Forces Shaping Firms' Decision to Innovate: Evidence from Large Australian Organisations*

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Abstract

This paper investigates the forces that lead some firms to engage in more innovative activities than others using a survey of over 200 large Australian firms. Many earlier studies on the determinants of innovation followed the Schumpeterian tradition, and focused on size and market structure as possible causes of innovativeness, however with the event of new qualitative measures of industry knowledge and managerial styles, these factors have been found to be insignificant. The results show that factors common to all industries, such as the extent of learning, knowledge spillovers, appropriability and managerial style, are more important than industry specific forces. Foreign owned companies were also found to be more innovative, other things considered.

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Introduction

There are several (non-exclusive) motivations for firms to engage in innovation. Innovations can reduce costs of production, they can increase the quality of products, they may capture or create new product markets and they may reduce the firm's reliance upon unreliable or capricious factors of production. In general, any innovation that gives the firm a sustained cost or demand-side advantage over its rivals should enhance its profit maximising capabilities.

This paper investigates the forces that lead some firms to engage in more innovative activities than others. It does not consider final outcomes nor does it assume a positive monotonic relationship between innovation and performance. Innovation is an inherently risky business and more innovative activities, or certain forms of innovation, may be debilitating in differing circumstances. Lack of innovation may accordingly be a well chosen decision by a firm and may be entirely appropriate given its operating environment and internal capabilities. Notwithstanding this, *successful* innovation, compared with no innovation at all, can be the key to a strong market position and high profits.

It is argued that the conditions under which innovation is desirable for firms will vary according to external pressures and constraints (the nature of its input and output markets, its production processes, knowledge spillovers), and, its inherited internal capabilities (principally via the skills and accumulated experience of its workforce). Once management has identified the desired balance between innovative and routine activities, it may seek to realise it through certain styles of management, the nature of the work culture in relation to learning and appropriation.

Innovation, which is '…to introduce changes and new ideas'[1] can refer to changes and ideas which are new to the world (an invention) or new to a firm (inventions, imitations and adaptations). This paper uses the second, broader meaning. Both inventions and imitations and adaptations affect firm performance, and it is likely that firms that the latter are complementary activities to the former. In this paper, therefore, a more innovative firm is either more creative and original or quicker to keep abreast of competitors and to modernise their operations.

The subsequent sections of this paper discuss first, the general approaches to theories of firm behaviour, and secondly a specific model characterising the innovation choice. Subsequently, the model is estimated using data from a survey that was undertaken between October 2001 and February 2002.

Models of firm behaviour

Neoclassical theories of firm behaviour have little to say about the determinants of innovative behaviour. The standard 'theory of the firm' is essentially concerned with the pricing and factor use decisions and has no direct comment about investment intentions. Jorgenson's (1971) prototype neoclassical investment model only represents decisions which have been motivated by the need to extend productive capacity. This is a peripheral motive for innovation investments which are more concerned with the need to compete and contain business uncertainty (see Webster 1999). Game theory explicitly models the innovation decision but it assumes a large amount of certainty in relation to the innovation and invention process such as the outcomes of invention, rival responses and invention costs. For many people, this assumes away critical features of invention and innovation.

[1] Cambridge International Dictionary of English

Evolutionary models, which owe many foundations to Nelson and Winter (1982), are perhaps more apposite. These models embrace behavioural or fundamental uncertainty[2] in both external markets and the firm's internal processes and argue that accordingly, firms neither possess, nor behave 'as if' they have, clearly defined objective functions. Procedures for profit making are instead determined on the basis of the firm's acquired skills and accumulated experience, intangible assets, history of innovation, and modus operandi. External pressures are influential, but not absolute as in the neoclassical model. What appears the best strategy *ex ante* will not necessarily work out the best *ex post*, because of bounded rationality and the fundamental uncertainty of the business world (Hall 1994). This process of path dependency and managerial latitude leads to diversity between firms not present in the neoclassical models.

