the competitive advantage of a firm. The evidence, however, suggests that the concept of innovation extends beyond technical change - such as R & D input - to incorporate the entire value chain of a firm. For instance, innovation can be embedded in the delivery of a backup service or marketing. The empirical work reveals appropriate technology as a competitive advantage, thereby supporting a broader concept of innovation. Also, the water industry is characterised by incremental rather than radical innovations.

The literature reports that external sources of innovation are important for competitive advantage (e.g. Nelson 1993a; 1993b). The empirical findings confirm this expectation, and buttress Oerlemans et al. (1998) observation that incremental innovators largely rely on external sources because protecting proprietary knowledge is not paramount.

In rethinking trade, the processes involved in innovation creation are inextricably linked to the other strands (Section 8.3). For example, innovation leads to competitive
advantage, innovation creation over distance relies upon networks, and the state creates conditions for innovation. In interpreting the literature, an awareness is required that innovation creation involves multiple and related processes. Innovation at the micro-level needs to be explained by more than technical change within a firm.

11.2.5 Rethinking competitive advantage

As shown in Section 7.3, only some of the characteristics of the water industry conform to Porter’s diamond model. Other characteristics are contrary to the idealised conditions proposed by the model. For instance, Porter’s (1990) stress on home market conditions does not fit with the industry in Australia where local linkages are not strong and inward FDI is substantial. The Australian industry possibly would be more internationally competitive if it conformed to the diamond model. The reality is, however, that a number of firms within the industry are still competitive without this conformity. Inter-firm networks, appropriate technology and cultural affinity are the factors that contribute to an alternative concept of competitiveness.

The empirical findings question Porter’s micro-level concept of competitive strategy as a simple cost/differentiation dichotomy (Table 3.2). In reality, there are varying degrees of combining strategies. For instance, a firm might compete domestically as a focused differentiator. When competing internationally, price could also become a consideration. There are also factors, such as cultural affinity, that lie outside Porter’s concept of competitive strategies. To reconcile this discrepancy, a more flexible model of competitive strategy is required. Lindahl and Beyers (1999) reach a similar conclusion.

Porter’s diamond model is still useful as a core strand at the macro-economic level. This is because it encompasses a number of previously discussed ideas (e.g. comparative advantage, product cycle). Further, the basic determinants of the model are flexible enough to be applied to different industries. The concept, however, does need to be refined for different industries. Importantly, a more sophisticated inclusion of the state is additionally required.
11.2.6 Inclusion of the state

The state provides conditions for the production and reproduction of capital (Jessop 1990). Included in this broad mission are providing the economic and political conditions to facilitate trade. A modified version of competitive advantage that incorporates the state is proposed in Chapter 2. While a theoretical explanation of the role of the state in trade is undeveloped in the literature, there are numerous ways to illustrate its influence (Sections 3.5.2; 10.3). The evidence supports an emphasis on the state’s role. Even if direct initiatives such as targeting prove ineffective, the myriad of indirect influences justifies the inclusion of the state. Moreover, an understanding of the interaction between state and trade can inform policy development (Section 10.4).

The influence of the state needs to be considered in relation to the different tiers of government. The source of influence also depends on the industry being studied. There are supra-national influences (e.g. WTO and regional trade agreements), although for the water industry these do not appear to have much impact. The influence of local government, however, is important for this industry.

11.2.7 Networks as interconnecting the other determinants

The empirical evidence supports a socially based interpretation of business behaviour (e.g. Granovetter 1985; Grabher 1993; Amin and Thrift 1995; O’Farrell and Wood 1998). Rethinking trade requires conceptualising networks as the means by which competitiveness extends over space. Furthermore, networks interconnect other processes that explain trade. For example, networks manifest as corporate strategies, where dynamic, unequal power relationships determine the strategy chosen. The internal and external determinants of the firm, such as sources of innovation, are connected by networks. Networks between decision-makers allow market information to be gathered. Furthermore, institutional capacity and national innovation systems come into existence because of networks between the private sector and public institutions.

The deficiency with the network literature is that other determinants are often neglected, in particular, structural influences of the state and institutions. Also, the networks
possessed by decision-makers within a firm are only useful if the firm has some competitive advantage to offer; networks do not explain what makes a firm competitive in the first place. The research has made clear that network theory - albeit important - is only one strand in a comprehensive explanation of trade.

### 11.2.8 Revising the theoretical framework of trade at the level of the firm

Figure 11.1 is a modified version of Figure 3.3. It incorporates several new features, as a result of the empirical material informing the theory. One feature is the recognition of the influence of the state emitting from different tiers of government. Second, the creation of competitive advantage is more complex than a dichotomy of cost and quality. Other factors such as cultural affinity are involved. Another feature is the recognition that there are three distinct methods of accessing export markets. FDI is one strategy that firms can use if there is a need to internalise proprietary knowledge. Direct export of goods or services is another option. Inter-firm collaborations are the third option used. The diagram illustrates the empirical finding that alliances between firms are an important method of export access.

A fourth feature of Figure 11.1 is the recognition that networks create and sustain the linkages between determinants, remaining effective over space. Note that firm-size is not diagrammatically indicated. This is because the concepts depicted in Figure 11.1 are applicable to different sizes of firms. Small firms tend to depend more on external determinants such as inter-firm strategies, whereas large firms can use FDI because of access to capital. The accommodation of different sizes heeds Grant’s (1994: 306) call for “constellations of firms” of different sizes in an overall trade theory.

Recall that Figure 2.1 shows how trade at the level of the firm is interrelated to national influences. These macro-level influences include factor conditions, institutional capacity, national innovation systems and actions by the state. The flexibility of the determinants in Figure 11.1 can accommodate this concept. For instance, in some industries, the external environment of the firm is more strongly linked with national innovation systems than in low technology sectors. Furthermore, industries of national significance (i.e. major employers and/or export earners) have a greater sphere of
influence on the state than specialised smaller industries (e.g. water technology). Likewise, the state usually exerts a more direct influence on national industries than it does on smaller, less crucial industries. For example, the Australian car manufacturing industry is more influenced by direct actions by the state (e.g. tariffs) than the water industry.

The theoretical framework conceptualised in Figure 11.1 can potentially be applied to explaining trade in different industries. Explaining the internationalisation of the wine industry, for example, would likely place an importance on factor conditions. Supranational influences, such as WTO agreements over agricultural commodities, probably need to be considered. In the case of the aerospace industry, innovation creation by internal R & D might be a fundamental determinant. Developing an explanation of trade applied to the biotechnology industry would perhaps stress multinational attempts to protect internal proprietary knowledge. The influence of the state in exercising ethical concerns, and thereby influencing flows of trade, might also be highlighted. Energy resource industries (e.g. coal, natural gas) would emphasise factor conditions, such as resource endowment and sea-port infrastructure. In the case of Australia, national influences exercised by the state are powerful because energy resource industries are major export earners. Innovation creation probably is less crucial in these industries than with high technology industries, although research into cleaner energy sources might have an influence.
Figure 11.1 Revised diagrammatic representation of determinants of trade at the level of the firm

Source: adapted from Figure 3.3 (Part One); modified from empirical analysis (Part Three).
11.3 Appraising the research

This section determines how effective the research methods are for gathering sufficient and appropriate information to address the research question. Section 11.3.1 evaluates how critical realism informs the development of the theoretical and empirical work. Section 11.3.2 reflects upon the limitations and suggests improvements for future research.

11.3.1 The contribution of critical realism

Critical realism is outlined in Section 5.1 as a philosophy to underpin research methods. A treatise of the philosophy has not been the intention. Nevertheless, critical realism contributes to the approach and interpretation of the research in several areas. One practical application of the philosophy is the search for causality, rather than regularity or generality. Applied to this research, when quantitative measures did not detect relationships between variables, the realist approach was to investigate causality using qualitative data, and not simply conclude that there is no casual relationship because regularity could not be established. Second, the philosophy creates an awareness of the dual importance of agency and structure. When firms trade, this involves decision-making individuals (i.e. actors) interacting within structural influences (i.e. institutions, the state, networks). The theoretical development in Part One recognises this; the empirical analysis in Part Three reinforces the insight. A third application is the use of intensive and extensive research methods, incorporating quantitative and qualitative data. Critical realism accommodates an eclectic approach by recommending that the most appropriate method depends on the context of the inquiry (Pratt 1995). The experience from this research would support this view. Qualitative data from interviews contributes to an explanation of relationships between variables more satisfactorily than analysis using quantitative data. Yet both methods remain complementary (Layder 1993; Yeung 1997b).

There are contributions due to critical realism’s ontological and epistemological perspectives. One is that the research is re-conceptualised as knowledge accumulates. For example, competitive advantage and innovation are highlighted in the theory as
crucial to an explanation. Yet the empirical results shift the emphasis to the fundamental role of networks. Section 5.2.5 shows how the questionnaire evolves as knowledge and experience is gained. Throughout the work the theory and empirical work are mutually reinforcing, continually feeding back to create new knowledge. The theoretical framework informs the empirical analysis in Part Three. In Section 11.2, empirical results inform further theoretical interpretation.

An additional contribution is the realist view of a multi-layered interpretation of reality. This is played out when attempting to understand trade. The firm and trade are the realities yet the individual actors have their own interpretation of these realities based on their real world experiences. In addition, the awareness of different perspectives of reality means that there is an acknowledgement by the researcher of restrictions and flaws in the interpretation of the reality being investigated. The limitations pertinent to this research are discussed next.

11.3.2 Identifying limitations of evidence and theory

There are inevitable restrictions with an ambitious research project. This section reflects on these. Each of the theoretical strands identified could be explored in more depth; indeed, an intensive treatment of each strand using several industry examples would yield enough material to generate separate theses. To cover several strands comprehensively involves a compromise between depth of investigation and its scope.

The use of interviews to gather information has inherent limitations. The one hour that many interviewees gave was generous, considering their hectic schedules in a corporate setting. Yet even with an organised approach to interviews (see Section 5.3), not all aspects could realistically be covered. Nor would an extended 3 hour interview (which would be highly unlikely) necessarily guarantee that the information would be improved.

The use of survey questionnaires also has limitations. Design of questionnaires is a balance between being succinct and yet still remaining comprehensive (see Section 5.2.4). The satisfactory response rate achieved (54%) is partly due to a compact
questionnaire that can extract useful information with minimal effort for the respondent. While additional questions regarding the different strands are ideally desirable, realistically this would make the questionnaire too long-winded and likely result in a low response rate.

Notwithstanding these limitations, improvements could be made without requiring a longer questionnaire. A useful addition would be a more extensive use of preferential ratings (i.e. ordinal measurements) to determine the relative importance of different sources of innovation, competitive advantage and export contacts. In hindsight, survey designs could have incorporated preferential ratings without making the questionnaire too long. Because nominal categories are used for many determinants rather than ordinal measurements, factor analysis is restricted. For instance, while it is known that word-of-mouth and active targeting are important methods of export access and how many firms used particular methods, the relative importance of each method cannot be compared. Cornish (1997a; 1997b) and Lindahl and Beyers (1999) extensively use preferential ratings (e.g. Likert scales) in their research, enabling multiple statistical cross comparisons.

In retrospect, surveys and interviews could have further investigated networks and strong and weak ties, although some of the questions do allude to this aspect (e.g. when developing international markets, who approached whom?). Bryson et al. (1993) offer suggestions for measuring the strength of supply and demand-side networks, such as the proportion of repeat business the firm receives over time and the number of referrals obtained from existing clients and from rival firms.

Without compromising a streamlined questionnaire design, these improvements could be achieved by having less emphasis on the government’s role and the influences of environmental initiatives. In hindsight, ‘cleaner production’ and ISO 14001 are not significant influences so these aspects could be downplayed. Although the role of the state in the development of environmental technologies and management was recognised from the preliminary research as important, it was highlighted too much in the early field-work. What a novice researcher chooses to emphasise is directed largely by what
he or she happens to initially read. It is only after a large amount of reading and fieldwork has been done that one can make a more informed choice about what aspects of the theory to investigate in depth.

Time series data from individual firms, such as export and turnover growth over the past decade, would be useful for contributing to a dynamic explanation of competitive advantage and trade. The relationship between changing competitive and corporate strategies and firm-level growth could be analysed. Comparing changes in variables such as capital, labour and R & D expenditure to changes in export growth would lead to a theoretically sophisticated interpretation, grounded in mathematics. In practice, overcoming the lack of time series data at the micro-level is more difficult than the other limitations discussed. To gather accurate data requires accessing the firm’s financial records. This is sensitive information and is restricted because the majority are firms are in private ownership. In some interviews, respondents were asked about export and turnover growth but it was apparent that answers were rough estimates at best (i.e. ‘guestimates’). It was realised during the field-work that any research ambitions to have a dynamic model of trade would have to be forgone for a static interpretation. To persist in asking probing questions about turnover growth would likely have put some interviewees offside and jeopardised the rest of the interview. Note that the interviews did enquire about the firm’s history to gain an idea of how competitive advantage develops and corporate strategies change. The qualitative interpretations do account somewhat for changes over time.

Two main limitations permeate the research: 1) only one industry has been studied; 2) it is confined to one economy. The first limitation has been imposed by logistic reasons but is also partly intentional to allow analytical clarity. Attempting to investigate how trade develops for a number of unrelated industries would have meant a superficial

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1 I remain sceptical of the accuracy of time series data in research by Lindahl and Beyers (1999), as their methods rely on telephone surveys seeking answers from firms, for example, about turnover growth over 5 years. Some degree of accuracy can be assumed when asking an informed respondent about figures from the previous financial year because the information is relatively fresh. However, verbal reporting of quantitative information from the past 5 or 10 years is susceptible to inaccuracies as memories fade for details and personnel within firms change. Calculating growth rates from cited figures instils more confidence in the accuracy of data from a past period.
interpretation of each theoretical strand. An underlying argument throughout the thesis is that a single industry study can yield rich insights; nevertheless, a cautious approach is required if adapting the theoretical framework to other industries. The unique characteristics of the industry studied must be recognised. Trade in other industries might also be explained by additional processes that are not encompassed by the four explanatory strands underpinning this research. The second limitation is a more serious impediment for claiming that the theoretical framework is widely applicable to other industries and places. Comparing export development of the water industry in several countries would contribute to a more robust interpretation. For example, the research asserts that clusters are not a pre-requisite of innovation creation; however, a definitive statement would need to be supported by international comparisons. Another case is that the factors identified as creating competitive advantage for the Australian industry, such as cultural affinity and appropriate technology, might be different for the water industry in other countries.

11.4 Conclusion

This chapter has served three purposes. The empirical work has been summarised with an emphasis on the important, surprising and most secure findings. Exporters and non-exporters have been compared, revealing that the differences between the two groups are expressed more satisfactorily by qualitative attributes than by quantitative measures. Overall, there is empirical support for explaining trade in this industry by the four explanatory strands identified. The second purpose was to reconcile the theoretical and empirical work. The macro and micro-level frameworks developed in Part One provide an insight into the processes involved in explaining trade. When applied to the Australian water industry, certain aspects need to be highlighted and others downplayed. A third purpose has been to appraise the work. Claims of new insights also need to be tempered by an awareness of the limitations. Critical realism has contributed to this awareness.

How should the literature on trade be interpreted in the context of knowledge gained by rethinking trade? Three areas of attention are noted. First, the theory of comparative
advantage, and factor endowment theory in general, should not be entirely discarded but considered as only one component of competitive advantage. Interestingly, World Trade Organization (2003) documents still make reference to comparative advantage as a generalised explanation of trade. This suggests that supra-national organisations have not kept pace with contemporary theoretical understanding of the processes they attempt to govern. Second, the theoretical explanation of trade is contingent on the industry being discussed. Characteristics of the industry guide the theoretical development; the theory in turn informs empirical interpretation. Section 11.2.8 demonstrates this. For trade explanations, it is not a case of ‘one theory fits all’. The theory must be flexible with its components adaptable to the industry. Furthermore, a macro-level trade study of a region or nation would have a different interpretation of the relevance of various explanations than compared with a micro-level study. Third, the scrutiny carried out in this thesis of Porter’s influential work on national and firm-level competitiveness suggests that these ideas are only one interpretation of the determinants of competitiveness. Some national governments, such as New Zealand and Portugal (see Porter 1998), appear to have uncritically embraced the concepts of home market competitiveness and industry clusters as panaceas for uncompetitive industries. Arguably, a more circumspect approach is required that takes into account the unique characteristics of local geographies, governance and industries.

Rethinking trade in an industry has contributed to the discipline of economic geography. It has also generated some implications for the Australian water industry and ideas for further research. These issues are discussed in the final chapter.
Chapter 12
Conclusion

This concluding chapter firstly revisits the aim of the research by summarising the knowledge that has been generated. Section 12.2 demonstrates how this work has enriched the discipline of economic geography. Four distinct contributions of theoretical and practical significance are identified. Section 12.3 discusses the implications for the Australian water industry. In general, the industry is destined to be a minor global player because the underlying conditions for competitiveness are lacking. To close, Section 12.4 outlines opportunities for further research.

12.1 Revisiting the aim of the research

The aim of this research was to develop an explanation of trade at the level of the firm and apply the ideas to the Australian water technology and management industry. As Chapter 1 argued, a comprehensive theory of trade has been lacking (e.g. Grant 1994). This industry was chosen because the sustainable management of water is an issue of global significance, and Australian firms can economically benefit by exporting relevant technologies and expertise. In addition, the water industry is useful for testing various theoretical ideas because there is a diversity of firms producing a variety of goods and services.

The critique of the literature, tempered by preliminary empirical analysis, led to four explanatory strands that provided the theme throughout the theoretical and empirical work. Analysis was conducted at the level of the firm but conceptualised within the context of influences external to the firm. Numerous questions were generated to bolster the main question: how does trade develop. To develop and test explanations, surveys and interviews were conducted with representatives from the water industry to gather relevant information. The theoretical framework was refined in Chapter 11 and argued to have the flexibility to be potentially adaptable to different industries.
A précis of how trade develops is as follows. The theoretical explanation is that innovative firms are more productive, which leads to competitive advantage over rivals. Greater competitiveness generates demand for goods and services across spatially separate locations. Trade is the result. What the empirical work finds is that R & D expenditure and registered patents increase the propensity to export for manufacturing firms, but are largely unrelated to export proportion. Innovation is often expressed as appropriate technology, rather than as a technology gap between rivals. Service firm create innovation by inter-firm collaborations. Innovation can create competitive advantage but there are also other factors. Competitive advantage is a multifaceted concept with some factors outside Porter’s (1985; 1990) cost / quality framework. Various corporate strategies also extend the influence of the firm. Networks are the means by which the internal environment of the firm connects with the external environment, thereby extending the firm’s competitiveness over space. The external environment comprises innovation sources, other firms, government agencies and export contacts. State and institutional support can influence various processes, such as setting vigorous demand conditions to amplify competitive advantage, contributing to the national innovation system, and facilitating networks. What the research eminently demonstrates is that the economic process of trade is not merely based on transaction cost. Trade needs to be understood as interactions across space of social relations, power structures and state influence.

12.2 Colouring in the black box of trade theory

It is curious that comprehensive explanations of trade have not been more fully explored within economic geography, given that trade is an integral part of numerous spatial-economic processes such as globalisation, regional development and uneven growth. International flows of products and capital interconnect and shape the geographies of regions. A better understanding of trade is concomitant with an improved analysis of spatial change. Trade is recognised in many works as an important process at the macro-economic level (e.g. Webber and Rigby 1996; Dicken 1998). However, at the micro-level trade is largely treated as a ‘black box’ in that the process is acknowledged, but the details remain unclear. Chapter 1 argued that theoretical shortcomings are a result of
gross generalisations that fail to perceive that it is not countries which trade, but firms within countries. Insights can be gained by considering the economic unit of the firm - and the individual decision-makers comprising these units - as integral to explaining how trade actually occurs.

This research contributes to the discipline by unpacking the black box and colouring in the mechanisms with theoretical insights. It has done this by developing a framework based on several theoretical ideas (Figures 2.2; 3.3; 11.1). Until this research, the conceptual strands had arguably not been satisfactorily integrated. In the comprehensive explanation that has been developed, the micro-level of the firm is informed by the macro-level environment. The framework is possibly malleable enough to be applied to other industries, provided that determinants are emphasised or de-emphasised accordingly (as demonstrated in Section 11.2). The framework provides a way of rethinking trade at the micro-level to better understand aspects of global spatial change.

By using the firm as the unit of analysis for a study of trade, a current research concern is addressed. A decade ago Dicken and Thrift (1992) called for research that recognised the importance of business enterprises in understanding the changing geography of production. In response, there have been initiatives that reconceptualise the firm as a fundamental economic unit, interconnected with the wider social, political and economic environment (Dicken and Malmberg 2001; Maskell 2001; Yeung 2001). The thesis has made a timely contribution to this agenda. It has conducted an intense study of trade in one industry, using the firm as the unit of analysis but with an awareness of external determinants. The theoretical insights, informed by empirical findings, vividly illustrate the “intricate (and) dialectical relationship between the firm and wider social relations in the capitalist market” (Yeung 2001: 294).

A third contribution is that a critical realist philosophy has been applied to a study of trade. The contribution here is twofold. One is that the research has added to recent geographic work that explores critical realism (e.g. Pratt 1995; Gandy 1996; Yeung 1997b). The purpose, however, has not been to analyse connections between the philosophy and the methods, but rather provide a sketch of critical realism’s usefulness.
The other contribution is the philosophy’s stipulation that uncovering causal factors requires theoretical development be informed by empirical work and subject to testing and re-conceptualisation. The research has critiqued a wide range of literature and distilled the useful elements. The ideas have been exposed to empirical testing. By imposing rigour on the developing ideas, this approach helps address Martin’s (1999: 389) disquiet that much contemporary geography has “acquired a worrying degree of theoretical and empirical laziness”.

A fourth contribution to the discipline is that the theory underpinning the research provides a platform to make informed practical recommendations. For example, because the ideal theoretical conditions for targeting are difficult to achieve in reality, targeting is argued to be an ineffective form of industry support (Sections 2.6.3; 10.1.2).

Understanding the theory of how networks develop can lead to ideas for improved action by the state. As commentators such as Peck (1999) and Martin (1999; 2001) advocate, geographic research, even if theoretically based, ought to have practical relevance for policy development. The theoretical framework has practical significance as its application can provide an informed assessment of the exporting prospects of an industry. This is demonstrated next.

12.3 Wet dreams - dry realities: implications for the internationalisation of the Australian water industry

The empirical findings have created a repository of information for an industry where official statistics are scant. Several new things are known about the industry: its economic magnitude and industrial organisation, the types of linkages between firms, the effectiveness of state and institutional support, and how export contracts are made. As a proportion of aggregate turnover, export revenue for the industry is 17%. This is comparable to the average export proportion for Australian manufacturing establishments, which was 16% of the sales of goods produced in 1998/99 (ABS 2000 # 8221.0). In this respect the water industry is of average competitiveness. Certainly, some firms are very active exporters: 47% of exporters in the sample (i.e. 40 out of 86 firms) have export proportions of 10% or more; of these, 21 firms (i.e. 24% of exporters) have
export proportions above 20%. Moreover, the Australian Water Association journal - *Water* - frequently reports Australian firms doing overseas work. Yet the water industry does not conform to the idealised model of competitiveness as articulated by Porter (1985; 1990). The industry probably would be more competitive if it had strong supplier linkages and more sophisticated home demand. Nevertheless, some firms are internationally competitive without widespread conformity to theories of competitive advantage. Discussions at various points of this research have explained how this is possible. Cultural affinity, appropriate technology and network formation are some of the processes that contribute to competitiveness and trade.