While the evolutionary approach emphasises the more germane aspects the innovation process, its reliance upon path dependent activities and outcomes makes it more difficult to model and estimate. Nonetheless, the following sections devise and test a model to capture managerial discretion aspect of these evolutionary models. We begin by discussion the type of soft or human technologies engineered within the firm.

[2] Uncertainty is the '...plurality of those descriptions of the future which the decision-maker looks upon in some degree, as possible' (Shackle 1961-62: 86). Uncertainty excludes actuarial risks (Knight 1921, especially 321 and Keynes 1937). The outcome of a proposed action is considered risky if it arises from situations (or classes of situations) that occur with such frequency that one is able to derive a reliable contingent frequency table for possible outcomes. Fundamentally uncertain outcomes, however, arise from situations, which are so singular, or unlike past cases that no estimate, which is meaningful or reliable ex post, can be made

A model of the decision to innovate

The choice of human technologies

We assume that the decision about how many resources a firm will commit towards innovative activities is rooted within the broader decision about the chosen human technologies.[3] Assume that there are two basic factors that contribute towards firm performance: the labour process and the physical technology. The labour process may be said to be governed by four discrete modes of operation: the level of synergy, the locus of decision-making, the level of proficiency and the emphasis on innovation. Together, these modes represent the soft or human technologies that managers (and to a lesser extent workers) explicitly or implicitly engineer within their workplaces. The desired level of each mode is based upon separate considerations emanating from the physical technologies, the characteristics of the product, the nature of the consumer market, the firm's acquired capabilities and mode of operation and other external factors.

The first three modes, being tangential to this paper, will be dealt with quickly. The first mode, the desired level of *synergy* among workers, is affected by whether managers want a human technology that promotes collaboration between workers and work units or one that favours individualised effort.[4] The second mode, the preferred *locus*, is based on whether managers need to decide whether it is preferable to have centralised or decentralised decision-making structures.[5] The third mode refers to the required level of *technical*

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[3] This model of human technologies has been adapted from an earlier paper Webster and Loundes (2003).

[4] In some production units, such as those dominated by production line technologies or knowledge spillovers, a high level of worker interaction is required for efficiency, but in others, such as door-to-door sales, this is less relevant. An example of the former would be a postal service firm, and of the latter, a law firm.

[5] Some production technologies may rely upon information being collected and dispersed equally at all points along the production chain. In these cases, it is efficacious for important decisions to be made by workers 'on-site'. In industries such as professional services, which are very customer focused, decisions and information

proficiency of its workers. More able and skilled workers are generally more expensive to hire and maintain and they will not always be the most cost effective form of labour.[6]

Finally, the last mode, the desired level of *innovation* required from individual workers determines the relative weight given to creative versus mechanical work. Firms operating in turbulent or rapidly evolving markets or technology areas often require greater inventive and innovative inputs into their production process in order to compete successfully. Some workers have a natural aptitude for creative work while others are more skilled at routinely producing accurately. For workers in the advertising industry, creativity comes before mechanical feasibility. However, for surgeons or civil engineers, mechanical feasibility is a primary consideration, much ahead of creativity.

While this model can be used to estimate the effects of the external factors and the complementary practices on the four human technologies, the following focuses on matters that are pertinent to the innovation versus mechanical trade-off.

Figure 1 presents a model of these human technologies and the arrowed lines represent the main lines of causation. Clearly, one could argue that there are several possible feedback influences and dual cause and effect relationships not depicted on the model. This omission is deliberate. The model is intended to portray the primary relationships relevant to the question at hand and this requires suppressing secondary details that do not essentially violate the basic tenet. It is argued that exogenous factors such as the physical technology, and the ownership structure of the company (that is, government versus non-government), the type of product, characteristics of the firm's labour markets, the firm's liquidity constraints, the

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are often sourced at the most decentralised level. However, in retail shops, government administration or defence, it may be more desirable for all of the important decisions to emanate from the top.