In the global context, however, Australian firms are minor players and are likely to remain so. Reports from the 1990s (e.g. Doherty 1991; DITRD 1993; EDC 1995; Macleay 1996; EMIAA 1998) - that enthusiastically espoused a potentially huge export industry - were largely exercises in delusion. Serious efforts to build networks with Asian decision-makers in infrastructure development should have begun in earnest over a decade ago. The run possibly has been left too late. The Anglo French firms are well established in Asia; in addition, US engineering consultancies are beginning to establish a presence (ABC Radio 2003).

For the domestic industry, water reforms have created more vigorous domestic demand conditions. However, foreign multinationals have seized many opportunities. The pessimism felt by some representatives of the industry is encapsulated in this comment from a head of a water utility: “Australia has given away a lot of market share to them (French multinationals). There are very few niches in the market left. It’s doubtful if Australia is ever going to develop an industry because it is gone” (p.c. Interview Code #106).

The implications for the industry are that some firms will continue to be successful exporters, either as independent specialists or by forming collaborations with larger players. A few manufacturers of wastewater treatment equipment and monitoring devices have found niches. Some Australian engineering firms are in demand because of a good reputation in project management (p.c. Interview Codes #96; #99a; #100a; #100b). Yet
overall, it is unlikely that Australia will ever be a major force in the global water industry because despite individual success stories, the fundamental framework for nurturing a competitive industry is not developed. For example, a stronger manufacturing sector is necessary to create the related and supporting industries required for a significant water technology sector. As the empirical work shows (Section 6.3), the majority of the manufacturing firms import the main components for products.

Assuming that it is an economically and socially desirable goal to have a water exporting sector, several developments need to occur. Because Australian Governments cannot match the funding that governments of some OECD competitors provide to their domestic environmental industries (Moore and Miller 1994; US Department of Commerce 1996; 1997; US EPA 1998), a more effective use of limited public resources is required to facilitate exports. One way could be to provide funding with flexible conditions that allows firms, particularly smaller enterprises, develop their own networks. Another suggestion is helping industry associations host delegations, given that associations have superior knowledge of the requirements for their industry than do government agencies (p.c. Interview Code #120; 121). Even if not initially for a commercial objective, overseas research collaborations should be encouraged as these can generate positive externalities (Section 10.2.4). One impediment the industry needs to overcome is the bias toward multinational giants when tenders are requested for domestic projects (p.c. Interview Code #120). A possible solution would be to require water utilities to use at least some local input, provided it is of high quality.

12.4 Opportunities for further research

There are ample opportunities for extending the research agenda on trade. A general limit of this research is that it is confined to one industry in one country. It would be useful to investigate whether the findings and interpretations discussed result from being an industry in a semi-peripheral economy, or whether similar results would be found if European and US water industry firms were studied. Ideally, comparing the water industry in several countries potentially allows a more comprehensive explanation of trade to be formulated. As there appears to be a paucity of studies of trade development
in the global water industry, such knowledge would be useful both theoretically and practically. Moreover, using different industries would test aspects of the explanatory strands (Section 11.2.8). Other strands that complement the original four might also be identified.

Analysis using time series data would probably produce a more sophisticated interpretation of trade than the static version developed. Time series data across a number of related industries would be useful for establishing more robust assertions. Investigating an industry that consists of a large proportion of public-listed companies would provide the necessary information. From annual reports, the rates of change over time of profit rates, productivity and export revenue could be calculated. In addition, this type of econometric investigation provides an arena for meaningful dialogue between economic geographers and economists.

The focus throughout this research has been the supply-side processes of trade. A fruitful area of theoretical development would be an exploration of demand-side explanations, such as investigating what causes a nation to import or host multinational firms. There is work that provides a direction. For instance, O’Connor and Daniels (2001) explain trade in producer services as converging demand conditions between trading nations. Similarly at the micro-level, Beyers and Lindahl’s (1996) study of producer service internationalisation also investigates the demand-side.

There is also opportunity to investigate if the strategies exporters use to develop international markets differ when selling in home markets. Recall that exports accounted for only about one-fifth of markets for businesses included in this study (Section 6.1). Even those firms that actively pursue international markets generally still rely on domestic clients for much of their turnover. A comparative study of the strategies firms use when developing domestic and international markets could better explain how competitive advantage varies over space. This would richly inform a theory of trade.

By rethinking explanations of trade, this thesis has produced a comprehensive insight from the supply-side. It has explained how the economic unit of the firm interacts with
the wider environment to instigate flows of goods, services and capital across space. Trade is a crucial and integral part of the process that contributes to spatial change at various geographic scales. The time is ripe for the continued rethinking of trade in order to better understand the dynamics of the global economy.
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Appendix A (Chapter 4)

Figure 4.1 (p. 112) is based on the following information. Table A.1 has been constructed by combining categories described by Aquatech directory (1996) with more detailed listings of products and services taken from the AWWA (Australian Water and Wastewater Association) (1999) and AWA (Australian Water Association (formerly the AWWA) (2000) Handbooks. The two main activities in the table - water and wastewater - are divided into a number of general categories (Columns 1 and 3), which can be divided further using AWWA (1999) and AWA (2000) listings as subcategories (Columns 2 and 4). The AWA and AWWA Handbooks contain about 180 separate product and service listings. These have been simplified by not having subcategories for pipes, pumps and filters. The Aquatech compendium lists 18 general categories each for water, wastewater and stormwater. Table A.1 has reduced these various listings into 12 general categories. This has been done by combining similar listings. For example, asset management, auditing and benchmarking are categorised as management services. Stormwater is included under the wastewater category.

Table A.1 Categories and subcategories of water and wastewater technology goods and management services

<table>
<thead>
<tr>
<th>WATER general categories</th>
<th>Subcategories</th>
<th>WASTEWATER</th>
<th>Subcategories</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Consulting</td>
<td>*research and development into aspects of water management</td>
<td>1. Consulting</td>
<td>*research into wastewater management</td>
</tr>
<tr>
<td></td>
<td>* advice on plant design and management practices</td>
<td></td>
<td>*advice on plant design and management practices</td>
</tr>
<tr>
<td>2. Engineering design and construction</td>
<td>*design and planning for water treatment plants and component plants</td>
<td>2. Engineering design and construction</td>
<td>*design and planning for water treatment plants and component plants</td>
</tr>
<tr>
<td></td>
<td>*project management</td>
<td></td>
<td>*project management</td>
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<td>3. Package treatment systems</td>
<td></td>
<td>3. Package treatment systems</td>
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<tr>
<td></td>
<td>*filtration media</td>
<td></td>
<td>*screening and grit removal</td>
</tr>
<tr>
<td></td>
<td>*reverse osmosis</td>
<td></td>
<td>*aerators</td>
</tr>
<tr>
<td></td>
<td>*irrigation equipment such as nozzles, reticulation systems</td>
<td></td>
<td>*blowers</td>
</tr>
<tr>
<td></td>
<td>*desalination equipment</td>
<td></td>
<td>*centrifuges</td>
</tr>
<tr>
<td></td>
<td>*disinfection equipment</td>
<td></td>
<td>*mixers</td>
</tr>
<tr>
<td>5. Habitat treatment systems</td>
<td>*maintenance of existing wetlands for water polishing</td>
<td>5. Habitat treatment systems</td>
<td>*tanks</td>
</tr>
<tr>
<td></td>
<td>*fish ecology</td>
<td></td>
<td>*disinfection systems (UV)</td>
</tr>
<tr>
<td></td>
<td>*freshwater ecology</td>
<td></td>
<td>*gas dosing</td>
</tr>
<tr>
<td>6. Monitoring (equipment supplies)</td>
<td>*laboratory equipment supplies</td>
<td>6. Monitoring (equipment supplies)</td>
<td>*sludge dewatering, drying, thickening and removal equipment</td>
</tr>
<tr>
<td></td>
<td>*monitoring and measuring devices</td>
<td></td>
<td>*vermiculture (i.e. worm farming)</td>
</tr>
</tbody>
</table>
Table A.1 Categories and subcategories of water and wastewater technology goods and management services (continued)

<table>
<thead>
<tr>
<th>WATER general categories</th>
<th>Subcategories</th>
<th>WASTEWATER</th>
<th>Subcategories</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Monitoring (sampling and analysis)</td>
<td>*laboratory services and advice</td>
<td>7. Monitoring (sampling and analysis)</td>
<td>*laboratory services and advice</td>
</tr>
<tr>
<td>8. Miscellaneous equipment</td>
<td>*piping *pumps *power equipment *valves</td>
<td>8. Miscellaneous equipment</td>
<td>*pipes *pumps *valves *power equipment</td>
</tr>
<tr>
<td>9. Chemical supplies</td>
<td>*various gases (chlorine, ozone, fluorine) *chlorination equipment *ozone equipment *fluoridation equipment</td>
<td>9. Chemical supplies</td>
<td>*biocides *coagulants *flocculants *lime handling equipment *chemical handling equipment</td>
</tr>
<tr>
<td>10. Management services</td>
<td>*asset management *auditing *software design * training</td>
<td>10. Management services</td>
<td>*grey water/ reuse management *residuals (sludge) management *asset management *auditing</td>
</tr>
<tr>
<td>11. Operation and maintenance</td>
<td>*water plant maintenance process control maintenance</td>
<td>11. Operation and maintenance (including sewer maintenance)</td>
<td>*process control (including software design) *sewer repair and maintenance *stormwater repair and maintenance</td>
</tr>
<tr>
<td>12. Catchment management</td>
<td>*scientific research *consultancy</td>
<td>12. Effluent reuse</td>
<td>*treatment systems *reticulation systems</td>
</tr>
<tr>
<td>13. Industrial wastewater treatment equipment</td>
<td>*oil/fats/water separators *cyanide/arsenic and heavy metal removal *specialised industry waste removal (e.g. photographic waste removal)</td>
<td>14. Stormwater treatment equipment</td>
<td>*gross pollutant traps *alternative use equipment (rain tanks)</td>
</tr>
<tr>
<td>15. Stormwater design</td>
<td>*street design for collection *distribution design for watering parks and gardens *kerb design</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Discussion A. 1 Why certain activities are excluded from the definition of the water industry

The water industry - as defined in Section 4.1 - includes products and services directly related to the treatment and management of water and wastewater. There are activities that are not included: distribution and disposal systems, storage infrastructure and building hardware. The following discussion justifies why certain activities have been excluded from the definition.

*Concrete contractors, metal fabrication, road building, earth works and power supply installation are not considered directly related to water treatment because such activities are commonplace in other industries.

*Distribution and disposal systems encompass water mains pipes, stormwater canals and drains, sewer mains and sewerage systems. Such infrastructure often accounts for over 80% of water industry assets (AWWA 1998; WSAA 1998). However, distribution and disposal systems are not included as part of the water industry for this research. This is for logistic reasons and because these systems are not directly involved in water treatment. The provision of infrastructure is better categorised as part of the civil engineering and construction industry. This possibly is a controversial omission as publications usually consider infrastructure as part of the water industry (e.g. Aquatech 1996; OECD 1996; AWWA 1999; AWA 2000).

*Pipes are not included because of their ubiquity and non-specialist application. Also, pipes are generally not elaborately transformed manufactured products (notwithstanding the use of new types of plastics and robotic pipeline inspection and maintenance equipment). It is acknowledged that pipes are essential supply inputs for treatment equipment; however, they are not categorised separately for this research.

*Storage infrastructure (e.g. large scale water tanks, reservoirs and dams) while possibly considered as part of the wider water industry, can also be classified as part of the civil engineering and building and construction sectors. Also, there is an awareness of environmentally sustainable development in modern water management. Since the 1980s there has been less emphasis on dam construction in Australia (see Smith 1998: 182-5). Furthermore, water related aid projects have less enthusiasm for dam construction than in previous decades (Asian Development Bank 1994). The exclusion of dams from the definition is largely arbitrary, mainly intended to reflect a more sensitive environmental focus of water management.

*Building hardware such as water pipes, water heaters, swimming pools, bathtubs, taps, toilets and domestic sewerage systems are not included as these products are more satisfactorily classed as part of the building industry. This is also because these are not involved in the direct treatment of water. Providers of equipment for small scale on-site treatment have been included. Domestic water meters have been included due to their importance as monitoring devices for consumption patterns. Services such as plumbing, water meter readings and water supply connections are, however, not included.

*Bottled water is not included because this research is concerned with intermediate goods and services, not consumer products. There is a huge market for bottled water in Asia (Karp 1995), although Australian firms are not prominent. There are Australian firms that do export equipment used for the production of bottled water (such as ultraviolet disinfection equipment). This equipment is included because it comprises intermediate products that are directly used in water treatment.
### Appendix B (Chapter 5)

#### Table B.1 Listing (by category of activity) of research sample of firms and organisations

<table>
<thead>
<tr>
<th>Category of activity; firm-size; identification code</th>
<th>Exp- orter</th>
<th>Name and location of firm</th>
<th>Method of contact: survey or interview</th>
<th>Date of interview or survey return</th>
<th>Professional position of participant</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MANUFACTURING FIRMS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pumps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*small (1)</td>
<td>1</td>
<td>SIHI Pumps Australia Pty Ltd (The Sterling Group), Bayswater VIC</td>
<td>Survey</td>
<td>23/6/99</td>
<td>Water industry manager</td>
</tr>
<tr>
<td>*small (2)</td>
<td>0</td>
<td>Iwaki Pumps, Castle Hill NSW</td>
<td>Survey</td>
<td>18/8/00</td>
<td>NSW sales manager</td>
</tr>
<tr>
<td>*med (3)</td>
<td>0</td>
<td>ITT Flygt Pumps Limited, Parramatta NSW</td>
<td>Survey</td>
<td>9/9/99</td>
<td>Marketing manager</td>
</tr>
<tr>
<td>*med (4)</td>
<td>0</td>
<td>Grundfos Pumps Pty Ltd, Regency Park SA</td>
<td>Survey</td>
<td>5/10/99</td>
<td>National product manager</td>
</tr>
<tr>
<td>*med (5)</td>
<td>1</td>
<td>Mono Pumps (Australia) Pty Ltd, Mordialloc VIC</td>
<td>Survey</td>
<td>1/6/99</td>
<td>Business development manager</td>
</tr>
<tr>
<td>*large (6)</td>
<td>1</td>
<td>Thompsons, Kelly &amp; Lewis Pty Ltd, Springvale VIC</td>
<td>Survey</td>
<td>5/10/99</td>
<td>Sales and marketing manager</td>
</tr>
<tr>
<td><strong>Valves</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*small (7)</td>
<td>1</td>
<td>Airvac-RSM Pty Ltd, Willoughby NSW</td>
<td>Survey</td>
<td>17/9/99</td>
<td>Director</td>
</tr>
<tr>
<td>*large (8)</td>
<td>1</td>
<td>Keystone Tyco Flow Control, Nowra NSW</td>
<td>Survey</td>
<td>11/10/99</td>
<td>Marketing development manager</td>
</tr>
<tr>
<td>*large (9)</td>
<td>1</td>
<td>Reliance Manufacturing Company, Fortitude Valley QLD</td>
<td>Survey</td>
<td>20/10/99</td>
<td>Business development manager</td>
</tr>
<tr>
<td><strong>Treatment chemicals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*small (10)</td>
<td>1</td>
<td>Tabco Pty Ltd, Dandenong South VIC</td>
<td>Survey</td>
<td>7/6/99 (also included a phone interview)</td>
<td>Manager</td>
</tr>
<tr>
<td>*small (11)</td>
<td>0</td>
<td>Austin Chemical Company Pty Ltd, Miranda NSW</td>
<td>Survey</td>
<td>22/6/99</td>
<td>Marketing manager</td>
</tr>
<tr>
<td>*small (12)</td>
<td>1</td>
<td>Hydrochem Pty Ltd, Cheltenham VIC</td>
<td>Survey</td>
<td>17/9/99</td>
<td>Manager</td>
</tr>
<tr>
<td>*small (13)</td>
<td>1</td>
<td>SNF (Australia) Pty Ltd, Balcatta WA</td>
<td>Survey</td>
<td>15/6/99</td>
<td>Business development manager</td>
</tr>
<tr>
<td>*small (14)</td>
<td>0</td>
<td>Aluminates Chemical Industries Group, Port Melbourne VIC</td>
<td>Survey</td>
<td>27/5/99</td>
<td>General manager</td>
</tr>
<tr>
<td>*med (15)</td>
<td>0</td>
<td>Elf Autochem (Australia) Pty Ltd, Dandenong South VIC</td>
<td>Survey</td>
<td>11/10/99</td>
<td>Strategy and marketing manager</td>
</tr>
<tr>
<td>*med (16)</td>
<td>1</td>
<td>Ciba Specialty Chemicals, Wyong NSW</td>
<td>Survey</td>
<td>29/8/99</td>
<td>National sales manager</td>
</tr>
<tr>
<td>*large (17)</td>
<td>1</td>
<td>Albright and Wilson (Australia) Limited, Yarraville VIC</td>
<td>Survey</td>
<td>9/6/99</td>
<td>Marketing manager</td>
</tr>
<tr>
<td>*large (18)</td>
<td>1</td>
<td>Orica Watercare, Ascot Vale VIC</td>
<td>Interview/survey</td>
<td>10/3/99</td>
<td>Business development manager</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

**Wastewater biological control products**

| *small (19) | 0 | HydroCare Australia Pty Ltd, Seven Hills NSW | Survey | 17/9/99 | General manager |
| *small (20) | 1 | Southern Cross Laboratories, Dural NSW | Survey | 4/10/99 | General manager |