[6] A high but expensive skill level may be optimal nonetheless in industries such as specialist health care and investment advice, but lower proficiently workers will be preferred in industries such as retail trade because of their compensating lower cost.

extent of knowledge spillovers from competitors and existing firm capabilities has a primary role in deciding the optimal balance between innovation and mechanical reliability.

Both the theoretical (Nelson 1959, Schmookler 1966, and Dosi 1988) and applied (Arvanitis and Kleinknecht 1996, Crepon *et al.* 1996, Geroski and Walters 1995) literature suggests that measures of demand for types of inventions (sometimes proxied in applied work by the elasticities of demand for the firm's output or changes in demand), tempered by technological opportunities are critical determinants to this balance. In addition, the costs of innovation and the firm's knowledge capabilities are also expected to influence the innovation decision at the margin. Since this study does not have direct data on these forces, it uses instead measures of the physical technology, firm size, the ownership structure of the company (that is, government versus non-government), the type of product, the nature of the firm's labour markets, the firm's liquidity constraints and the extent of knowledge spillovers from competitors. It is often unclear however, what ultimate force some of these proximate variables reflect and there is often discussion among researchers about whether size indicates the firm's ability to finance investments and innovative activities, or their ability to reap returns *ex post* through large sale production and established channels into many markets, or perhaps their ability to prevent imitation through quasi-legal sanctions (refs)

Complementry policies for innovative activities

Once managers have decided upon a balance between innovative and routine activities, it is assumed that they enact complementary practices to operationalise their choice. In the model, these practices may include encouraging particular managerial styles, increasing effort to communicate with workers, and, in the case of the innovativeness mode, more support for key staff to learn about new products and processes, and the greater use of means to appropriate profits from the introduction of new products and processes. The use and effectiveness of these complementary practices is a discretionary managerial decision, but is

also subject to constraints external to the firm. For example, how effective patents are for protecting new products will depends both on how patentable the product is and how many resources the company devotes to establishing and defending its patent.

The use of effective means of appropriating returns is perhaps the strongest and most cited force determining the inventive or innovation decisions in the literature, whether this is through extensive use of patents and secrecy – forces discretionary to the firm – or, through less directly malleable forces such as company size, market concentration is still under debate (see Felder *et al.* 1996, Kleinknecht 1996 for example).

The data

The Melbourne Institute Business Survey

Data was derived from a business survey of large Australian firms during the period from October 2001 to February 2002. The largest 1000 enterprises (by total revenue) were chosen from the IBISWorld enterprise database, and subsequent to initial calls, 813 surveys were mailed out, with 281 useable surveys returned. This is a response rate of 28 per cent, which is consistent with surveys of this type (see for example, Huselid 1995, Covin *et al.* 2001). Descriptive statistics for the organisations are given in Table 1, which presents the major industry categories, location and employment size of the organisations in our survey. More than a quarter of organisations were located in manufacturing, with the next highest proportion represented by finance and insurance, wholesale trade, electricity, gas and water supply, and property and businesses services. Importantly however, the distribution of responses across characteristics does not differ markedly from the initial selected population,

implying that the responses should not be biased towards a particular group.[7] This is confirmed by the regression analysis which found no support for the hypothesis that there has been a selection bias in the responding firms based on industry and company type.

Respondents were asked to answer using a seven-point Likert scale with the anchors 1=strongly disagree and 7=strongly agree. Perceptual measures permit comparisons across very different organisations and industries and are easy to collect because they place fewer burdens on respondents than administrative or factual entries. However, they contain a subjective element and thus an undefined error and it would be unwise to over interpret the findings.