**Monitoring instruments**

<p>| *small (21) | 0 | Action Instrumentation and Controls, Jindalee QLD | Survey | 15/10/99 | Managing director |
| *small (22) | 0 | Pacific Dynamics Pty Ltd, Artarmon NSW | Survey | 19/10/99 | Managing director |
| *small (23) | 0 | Extech Equipment Pty Ltd, Boronia VIC | Survey | 25/5/99 | Managing director |
| *small (24) | 1 | Measuring and Control Equipment Limited, Pennant Hills NSW | Survey | 12/10/00 | Director |
| *small (25) | 1 | Mindata Australia Pty Ltd, Seafor VIC | Survey | 25/5/99 | Business development manager |
| *small (26) | 1 | Pryde Measurement Pty Ltd, Ashburton VIC | Survey | 18/6/99 | Business development manager |
| *small (27) | 1 | Combined Instrument Systems, Ringwood VIC | Interview | 21/5/99 | Managing director |
| *med (28) | 1 | Hawk Measurement Systems Pty Ltd, Nunawading VIC | Survey | 26/8/99 | Managing director |
| *med (29) | 1 | Greenspan Technology Pty Ltd, Warwick QLD | Survey | 23/9/99 | CEO: business |
| *med (30) | 1 | John Morris Scientific Pty Ltd, Chatswood NSW | Survey | 30/9/99 | Product manager: environmental |
| *med (31) | 0 | ABB Instrumentation Pty Ltd, Taren Point NSW | Survey | 21/6/99 | General manager |
| *med (32) | 0 | Radiometer Pacific Pty Ltd, Nunawading VIC | Survey | 3/6/99 | National marketing co-ordinator |</p>
<table>
<thead>
<tr>
<th>Category of activity; firm-size, identification code</th>
<th>Exp.</th>
<th>Name and location</th>
<th>Method of contact</th>
<th>Date of interview or survey return</th>
<th>Professional position of participant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water treatment equipment (including gas/chemical dosing/O3/Cl equipment)</td>
<td>*small (33)</td>
<td>0 Aquacure Water Treatment, Dutton Park QLD</td>
<td>Survey</td>
<td>21/9/00</td>
<td>Director</td>
</tr>
<tr>
<td></td>
<td>*small (34)</td>
<td>1 Index Group, Carole Park QLD</td>
<td>Survey</td>
<td>11/10/00</td>
<td>Managing director</td>
</tr>
<tr>
<td></td>
<td>*small (35)</td>
<td>1 ArabAust Watertek, West Perth WA</td>
<td>Interview</td>
<td>9/7/98</td>
<td>Owner/manager</td>
</tr>
<tr>
<td></td>
<td>*small (36)</td>
<td>0 Hydramet Pty Ltd, Canning Vale WA</td>
<td>Survey</td>
<td>22/10/99</td>
<td>Managing director</td>
</tr>
<tr>
<td></td>
<td>*small (37)</td>
<td>1 Citcor Pty Ltd, Fremantle WA</td>
<td>Interview</td>
<td>10/7/98</td>
<td>Owner/manager</td>
</tr>
<tr>
<td></td>
<td>*small (38)</td>
<td>1 Aquagenics Pty Ltd, Smithfield NSW</td>
<td>Survey</td>
<td>16/10/99</td>
<td>Managing director</td>
</tr>
<tr>
<td></td>
<td>*small (39)</td>
<td>1 Bran + Luebbe Pty Ltd, Silverwater NSW</td>
<td>Survey</td>
<td>5/10/99</td>
<td>Managing director</td>
</tr>
<tr>
<td></td>
<td>*med (40)</td>
<td>1 Ionics Watertec Pty Ltd, Darra QLD</td>
<td>Survey</td>
<td>1/12/99</td>
<td>Managing director</td>
</tr>
<tr>
<td></td>
<td>*med (41)</td>
<td>0 ProMinent &amp; Fluid Controls Pty Ltd, Brookvale NSW</td>
<td>Survey</td>
<td>11/10/99</td>
<td>Director: marketing</td>
</tr>
<tr>
<td></td>
<td>*med (42)</td>
<td>1 Wallace &amp; Tiernan Pacific Pty Ltd, Artarmon NSW</td>
<td>Survey</td>
<td>20/10/99</td>
<td>Managing director</td>
</tr>
<tr>
<td>UV disinfection equipment</td>
<td>*small (43)</td>
<td>1 Australian Ultra Violet Service (Operations) Pty Ltd Thomastown, VIC</td>
<td>Survey</td>
<td>20/12/98</td>
<td>Manager</td>
</tr>
<tr>
<td></td>
<td>* small (44)</td>
<td>1 Ultraviolet Technology of Australasia Pty Ltd, Marden SA</td>
<td>Interview</td>
<td>1/6/00</td>
<td>Sales manager</td>
</tr>
<tr>
<td>Filters; filtration medium</td>
<td>*small (45)</td>
<td>0 Process &amp; Pollution Control, Kedron QLD</td>
<td>Survey</td>
<td>4/10/99</td>
<td>Manager</td>
</tr>
<tr>
<td></td>
<td>*small (46)</td>
<td>0 Swan Filtration, Osborne Park WA</td>
<td>Survey &amp; interview</td>
<td>9/7/98</td>
<td>Manager/owner</td>
</tr>
<tr>
<td></td>
<td>*small (47)</td>
<td>1 Leyton House Industries Pty Ltd, Brighton VIC</td>
<td>Survey</td>
<td>7/6/99</td>
<td>Manager/owner</td>
</tr>
<tr>
<td></td>
<td>*small (48)</td>
<td>1 Walker Filtration Pty Ltd, Eltham VIC</td>
<td>Survey</td>
<td>10/6/99</td>
<td>Sales manager</td>
</tr>
<tr>
<td></td>
<td>*small (49)</td>
<td>1 PICA Australia, Eltham VIC</td>
<td>Survey</td>
<td>15/6/99</td>
<td>Managing director</td>
</tr>
<tr>
<td></td>
<td>*small (50)</td>
<td>1 Haycarb Holdings Australia Pty Ltd, Glen Waverley VIC</td>
<td>Survey</td>
<td>15/6/99</td>
<td>Sales manager</td>
</tr>
<tr>
<td></td>
<td>*small (51)</td>
<td>1 Zeolite, Melbourne (city) VIC</td>
<td>Interview</td>
<td>29/3/99</td>
<td>Business development manager</td>
</tr>
<tr>
<td></td>
<td>*med (52)</td>
<td>1 Amiad Australia Pty Ltd, Eltham VIC</td>
<td>Survey</td>
<td>10/6/99</td>
<td>Managing director</td>
</tr>
<tr>
<td></td>
<td>*med (53)</td>
<td>1 River Sands Pty Ltd, Loganholme QLD</td>
<td>Survey</td>
<td>27/9/99</td>
<td>Sales manager</td>
</tr>
<tr>
<td></td>
<td>*med (54)</td>
<td>1 Cuno Pacific Pty Ltd, Blacktown NSW</td>
<td>Survey</td>
<td>27/9/99</td>
<td>Marketing manager</td>
</tr>
<tr>
<td>*Lrg (55)</td>
<td>1</td>
<td>US Filter (USF Memcor) Limited, Windsor NSW</td>
<td>Interview</td>
<td>13/7/99</td>
<td>Engineering manager</td>
</tr>
<tr>
<td>---</td>
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<td>---</td>
</tr>
<tr>
<td><strong>Wastewater treatment equipment:</strong> aerators, air diffusers, blowers, centrifuges, clarifiers, dryers, mixers, sludge dewatering/thickening/drying/handling equipment; also stormwater litter traps,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*small (56)</td>
<td>1</td>
<td>EpcoAustralia, Sumner Park QLD</td>
<td>Survey</td>
<td>19/9/00</td>
<td>Managing director</td>
</tr>
<tr>
<td>*small (57)</td>
<td>1</td>
<td>Patrick, Charles Pty Ltd, Crows Nest NSW</td>
<td>Survey</td>
<td>11/10/99</td>
<td>Director</td>
</tr>
<tr>
<td>*small (58)</td>
<td>0</td>
<td>Andritz Pty Ltd, Dandenong VIC</td>
<td>Survey</td>
<td>26/5/99</td>
<td>Regional sales manager</td>
</tr>
<tr>
<td>*small (59)</td>
<td>1</td>
<td>Tuthill Australia Pty Ltd, Kilsyth VIC</td>
<td>Survey</td>
<td>11/6/99</td>
<td>Sales and marketing manager</td>
</tr>
<tr>
<td>*small (60)</td>
<td>1</td>
<td>Ecosol Group, Adelaide SA</td>
<td>Survey</td>
<td>18/10/00</td>
<td>National marketing manager</td>
</tr>
<tr>
<td>*med (61)</td>
<td>1</td>
<td>CDS Technologies, Mornington VIC</td>
<td>Interview</td>
<td>20/5/99</td>
<td>National sales manager</td>
</tr>
<tr>
<td>*med (62)</td>
<td>1</td>
<td>Lightnin Mixers Pty Ltd, Regents Park NSW</td>
<td>Survey</td>
<td>20/10/99</td>
<td>Marketing director</td>
</tr>
<tr>
<td>*med (63)</td>
<td>0</td>
<td>Westfalia Separator Australia, Tullamarine VIC</td>
<td>Survey</td>
<td>15/6/99</td>
<td>Environment products engineer</td>
</tr>
<tr>
<td>*med (64)</td>
<td>1</td>
<td>Aquatec-Maxcon Pty Ltd, North Ryde NSW</td>
<td>Interview</td>
<td>28/7/99</td>
<td>Product manager</td>
</tr>
<tr>
<td>*med (65)</td>
<td>1</td>
<td>Supaflo Technologies Pty Ltd, Frenchs Forest NSW</td>
<td>Survey</td>
<td>11/10/99</td>
<td>Manager: environmental engineering</td>
</tr>
<tr>
<td>*med (66)</td>
<td>0</td>
<td>Alfa Laval Pty Ltd, Homebush Bay NSW</td>
<td>Survey</td>
<td>20/9/99</td>
<td>Sales manager</td>
</tr>
<tr>
<td>*med (67)</td>
<td>1</td>
<td>SPIRAC Engineering Pty Ltd, Bibra Lake WA</td>
<td>Survey</td>
<td>17/8/00</td>
<td>Managing director</td>
</tr>
<tr>
<td>Category of activity; firm-size; identification code</td>
<td>Exp</td>
<td>Name and location</td>
<td>Method of contact</td>
<td>Date of interview or survey return</td>
<td>Professional position of participant</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>-----</td>
<td>-------------------</td>
<td>------------------</td>
<td>-----------------------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td><strong>Wastewater treatment:</strong> onsite package plants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*small (68)</td>
<td>0</td>
<td>Aeration Treatment Systems, Brisbane Markets QLD</td>
<td>Survey</td>
<td>4/10/99</td>
<td>Director</td>
</tr>
<tr>
<td>*small (69)</td>
<td>1</td>
<td>Biomax Pty Ltd, Balcatta WA</td>
<td>Survey</td>
<td>20/10/99</td>
<td>Sales and marketing manager</td>
</tr>
<tr>
<td>*small (70)</td>
<td>1</td>
<td>Enviroflow Wastewater Treatment, Rocklea Junction QLD</td>
<td>Survey</td>
<td>18/9/00</td>
<td>Managing director</td>
</tr>
<tr>
<td><strong>Wastewater treatment:</strong> specialist biological process treatment</td>
<td></td>
<td></td>
<td></td>
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<td>Interview</td>
<td>9/7/98</td>
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<td>Survey</td>
<td>15/8/99</td>
<td>Manager</td>
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<td><strong>Waste water industrial treatment equipment:</strong> oil/ water separation, heavy metal removal</td>
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<td>Survey</td>
<td>9/6/99</td>
<td>Marketing manager</td>
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<td>Survey</td>
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<td>Survey</td>
<td>23/9/00</td>
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<td>Interview</td>
<td>28/5/99</td>
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<td>Date of interview or survey return</td>
<td>Professional position of participant</td>
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<td>Survey 15/10/99</td>
<td>Manager Victoria</td>
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<td>Director: environmental engineering/ water resources</td>
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<td>Interview 15/2/99</td>
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<td>Method of contact</td>
<td>Date of interview or survey return</td>
<td>Professional position of participant</td>
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<td>Interview</td>
<td>3/6/99</td>
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<td>1/7/99</td>
<td>Principal engineer</td>
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<td>Manager: international projects</td>
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<td>15/2/99</td>
<td>Manager: Vic, TAS, SA</td>
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<td>Snowy Mountain Engineering Corporation, Hartwell VIC</td>
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<td>13/10/00</td>
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<td>*lrg (103a)</td>
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<td>Survey</td>
<td>20/10/99</td>
<td>Manager water and environmental</td>
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<td>*lrg (103b)</td>
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<td>Kinhill Pty Ltd (SA branch) Head office, Parkside SA</td>
<td>Survey</td>
<td>15/10/99</td>
<td>Manager water and wastewater</td>
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<td>Survey</td>
<td>1/12/99</td>
<td>Manager water</td>
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<td>Survey</td>
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<td>Interview</td>
<td>17/2/99</td>
<td>Proposals manager</td>
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<td>Survey</td>
<td>25/11/99</td>
<td>Business development manager</td>
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<tr>
<td>*large (108)</td>
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<td>Australian Water Technologies, Sydney (city) NSW</td>
<td>Interview</td>
<td>15/7/99</td>
<td>General manager: strategic planning</td>
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<td>Interview</td>
<td>19/5/99</td>
<td>Laboratory/ operations manager</td>
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<td>WSL Consultants, Richmond VIC</td>
<td>Survey</td>
<td>17/8/00</td>
<td>Director bioscience &amp; business development</td>
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<td>*med (111)</td>
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<td>MGT Environmental Consulting, Oakleigh VIC</td>
<td>Survey</td>
<td>17/10/00</td>
<td>Operations manager</td>
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<td>Management/operations/BOOT operators</td>
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<td>Interview</td>
<td>7/7/99</td>
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<td>Deputy chief executive</td>
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<td>*small (119)</td>
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<td>Name and location of organisation</td>
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<td>Date of interview or survey return</td>
<td>Professional position of participant</td>
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<td>Interview</td>
<td>12/7/99</td>
<td>Executive director</td>
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<td>Executive director</td>
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<td>2/6/00</td>
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<td>Interview</td>
<td>24/8/99</td>
<td>Director</td>
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<td>Research Institutions (government funded)</td>
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<td>Interview</td>
<td>4/2/99</td>
<td>Business development manager</td>
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<td>Interview</td>
<td>24/8/99</td>
<td>Director</td>
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<td>(126)</td>
<td>1 CRC Waste Management &amp; Pollution Control, Kensington NSW</td>
<td>Interview</td>
<td>7/7/99</td>
<td>Business development manager: intern- national</td>
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<td>Government Departments</td>
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<td>(127)</td>
<td>n/a Environment Australia, Canberra ACT</td>
<td>Interview</td>
<td>25/8/99</td>
<td>Person 1: Assistant director</td>
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<td>Environment Industries Focus Unit (EIFU); Person 2: Manager EIFU</td>
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<td>Interview</td>
<td>24/8/99</td>
<td>Director infrastructure development</td>
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</table>
Appendix B (continued)

Display B.1 Survey questionnaires

The following displays show three different survey designs, corresponding to Versions 1, 2 and 3 (see Table 5.2 for details of the differences). Note that Version 3 contains separate surveys for manufacturers and service providers.
Appendix B (continued)

Display B.2 Interview questionnaires

Examples of different interview questionnaires are shown. Note how some questions vary depending on the type of organisation.
Appendix B (continued)

Display B.3 Cover letters

Examples of the official university permission letter and cover letters are displayed. Notice how the cover letters evolve over the course of the research. Latter versions contain specific references to the firm or organisation concerned.
Appendix B (continued)

Display B.4 Interview transcript

This display shows an example of an interview transcript. The interviews were transcribed from the tape and then the material was organised into themes, as indicated by the sub-headings in the transcription. Other than rearranging the content, editing was kept minimal. Transcripts were generally sent to participants, with the option of correcting the information if they wished. No participants had any objections to quotations being used.
Appendix C (Chapter 6)

Table C.1 shows that the degree of severity of the 1998 Asian downturn (as a rating out of 5 for extreme impact). Notice how the impact does not vary for different size firms.