Similar to many other studies of this type (see for example Arvanitis 2002, Hollenstein 2002), the majority of variables used in this paper are constructed using factor analysis techniques rather than a single variable. The reason for using factored variables is that the use of a single variable is unlikely to adequately measure the underlying latent construct of interest, such as the level of innovation within the firm, or the management style adopted. The factored variables were constructed from the data by first selecting *a priori* items it was believed represented aspects of our variables. Factor analysis was undertaken and used to reject those items with factor loadings below 0.25 and derived measures based on the average of the 7-point Likert scale of the remaining items.[8] The two main problems with using factor variables as explanators is first, it is difficult to interpret the values the variable takes and second, there is potentially a large amount of missing data present in such constructed factor

[7] The main exceptions are: a slight over-representation of electricity, gas and water suppliers, transport and storage and education, with a corresponding under-representation of organisations from wholesale trade and finance and insurance; an over-representation of respondents from Queensland and South Australia, with a corresponding under-representation in NSW; and an over-representation of respondents from the larger firms, as measured by the number of employees.

variables. To overcome both these problems, a summated scale is constructed as the average score on questions answered that corresponded to the factor.

Developing variable measures from the data

Following the discussion above, item questions from the survey questionnaire and the IBISWorld data base have be used to devise measures of:

1. The innovativeness of the chosen human technology.
2. The external conditions: physical technology, corporate structure and size, external product market conditions, external labour market conditions, liquidity constraints and the extent of knowledge spillovers from competitor firms. No measures were available for the pre-existing capabilities of the firm.[9]
3. The complementary practices: management style and communication techniques, the effectiveness of avenues for learning and the effectiveness of means of appropriability.

Table 2 presents a summary of the selected measures. The *innovation mode*, is defined by the priority given by the organisation to innovation and the state-of-the-art developments. This included managers' rating on the 1 to 7 scale of: resources devoted to organisational change and other firms' technologies over the past three years; how often new or modified products have been introduced over the past three years; the extent to which their firm was good at implementing new ideas; the extent to which firm produces a continuous stream of state-or-art products; the extent to which firm was first to the market with new products; and the extent to which the firm responded to early market signals concerning new opportunities. While this measure of innovation includes information on R&D expenditures, it does not rely

[8] Where appropriate, the 1 to 7 scales were reversed to order items in a consistent direction. All *a priori* innovation items were included in its summated scale.

upon R&D expenditure explicitly because of frequent under-reporting in accounting data, especially for medium size companies, and concerns about consistency of definition between firms. Empirical studies which rely solely upon accounting R&D data have been found to get unreliable results (Kleinknecht 1996).

The external conditions variables were comprised of a combination of objective industry and company data. Only a rather limited measure of the extent of expenditure on *physical technology* was available.[10] This comprised two measures of the firm's expenditure on plant and equipment and on external technologies. To some extent, the industry variables will capture other dimensions of the dominant physical technology and thus the technological opportunities available to the firm. *Corporate size and structure* variables included data on the total revenue, foreign versus local ownership, whether the firm was a single integrated business, a multiple related business or another type, whether is was public, private or government, and whether it was listed on the stock exchange. The *external product market* variables were reflected in a series of 16 industry dummies to reflect the 17 major industry groups, a measure of product market volatility (based on the uncertainty scales of Miller 1994), and the ease of entry into the industry. Except for the industry coding (which is done by IBISWorld), these measures were drawn from survey responses. Knowledge spillovers from competitors were measured as the average effectiveness of all firms in the firm's industry at appropriating the advantages of their new and improved products and processes. Two separate measures were calculated: one for advantages arising from products and the other for advantages from processes. The argument is that the greater the ability of other

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[9] A recent UK study by Athreye 2001 found supporting evidence for the influence of internal accumulated capabilities.

[10] Unfortunately, data limitations preclude the inclusion of more appropriate variables such as the nature of the production process..

firms in their industry at keeping their knowledge and competitive advantages to themselves, the fewer the spillovers that will naturally flow to their colleague firms.

External labour market condition variables were derived from two survey questions on how difficult it was to recruit suitable people and on relative turnover of skilled staff within the firm.

The *liquidity constraint* variable was the ratio of liabilities to total equity from the IBISWorld data.

Finally, a series of variables were constructed to reflect internal management techniques. Three different types of *management style* were distinguishable from the data (rather than *a priori*). The first style, 'inflexible', reflected the inflexibility and unresponsiveness of the organisation's functional areas. The second, 'systematic', indicated managerial reliance upon formal and extensive quantitative analysis rather than intuitive information for making decisions. The third factor, 'aggressive', reflected how aggressive managers were in the face of uncertainty and how willing they were to initiate competitive clashes with rival companies. The last management technique variable was a measure of how, and to what extent, the firm made an effort to communicate with its employees. This variable, *communication techniques*, gives weight to organisations that have clear strategic missions that are understood throughout the enterprise, use several procedures to communicate with staff, involve employees directly in decisions and act on suggestions of employees. The *extent of learning* about new products and processes was derived from a series of questions about how much companies learnt from licensing new technologies, patent disclosures, publications or technical meeting, informal and formal networks with other organisations, hiring skilled employees from other companies, reverse engineering, R&D, lead customers, suppliers and consultants. The effectiveness of the *means of appropriating* the profits from innovation was collected from a series of questions about the effectiveness of the following methods for both

new products and processes: patents, secrecy, lead time, moving quickly down the learning curve, control over distribution, brand name and marketing, organisational know-how and capabilities and product and production complexity (adapted from Levin *et al.* 1987).

Descriptive analysis

Given that most of the measures devised for the model have been ordinally enumerated, it makes little sense to present absolute descriptive data as only the distributions convey information. The following four figures present histograms for four key variables: the mode of innovativeness, the extent of industry spillovers (17 measures – one for each sector), the extent of learning within each firm from the specified sources and the extent to which the firm appropriates returns from its process advantages. A normal distribution has been overlaid on the figure for comparative purposes. These figures show, that with the exception of industry spillovers – which only represented 17 data points – that each variable has an approximately bell shaped distribution.