Table C.1 Asian downturn by firm size

<table>
<thead>
<tr>
<th>Asian downturn overall</th>
<th>Small firms Asian crisis</th>
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<tbody>
<tr>
<td><strong>Mean</strong> 2.8375</td>
<td><strong>Mean</strong> 2.514286</td>
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<tr>
<td><strong>Standard Error</strong> 0.123816</td>
<td><strong>Standard Error</strong> 0.185034</td>
</tr>
<tr>
<td><strong>Median</strong> 3</td>
<td><strong>Median</strong> 3</td>
</tr>
<tr>
<td><strong>Mode</strong> 3</td>
<td><strong>Mode</strong> 3</td>
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<tr>
<td><strong>Standard Deviation</strong> 1.10744</td>
<td><strong>Standard Deviation</strong> 1.094678</td>
</tr>
<tr>
<td><strong>Sample Variance</strong> 1.226424</td>
<td><strong>Sample Variance</strong> 1.198319</td>
</tr>
<tr>
<td><strong>Skewness</strong> -0.18567</td>
<td><strong>Skewness</strong> -0.18123</td>
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<tr>
<td><strong>Range</strong> 4</td>
<td><strong>Range</strong> 3</td>
</tr>
<tr>
<td><strong>Minimum</strong> 1</td>
<td><strong>Minimum</strong> 1</td>
</tr>
<tr>
<td><strong>Maximum</strong> 5</td>
<td><strong>Maximum</strong> 4</td>
</tr>
<tr>
<td><strong>Sum</strong> 227</td>
<td><strong>Sum</strong> 88</td>
</tr>
<tr>
<td><strong>Count</strong> 80</td>
<td><strong>Count</strong> 35</td>
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</table>

<table>
<thead>
<tr>
<th>Medium size firms Asian crisis</th>
<th>Large firms Asian crisis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong> 2.896552</td>
<td><strong>Mean</strong> 3.4375</td>
</tr>
<tr>
<td><strong>Standard Error</strong> 0.212566</td>
<td><strong>Standard Error</strong> 0.203485</td>
</tr>
<tr>
<td><strong>Median</strong> 3</td>
<td><strong>Median</strong> 3</td>
</tr>
<tr>
<td><strong>Mode</strong> 3</td>
<td><strong>Mode</strong> 3</td>
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<tr>
<td><strong>Standard Deviation</strong> 1.144703</td>
<td><strong>Standard Deviation</strong> 0.813941</td>
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<tr>
<td><strong>Sample Variance</strong> 1.310345</td>
<td><strong>Sample Variance</strong> 0.6625</td>
</tr>
<tr>
<td><strong>Kurtosis</strong> -0.63962</td>
<td><strong>Kurtosis</strong> 0.132385</td>
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<tr>
<td><strong>Skewness</strong> -0.09159</td>
<td><strong>Skewness</strong> 0.652378</td>
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<tr>
<td><strong>Range</strong> 4</td>
<td><strong>Range</strong> 3</td>
</tr>
<tr>
<td><strong>Minimum</strong> 1</td>
<td><strong>Minimum</strong> 2</td>
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<tr>
<td><strong>Maximum</strong> 5</td>
<td><strong>Maximum</strong> 5</td>
</tr>
<tr>
<td><strong>Sum</strong> 84</td>
<td><strong>Sum</strong> 55</td>
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<tr>
<td><strong>Count</strong> 29</td>
<td><strong>Count</strong> 16</td>
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</table>
Appendix D (Chapter 7)

Figure D.1 Relationship between competitiveness (turnover per employee) and export proportion (N = 57)

Export proportion = 0.2 – 0.02 (turnover/employee)

Regression analysis

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<thead>
<tr>
<th>Variable</th>
<th>Result</th>
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<td>Proportion of total variance</td>
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</tr>
<tr>
<td>$F (1, 55)$ value = 0.01</td>
<td>$p = 0.9$</td>
</tr>
<tr>
<td>Turnover per employee (A$ M)</td>
<td>$p = 0.9$</td>
</tr>
</tbody>
</table>
Appendix D (Chapter 7)

It is assumed that large firms are generally old, and small firms are young. The context of the argument (Section 7.1.2) is that older and larger firms are expected to have more experience and resources to enter export markets than younger and smaller firms. The result shown in Table D.1 suggests a strong correlation between firm-size and age. The pattern also is evident in Table D.2. One third of small firms are less than 10 years old; one-fifth are older than 25 years. For large firms, one-fifth are less than a decade old; three-quarters are older than 25 years.

Table D.1 Relationship between firm-size and age for exporting firms

<table>
<thead>
<tr>
<th>Correlations</th>
<th>AGE</th>
<th>TURNOVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE Pearson Correlation</td>
<td>1</td>
<td>.300**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.</td>
<td>.006</td>
</tr>
<tr>
<td>N</td>
<td>85</td>
<td>83</td>
</tr>
<tr>
<td>TURNOVER Pearson Correlation</td>
<td>.300**</td>
<td>1</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.006</td>
<td>.</td>
</tr>
<tr>
<td>N</td>
<td>83</td>
<td>88</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

Table D.2 Number of exporting firms by size in different age categories

<table>
<thead>
<tr>
<th>Size category</th>
<th>No. of firms established before 1975; after 1990</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 81 (5 unknown)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small firms N = 36</td>
<td>7 &lt; 1975 out of 36</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>12 &gt; 1990 out of 36</td>
<td>33</td>
</tr>
<tr>
<td>Medium firms N = 28</td>
<td>9 &lt; 1975 out of 28</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>7 &gt; 1990 out of 28</td>
<td>25</td>
</tr>
<tr>
<td>Large firms N = 17</td>
<td>13 &lt; 1975 out of 17</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>3 &gt; 1990 out of 17</td>
<td>18</td>
</tr>
</tbody>
</table>
Figure E.1 Relationship between R&D proportion and export proportion  
N = 50 firms (exporters only)

Export proportion \(= 0.16 + 0.27 \times \text{(R&D proportion)}\)

Spearman’s \(\rho\) test \((r_s = 0.24; p = 0.09; N = 50)\)  (Note: Spearman’s rho is used because it is a distribution-free test. The result is the same on both raw and log transformed data.)
Table E.1 Regression analysis for export proportion (dependent variable) and R&D proportion (independent variable)  (N = 50) (exporters only)  (to accompany Figure E.1)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>Adjusted $R^2 = 0.05$</td>
</tr>
<tr>
<td>$F (1, 48)$ value = 3.64</td>
<td>$p = 0.06$</td>
</tr>
<tr>
<td>R&amp;D proportion</td>
<td>$p = 0.06$</td>
</tr>
</tbody>
</table>
Figure E.2 Relationship between patent proportion and export proportion
N = 50 (exporters only)

Export proportion = 0.19 + 0.01*(patent proportion)

Spearman’s ρ test ($r_s = 0.17; p = 0.23; n = 50$)

Table E.2 Regression analysis for export proportion (dependent variable) and patent proportion (independent variable)  N = 50 (exporters only) (to accompany Figure E.2)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>adjusted $R^2 = -0.02$</td>
</tr>
<tr>
<td>$F (1, 48)$ value = 0.007</td>
<td>$P = 0.93$</td>
</tr>
<tr>
<td>patent proportion</td>
<td>$P = 0.93$</td>
</tr>
</tbody>
</table>
Table E.3 Multiple regression analysis for export proportion (dependent variable) and R&D proportion and patent proportion (independent variables)  
N = 50 (exporters only)  

Export proportion = 0.17 + 0.28*(R&D proportion) – 0.06*(patent proportion)  

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>adjusted $R^2 = 0.03$</td>
</tr>
<tr>
<td>F (2, 47) value = 1.87</td>
<td>$p = 0.17$</td>
</tr>
<tr>
<td>R&amp;D per turnover</td>
<td>$p = 0.06$</td>
</tr>
<tr>
<td>Patents per turnover</td>
<td>$p = 0.68$</td>
</tr>
</tbody>
</table>

*Source:* see Table 8.2.  

(Note: there is no Figure E.3)
Figure E.4a Relationship between turnover (i.e. firm-size) and R&D proportion
(2 outliers with large turnovers eliminated) N = 75 (exporters & non-exporters)
Figure E.4b Relationship between turnover and R & D proportion (magnification of smaller values in Figure E.4a) (exporters & non-exporters)

Spearman’s ρ test ($r_s = -0.15; p = 0.2; N = 75$)

Table E.4 Regression analysis for R&D proportion (dependent variable) and turnover (independent variable) (N = 75)
(to accompany Figures E.4a & E.4b)

R&D proportion = $-0.08 - 0.15 \times \text{turnover}$

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>adjusted $R^2 = 0.01$</td>
</tr>
<tr>
<td>$F$ (1, 73) value = 1.72</td>
<td>$p = 0.19$</td>
</tr>
<tr>
<td>Turnover (A$ \text{M}$)</td>
<td>$p = 0.19$</td>
</tr>
</tbody>
</table>
Figure E.5a Relationship between turnover and R&D expenditure
N = 77 (exporters & non-exporters)
Figure E.5b Relationship between turnover and R&D expenditure
(magnification of smaller values in Figure E.5a) (exporters & non-exporters)

Spearman’s ρ test ($r_s = 0.38; p < 0.01$ **; $N = 77$)

Table E.5 Regression analysis for R&D expenditure (dependent variable) and
turnover (independent variable) ($N = 77$)
(to accompany Figures E.5a & E.5b)

R & D expenditure = 0.08 + 0.79*(turnover)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>adjusted $R^2 = 0.62$</td>
</tr>
<tr>
<td>F (1, 75) value = 126.9</td>
<td>$p &lt; 0.01$ **</td>
</tr>
<tr>
<td>Turnover (A$M$)</td>
<td>$p &lt; 0.01$ **</td>
</tr>
</tbody>
</table>

Note:
1. ** denotes significance at $p < 1\%$. Not to be confused with an asterisk between coefficients [e.g. $0.79^\ast$*(turnover)] indicating a multiplication sign ($\ast$).
Figure E.6 Relationship between turnover and proportion of patents
(1 outlier with large turnover eliminated) N = 76 (exporters & non-exporters)

Patent proportion = 0.61 – 0.06*(turnover)

Spearman’s ρ test ($r_s = 0.23; p = 0.06; N = 76$)

Table E.6 Regression analysis for proportion of patents (dependent variable) and turnover (independent variables) (N = 76)
(to accompany Figure E.6)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>adjusted $R^2 = -0.01$</td>
</tr>
<tr>
<td>F (1, 74) value = 0.24</td>
<td>$p = 0.62$</td>
</tr>
<tr>
<td>Turnover (A$ M)</td>
<td>$p = 0.62$</td>
</tr>
</tbody>
</table>
Figure E.7 Relationship between turnover and no. of patents N = 75 (2 outliers eliminated) (exporters & non-exporters)

![Graph showing the relationship between turnover in $M and the number of patents.]