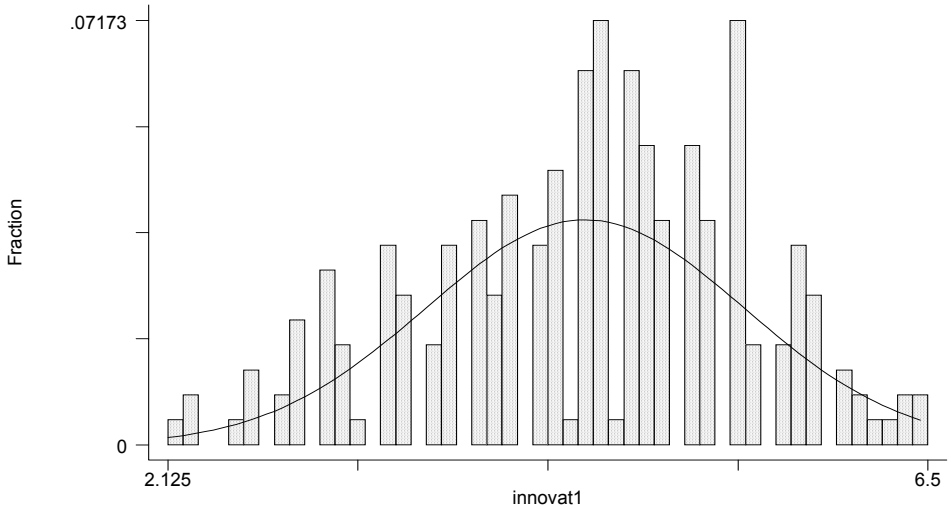

Figure 1. Measure of Innovativeness

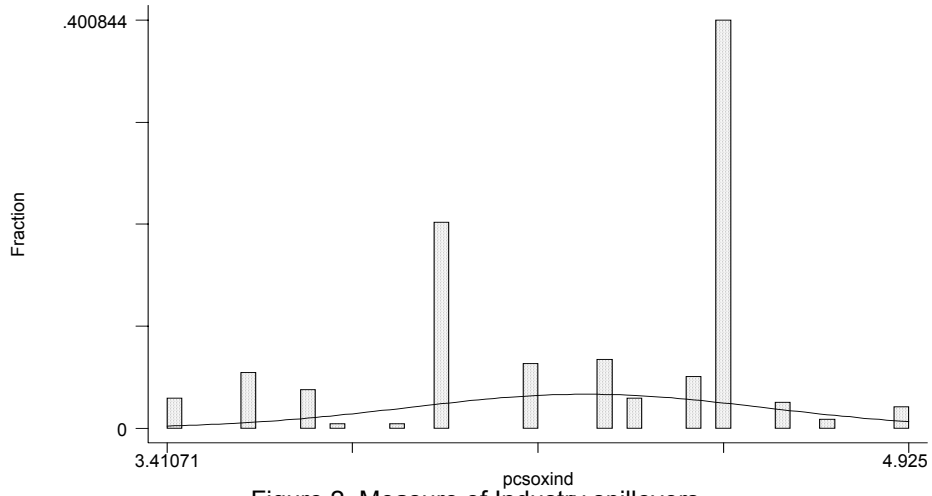

Figure 2. Measure of Industry spillovers

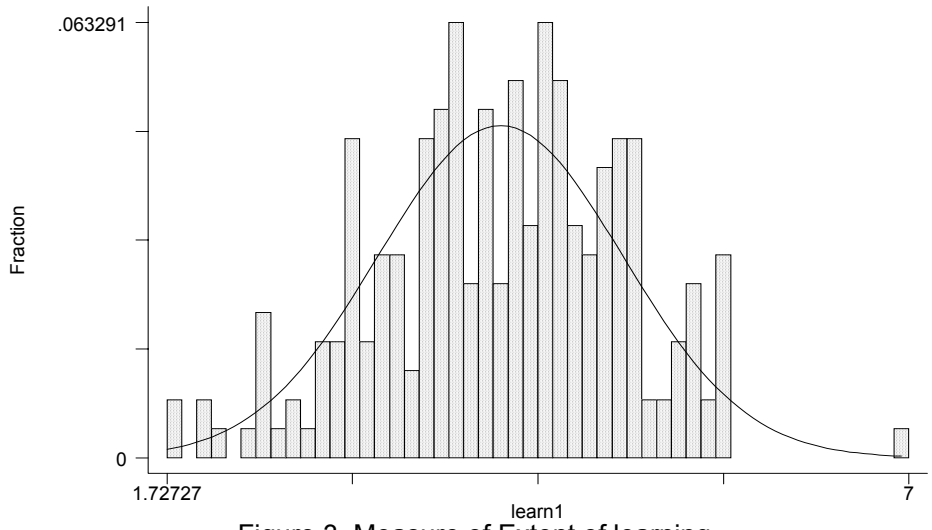

Figure 3. Measure of Extent of learning

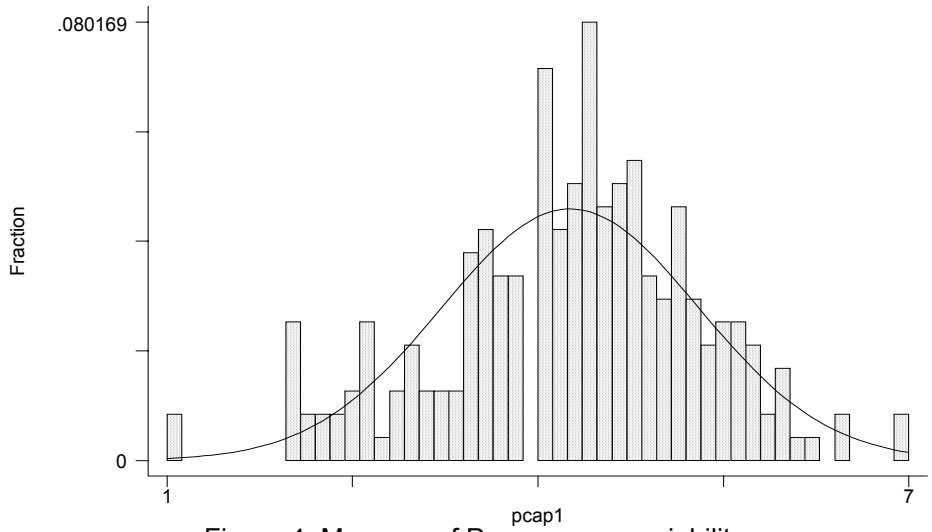

Figure 4. Measure of Process appropriability

Estimated effects

Specifying the model

The model of climate presented in Figure 1 implies that the innovativeness human technology is determined by the external conditions (contained in the vector **z**) and fashioned by the complementary practices (in vector **x**). Since by construction, the measure *I* is bound between 1 and 7, it has been modelled as a logistic function. Assuming υ_i represents an i.i.d. error term, this gives:

$$I_i = \left[\frac{6}{1 + \exp(-\mathbf{z}_i'\beta - \mathbf{x}_i'\alpha)} \right] + 1 + \upsilon_i \qquad (1)$$