Spearman’s ρ test ($r_s = 0.38$; $p < 0.01$; N = 75)

Table E.7 Regression analysis for no. of patents (dependent variable) and turnover (independent variables) (N = 75)
(to accompany Figure E.7)

No. of patents = 2.65 + 0.41*(turnover)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>adjusted $R^2 = 0.16$</td>
</tr>
<tr>
<td>F (1, 73) value = 15.19</td>
<td>$p &lt; 0.01$ **</td>
</tr>
<tr>
<td>Turnover (A$ M)</td>
<td>$p &lt; 0.01$ **</td>
</tr>
</tbody>
</table>
Table E.8 Regression analysis for export proportion (dependent variable) and R&D proportion, patent proportion and turnover (independent variables)  
(N = 21) (exporters only) (log transformed)

\[
\ln \text{Export proportion} = -1.25 + 0.34 \ln \text{R&D proportion} + 0.06 \ln \text{turnover} + 0.03 \ln \text{patent proportion}
\]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>( R^2 = -0.05 )</td>
</tr>
<tr>
<td>( F ) (3, 17) value = 0.70</td>
<td>( p = 0.57 )</td>
</tr>
<tr>
<td>R&amp;D proportion (log transformed)</td>
<td>( p = 0.18 )</td>
</tr>
<tr>
<td>Turnover (A$ M) (log transformed)</td>
<td>( p = 0.84 )</td>
</tr>
<tr>
<td>Patent proportion (log transformed)</td>
<td>( p = 0.91 )</td>
</tr>
</tbody>
</table>

Table E.9 Regression analysis for export proportion (dependent variable) and R&D proportion and turnover (independent variables)  
(N = 21) (exporters only) (log transformed)  
(Note this test deliberately does not use patent proportion so a larger sample size is retained)

\[
\ln \text{Export proportion} = -0.89 + 0.46 \ln \text{R&D proportion} + 0.03 \ln \text{turnover}
\]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>( R^2 = 0.17 )</td>
</tr>
<tr>
<td>( F ) (2, 36) value = 4.74</td>
<td>( p &lt; 0.01 ** )</td>
</tr>
<tr>
<td>R&amp;D proportion (log transformed)</td>
<td>( p &lt; 0.01 ** )</td>
</tr>
<tr>
<td>Turnover (A$ M) (log transformed)</td>
<td>( p = 0.85 )</td>
</tr>
</tbody>
</table>

Table E.10 Multiple regression analysis for turnover per employee (dependent variable) and innovation proxies (independent variables)  
(N = 75) (exporters & non-exporters)

Turnover per employee = 0.34 + 0.13*(patent proportion) – 0.10*(R&D)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>( R^2 = -0.003 )</td>
</tr>
<tr>
<td>( F ) (2, 72) value = 0.88</td>
<td>( p = 0.42 )</td>
</tr>
<tr>
<td>Patent proportion</td>
<td>( p = 0.27 )</td>
</tr>
<tr>
<td>R&amp;D proportion</td>
<td>( p = 0.42 )</td>
</tr>
</tbody>
</table>
Table E.11 Multiple regression analysis for turnover per employee (dependent variable) and innovation proxies and turnover (independent variables) (N = 21) (exporters & non-exporters) (log transformed)

\[ \ln \text{Turnover per employee} = -1.52 + 0.34 \times (\ln \text{turnover}) - 0.15 \times (\ln \text{patent proportion}) + 0.14 \times (\ln \text{R&D}) \]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>Adjusted R^2 = 0.06</td>
</tr>
<tr>
<td>F (3, 17) value = 1.40</td>
<td>p = 0.28</td>
</tr>
<tr>
<td>Turnover (log transformed)</td>
<td>p = 0.25</td>
</tr>
<tr>
<td>Patent proportion (log transformed)</td>
<td>p = 0.60</td>
</tr>
<tr>
<td>R&amp;D proportion (log transformed)</td>
<td>p = 0.55</td>
</tr>
</tbody>
</table>

Table E.12 Multiple regression analysis for turnover per employee (dependent variable) and innovation proxies only (independent variables) (N = 21) (exporters and non-exporters) (log transformed)

\[ \ln \text{Turnover per employee} = -1.27 - 0.36 \times (\ln \text{patent proportion}) + 0.09 \times (\ln \text{R&D}) \]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>adjusted R^2 = 0.03</td>
</tr>
<tr>
<td>F (2, 18) value = 1.35</td>
<td>p = 0.29</td>
</tr>
<tr>
<td>Patent proportion (log transformed)</td>
<td>p = 0.13</td>
</tr>
<tr>
<td>R&amp;D proportion (log transformed)</td>
<td>p = 0.69</td>
</tr>
</tbody>
</table>
Appendix F (Chapter 11)

Multiple regression analysis on variables

This test is to find out if export proportion can be explained by the empirical variables that use ratio data. These are combined into a multiple regression analysis. All exporters (manufacturers and service providers) are included. Export proportion is the dependent variable; turnover (as a proxy for size), age, R & D proportion, patent proportion and turnover per employee (as a proxy for competitiveness) are the independent variables. The result is non-significant (adjusted $R^2 = 0.02$; $F (5, 50) = 1.18$; $p = 0.33$; $N = 56$) (Table F.1). Because patent proportions have a large amount of zero values, the test is run again eliminating this variable. The result remains non-significant (adjusted $R^2 = 0.03$; $F (4, 51) = 1.45$; $p = 0.23$; $N = 56$) (Table F.2). Table 11.3 (p. 287) indicates that log transformation of the raw data (with patents eliminated) does produce a significant result. Even then, the amount of variance in export proportion explained by the independent variables is only 15%.

Table F.1 Multiple regression analysis for export proportion (dependent variable); turnover, age, turnover per employee, R & D proportion and patent proportion (independent variables) $(N = 56)$

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>adjusted $R^2 = 0.02$</td>
</tr>
<tr>
<td>$F (5, 50)$ value $= 1.18$</td>
<td>$p = 0.33$</td>
</tr>
<tr>
<td>R &amp; D proportion (per turnover)</td>
<td>$p = 0.09$</td>
</tr>
<tr>
<td>Age</td>
<td>$p = 0.29$</td>
</tr>
<tr>
<td>Turnover per employee</td>
<td>$p = 0.43$</td>
</tr>
<tr>
<td>Turnover (A$ M$)</td>
<td>$p = 0.63$</td>
</tr>
<tr>
<td>Patent proportion (per AS M turnover)</td>
<td>$p = 0.68$</td>
</tr>
</tbody>
</table>

Table F.2 Multiple regression analysis for export proportion (dependent variable); turnover, age, competitiveness and R & D proportion (independent variables) $(N = 56)$

<table>
<thead>
<tr>
<th>Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of total variance</td>
<td>adjusted $R^2 = 0.03$</td>
</tr>
<tr>
<td>$F (4, 51)$ value $= 1.45$</td>
<td>$p = 0.23$</td>
</tr>
<tr>
<td>R &amp; D proportion</td>
<td>$p = 0.10$</td>
</tr>
<tr>
<td>Age</td>
<td>$p = 0.29$</td>
</tr>
<tr>
<td>Turnover per employee</td>
<td>$p = 0.43$</td>
</tr>
<tr>
<td>Turnover (A$ M$)</td>
<td>$P = 0.61$</td>
</tr>
</tbody>
</table>

Appendix F (continued)

Factor analysis on variables (Chapter 11)

This section presents results of factor analysis using ratio variables: turnover (A $ M) (proxy for size); age (years established up to 2000); export proportion (export turnover p.a. / total firm turnover p.a.); R & D proportion (R & D expenditure p.a./ total firm turnover p.a.); turnover per employee (proxy for productivity or competitiveness); patent proportion (no. of registered patents/ total firm turnover p.a.).

Factor analysis is conducted on three groups:

1. All firms (exporters and non exporters) Because export proportion does not apply to non-exporters, this variable is eliminated in the 'all firms' group.

2. Non exporters

3. Non- exporters (including export proportion as a variable)

Note that all zero values for R & D and patent counts are included.

If the initial result for a group is not significant, the raw data is transformed into natural logarithms. This is done to avoid a Type 2 error. Also, because factor analysis analyses correlations, then any underlying non-linear relationships should become apparent with log transformation (Wright 1997; Corston and Colman 2003). The criteria for determining if a result is significant are based on Corston and Colman (2003: 142-154).

What is found is that none of the tests on the three groups, both with raw variables and log transformations, are significant. The following output and related comments explain why.
1.a ‘All firms’ factor analysis

Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>TURNOVER</th>
<th>AGE</th>
<th>RANDD</th>
<th>COM</th>
<th>PAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORRELATION</td>
<td>1.000</td>
<td>.300</td>
<td>-.112</td>
<td>.033</td>
<td>-.090</td>
</tr>
<tr>
<td>TURNOVER</td>
<td></td>
<td>.300</td>
<td>1.000</td>
<td>.084</td>
<td>.038</td>
</tr>
<tr>
<td>AGE</td>
<td>-.112</td>
<td>-.219</td>
<td>1.000</td>
<td>.037</td>
<td>.154</td>
</tr>
<tr>
<td>RANDD</td>
<td></td>
<td></td>
<td></td>
<td>1.000</td>
<td>.154</td>
</tr>
<tr>
<td>COM</td>
<td>.033</td>
<td>.084</td>
<td>.037</td>
<td>1.000</td>
<td>.154</td>
</tr>
<tr>
<td>PAT</td>
<td>-.090</td>
<td>.038</td>
<td>.154</td>
<td>.154</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Sig. (1-tailed)  | TURNOVER | AGE   | RANDD | COM   | PAT   |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TURNOVER</td>
<td></td>
<td>.003</td>
<td>.158</td>
<td>.383</td>
<td>.211</td>
</tr>
<tr>
<td>AGE</td>
<td>.003</td>
<td></td>
<td>.024</td>
<td>.226</td>
<td>.367</td>
</tr>
<tr>
<td>RANDD</td>
<td>.158</td>
<td>.024</td>
<td></td>
<td>.372</td>
<td>.083</td>
</tr>
<tr>
<td>COM</td>
<td>.383</td>
<td>.226</td>
<td>.372</td>
<td></td>
<td>.083</td>
</tr>
<tr>
<td>PAT</td>
<td>.211</td>
<td>.367</td>
<td>.083</td>
<td>.083</td>
<td></td>
</tr>
</tbody>
</table>

KMO and Bartlett's Test

<table>
<thead>
<tr>
<th></th>
<th>Kaiser-Meyer-Olkin Measure of Sampling Adequacy.</th>
<th>.521</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bartlett's Test of Sphericity</td>
<td>Approx. Chi-Square</td>
<td>17.084</td>
</tr>
<tr>
<td></td>
<td>df</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td>.073</td>
</tr>
</tbody>
</table>

The test is not proceeded with further because only a few values in the correlation matrix are above 0.30. It is therefore unlikely that many variables share common factors. The K-M-O measure is above 0.5 indicating correlations between pairs of variables are affected by other variables. (If the KMO measure is less than 0.5, then partial correlations are high and correlations between pairs of variables are relatively unaffected by other variables, and the factor analysis should not proceed.) However, Bartlett’s test of sphericity shows p = 0.073; this means that the test fails to reject the hypothesis that the correlation matrix is an identity matrix, with no correlation between the variables. If the test fails to reject this hypothesis at p < 0.05, then there are insufficient intercorrelations between variables and the factor analysis is futile (Corston and Colman 2003: 146).
Log transformation is conducted on the raw variables. Because patent proportions contain numerous zero values for individual firms, the log transformation omits this variable so a larger sample size is retained.

1.b ‘All firms’ factor analysis (log transformation)

<table>
<thead>
<tr>
<th>Correlation Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>TURNOVER</td>
</tr>
<tr>
<td>TURNOVER</td>
</tr>
<tr>
<td>AGE</td>
</tr>
<tr>
<td>RAND</td>
</tr>
<tr>
<td>COMP</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sig. (1-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TURNOVER</td>
</tr>
<tr>
<td>.000</td>
</tr>
<tr>
<td>.018</td>
</tr>
<tr>
<td>.042</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>KMO and Bartlett’s Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaiser-Meyer-Olkin Measure of Sampling Adequacy.</td>
</tr>
<tr>
<td>Bartlett's Test of Sphericity</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

The K-M-O measure is above 0.50 and the Bartlett’s test rejects the hypothesis (at p < 0.001) that the correlation matrix is an identity matrix. These two diagnostic tests indicate the data are suitable for factor analysis. The first diagnostic test using the Correlation Matrix shows that only some of the values are above 0.30 so the reliability of the factor analysis is dubious.

Proceeding further with the log transformed test shows that two factors only explain 44.7% and 27.5% of the variance. Also, the Scree plot does not decline sharply in the first two components. If these factors were to explain variance, then the percentage of variance would be higher (e.g. over 90% cumulative variance for the first two factors) and the Scree plot would show a rapid decline over the first two factors.