where *I* is the measure of *innovativeness* and *i* represents the individual organisation. This produces a function, depicted in Figure 5, whereby *I* is must lie between one and seven for all values of the exogenous variables constrained in **z** and **x.** It is unlikely that υ_i is normally distributed, given that *I* is a bounded variable and it is assumed that $\ln(I_i) =$ $\ln\{f(.)\} + v_i$, such that $v_i \sim N(0, \tau^2)$, where $f(.) = \ln\left[\frac{6}{1 + \exp(-\mathbf{z}_i'\beta - \mathbf{x}_i'\alpha)} + 1 \right]$.

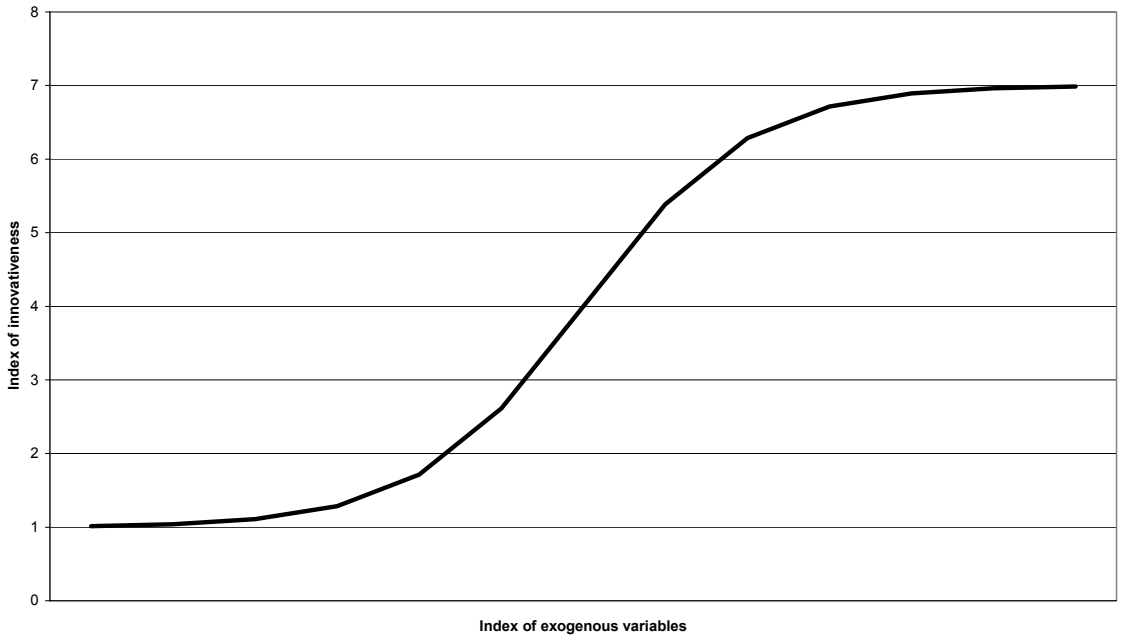

Figure 5. Diagrammatic representation of a logistic function

Regression results

Results from the non-linear estimation of (1) using the full specification of the model is presented in the first two columns of data in Table 3. The last two columns present the significant variables only. Table 4 presents a written summary of these results.