<table>
<thead>
<tr>
<th>Communalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
</tr>
<tr>
<td>TURNOVER</td>
</tr>
<tr>
<td>AGE</td>
</tr>
<tr>
<td>RAND</td>
</tr>
<tr>
<td>COMP</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.
Total Variance Explained

<table>
<thead>
<tr>
<th>Component</th>
<th>Initial Eigenvalues</th>
<th>Extraction Sums of Sq. Loadings</th>
<th>Rotation Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total % of Var.</td>
<td>Cumulat. %</td>
<td>Total % of Var.</td>
</tr>
<tr>
<td>1</td>
<td>1.789</td>
<td>44.731</td>
<td>1.789</td>
</tr>
<tr>
<td>2</td>
<td>1.099</td>
<td>27.468</td>
<td>1.099</td>
</tr>
<tr>
<td>3</td>
<td>0.581</td>
<td>14.516</td>
<td>0.581</td>
</tr>
<tr>
<td>4</td>
<td>0.531</td>
<td>13.285</td>
<td>0.531</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.

Scree Plot

Component Matrixa

<table>
<thead>
<tr>
<th>Component</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE</td>
<td>.813</td>
<td></td>
</tr>
<tr>
<td>TURNOVER</td>
<td>.787</td>
<td>.187</td>
</tr>
<tr>
<td>RAND</td>
<td>-.646</td>
<td>.548</td>
</tr>
<tr>
<td>COMP</td>
<td>.302</td>
<td>.871</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.

a. 2 components extracted.
### Rotated Component Matrix

<table>
<thead>
<tr>
<th></th>
<th>Component 1</th>
<th>Component 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE</td>
<td>.803</td>
<td>.146</td>
</tr>
<tr>
<td>RAND</td>
<td>-.767</td>
<td>.360</td>
</tr>
<tr>
<td>TURNOVER</td>
<td>.710</td>
<td>.387</td>
</tr>
<tr>
<td>COMP</td>
<td>.710</td>
<td>.387</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

### Component Transformation Matrix

<table>
<thead>
<tr>
<th>Component</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.965</td>
<td>.262</td>
</tr>
<tr>
<td>2</td>
<td>-.262</td>
<td>.965</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

### 2.a ‘Non-exporters’ factor analysis

### Correlation Matrix

<table>
<thead>
<tr>
<th>Correlation</th>
<th>TURNOVER</th>
<th>AGE</th>
<th>RANDD</th>
<th>COMP</th>
<th>PAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TURNOVER</td>
<td>1.000</td>
<td>.089</td>
<td>-.197</td>
<td>.336</td>
<td>.097</td>
</tr>
<tr>
<td>AGE</td>
<td>.089</td>
<td>1.000</td>
<td>.104</td>
<td>.437</td>
<td>.260</td>
</tr>
<tr>
<td>RANDD</td>
<td>-.197</td>
<td>.104</td>
<td>1.000</td>
<td>-.158</td>
<td>-.107</td>
</tr>
<tr>
<td>COMP</td>
<td>.336</td>
<td>.437</td>
<td>-.158</td>
<td>1.000</td>
<td>.355</td>
</tr>
<tr>
<td>PAT</td>
<td>-.097</td>
<td>.260</td>
<td>-.107</td>
<td>.355</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Sig. (1-tailed)

<table>
<thead>
<tr>
<th>Correlation</th>
<th>TURNOVER</th>
<th>AGE</th>
<th>RANDD</th>
<th>COMP</th>
<th>PAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TURNOVER</td>
<td>.340</td>
<td>.314</td>
<td>.016</td>
<td>.044</td>
<td></td>
</tr>
<tr>
<td>AGE</td>
<td>.178</td>
<td>.314</td>
<td>.231</td>
<td>.044</td>
<td></td>
</tr>
<tr>
<td>RANDD</td>
<td>.054</td>
<td>.016</td>
<td>.231</td>
<td>.044</td>
<td></td>
</tr>
<tr>
<td>COMP</td>
<td>.327</td>
<td>.110</td>
<td>.309</td>
<td>.044</td>
<td></td>
</tr>
</tbody>
</table>

### KMO and Bartlett’s Test

<table>
<thead>
<tr>
<th>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</th>
<th>.520</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bartlett's Test of Sphericity</td>
<td>Approx. Chi-Square</td>
</tr>
<tr>
<td></td>
<td>df</td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
</tr>
</tbody>
</table>

Test is not proceeded with because the three diagnostic tests have not produced evidence that the factor analysis will be reliable. Because of this, log transformation is conducted on the raw variables.
2.b ‘Non-exporters’ factor analysis (log transformed)

**Correlation Matrix**

<table>
<thead>
<tr>
<th></th>
<th>TURNOVER</th>
<th>AGE</th>
<th>RANDD</th>
<th>COMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TURNOVER</td>
<td>1.000</td>
<td>.556</td>
<td>-.112</td>
<td>.727</td>
</tr>
<tr>
<td>AGE</td>
<td>.556</td>
<td>1.000</td>
<td>-.078</td>
<td>.522</td>
</tr>
<tr>
<td>RANDD</td>
<td>-.112</td>
<td>-.078</td>
<td>1.000</td>
<td>-.026</td>
</tr>
<tr>
<td>COMP</td>
<td>.727</td>
<td>.522</td>
<td>-.026</td>
<td>1.000</td>
</tr>
<tr>
<td>Sig. (1-tailed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TURNOVER</td>
<td>.060</td>
<td>.060</td>
<td>.387</td>
<td>.013</td>
</tr>
<tr>
<td>AGE</td>
<td>.387</td>
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<td>.473</td>
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<tr>
<td>RANDD</td>
<td>.013</td>
<td>.075</td>
<td>.473</td>
<td></td>
</tr>
<tr>
<td>COMP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**KMO and Bartlett's Test**

| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | 0.678 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 6.917 | df | 6 | Sig. | 0.329 |

Test is not proceeded with because the three diagnostic tests have not produced evidence, even with log transformed variables, that the factor analysis will be reliable.

3.a ‘Exporters’ factor analysis

**Correlation Matrix**

<table>
<thead>
<tr>
<th></th>
<th>TURNOVER</th>
<th>AGE</th>
<th>EXPROP</th>
<th>RANDD</th>
<th>COMP</th>
<th>PATTO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TURNOVER</td>
<td>1.000</td>
<td>.368</td>
<td>-.010</td>
<td>-.123</td>
<td>-.039</td>
<td>-.100</td>
</tr>
<tr>
<td>AGE</td>
<td>.368</td>
<td>1.000</td>
<td>-.197</td>
<td>-.314</td>
<td>-.091</td>
<td>-.133</td>
</tr>
<tr>
<td>EXPROP</td>
<td>-.010</td>
<td>-.197</td>
<td>1.000</td>
<td>.269</td>
<td>-.077</td>
<td>.024</td>
</tr>
<tr>
<td>RANDD</td>
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<td>-.314</td>
<td>.269</td>
<td>1.000</td>
<td>.079</td>
<td>.274</td>
</tr>
<tr>
<td>COMP</td>
<td>-.039</td>
<td>-.091</td>
<td>-.077</td>
<td>.079</td>
<td>1.000</td>
<td>.010</td>
</tr>
<tr>
<td>PATTO</td>
<td>-.100</td>
<td>-.133</td>
<td>.024</td>
<td>.274</td>
<td>.010</td>
<td>1.000</td>
</tr>
</tbody>
</table>

**KMO and Bartlett's Test**

| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | 0.577 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 23.808 | df | 15 | Sig. | 0.068 |

Test is not proceeded with because the three diagnostic tests have not produced evidence that the factor analysis will be reliable. Because of this, log transformation is conducted on the raw variables.
3.b ‘Exporters’ factor analysis (log transformed)

### Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>TURNOVER</th>
<th>AGE</th>
<th>EXPPROP</th>
<th>RANDD</th>
<th>COMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>1.000</td>
<td>.437</td>
<td>-.048</td>
<td>-.313</td>
<td>.031</td>
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<tr>
<td>AGE</td>
<td>.437</td>
<td>1.000</td>
<td>-.296</td>
<td>-.417</td>
<td>.048</td>
</tr>
<tr>
<td>EXPPROP</td>
<td>-.048</td>
<td>-.296</td>
<td>1.000</td>
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<td>-.128</td>
</tr>
<tr>
<td>RANDD</td>
<td>-.313</td>
<td>-.417</td>
<td>.393</td>
<td>1.000</td>
<td>.160</td>
</tr>
<tr>
<td>COMP</td>
<td>.031</td>
<td>.048</td>
<td>-.128</td>
<td>.160</td>
<td>1.000</td>
</tr>
</tbody>
</table>

### KMO and Bartlett’s Test

| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | .576 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 28.947 |
| df | 10 |
| Sig. | .001 |

The K-M-O measure is above 0.50 and the Bartlett’s test rejects the hypothesis (at p = 0.001) that the correlation matrix is an identity matrix. These two diagnostic tests indicate the data are suitable for factor analysis. The first diagnostic test using the Correlation Matrix shows that only some of the values are above 0.30. Factor analysis is conducted but the reliability of the results is not high.

As the Total Variance Table shows, the first extracted factor explains only 40% of the variance of the original variables. The second factor explains a further 22% of variance. Only 62% of variance is explained by the two extracted factors. Furthermore, the Scree plot does not decline sharply, indicating that the first two factors only account for some of the variance.

The Component Matrix suggests that competitiveness (turnover per employee) has a moderate influence on other variables. From Chapter 7, it is known that there is relationship between firm size and competitiveness. Mathematically, both variables share turnover as a value so a relationship is not surprising.

### Communalities

<table>
<thead>
<tr>
<th></th>
<th>Initial</th>
<th>Extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>TURNOVER</td>
<td>1.000</td>
<td>.412</td>
</tr>
<tr>
<td>AGE</td>
<td>1.000</td>
<td>.632</td>
</tr>
<tr>
<td>EXPPROP</td>
<td>1.000</td>
<td>.475</td>
</tr>
<tr>
<td>RANDD</td>
<td>1.000</td>
<td>.662</td>
</tr>
<tr>
<td>COMP</td>
<td>1.000</td>
<td>.884</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.
Total Variance Explained

<table>
<thead>
<tr>
<th>Component</th>
<th>Initial Eigenvalues</th>
<th>Extraction Sums of Squared Loadings</th>
<th>Rotation Sums of Squared Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>% of Variance</td>
<td>Cumulative %</td>
<td>Total % of Variance</td>
</tr>
<tr>
<td>4</td>
<td>.513</td>
<td>10.266</td>
<td>.513</td>
</tr>
<tr>
<td>5</td>
<td>.446</td>
<td>8.916</td>
<td>.446</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.

Component Matrix

<table>
<thead>
<tr>
<th>Component</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE</td>
<td>.793</td>
<td></td>
</tr>
<tr>
<td>RANDD</td>
<td>-.776</td>
<td>.244</td>
</tr>
<tr>
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</table>

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Scree Plot

Component Number

Eigenvalue
### Rotated Component Matrix

<table>
<thead>
<tr>
<th>Component</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>RANDD</td>
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<tr>
<td>AGE</td>
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<td>.130</td>
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<tr>
<td>TURNOVER</td>
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<td>.130</td>
</tr>
<tr>
<td>EXPPROP</td>
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<td>-.424</td>
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<tr>
<td>COMP</td>
<td>.936</td>
<td></td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

### Component Transformation Matrix

<table>
<thead>
<tr>
<th>Component</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-.994</td>
<td>.106</td>
</tr>
<tr>
<td>2</td>
<td>.106</td>
<td>.994</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Author/s:  
Nadolny, Andrew John

Title:  
Rethinking trade: developing and applying an explanation to the Australian water technology and management industry

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2004

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