One of the major shortcomings from using measure based on Likert scales it that it is not possible to interpret the size of the estimated coefficients other than by comparison with other variables measured in the same way. However, these scales do enable researchers to assess whether a variable has a statistically significant relationship, once other factors are controlled for, and whether that association is direct or inverse. A further consideration to bear in mind when interpreting these results is the possible endogeneity of some variables which our model treats as partly exogenous to the innovation decision. Market volatility and firm size are possible contenders here. Innovativeness may cause, not result from market volatility and ditto for firm growth. The lack of time series and historic variables in the data set are an unfortunate limitation of this study.

Nonetheless, given the limitation imposed by the cross-sectional nature of the data, the findings are suggestive and not counter-intuitive. Table 3 reveals that investment in new physical capital is likely to be a complement to or determinant of the companies' innovation stance. More innovative companies also spend more on new physical capital goods. Few of the variables that described the corporate structure were shown to influence innovation. Foreign owned companies were found to be more innovative, *ceteris paribus*. The smaller of the companies in our large company population (medium companies) were associated with higher levels of innovation, although this effect was only apparent when many of the insignificant variables were dropped (this effect is also found in Martinez-Ros and Labeaga 2002).[11] This is not similar to the empirical findings of Brouwer and Kleinknecht (1996), and Felder *et al.* (1996), who report that the largest companies compared with medium-size companies are not only more likely to invent, but also spend more on inventive activities. Publicly listed industrial companies, were more likely, all other things considered, to be innovative (significant at the 10 per cent level).

Of all the industry dummy variables, only wholesale trade was significant at the 5 per cent level. If the dependent variable is regressed on the industry dummies only, many were found to be significant but once account is taken of the other variables – being systematic features common to all the industries – they lose significance. Several of the qualitative measures of the nature of the industry were however significant. Firms operating in more volatile product markets adopted a significantly more innovative mode of production than other firms. There was no association between the contestability of the market (ease of entry and concentration) and innovativeness (15 per cent significance). Overseas empirical work for the importance of non-price competition is mixed (Arvanitis and Kleinknecht 1996) but, similar to our results,

[11] This was the only variable to change significant markedly as the most insignificant variables were dropped. This change was most likely due to the inclusion of an additional 66 cases.

there is little evidence that market structure, such as concentration and contestability, matter (Arvanitis and Kleinknecht 1996, Crepon *et al.* 1996, Geroski and Walters 1995, Felder *et al.* 1996, Martinez-Ros and Labeaga 2002, Arvanitis 2002). A higher degree of knowledge spillovers about product and process advantages emanating from other companies in the same industry sector were significantly and positively associated with the firms adopted innovation stance. If spillovers emanating from product and process advantages were entered separately, only one was significant but each was significant and correctly signed if included in the regression without the other variable. Accordingly, we conclude that they should be treated as a combined variable.

Most of the hypothesised complementary internal firm practices were found to have a significant association with the firm's innovation mode. Less inflexible styles of management, more aggressive managerial approaches and greater use of formal communication techniques within firms were all significantly associated with more innovative modes of production. Additionally, and not surprisingly, the more the firm successfully learned about new product and processes from networks, meetings, hiring skilled workers and licenses, and so on, the more likely it was to have a highly innovative stance. Studies from Europe have found consistent support for a positive relationship between the differing measures of the extent of learning and innovation (Hollenstein 2002,). Finally, effective use of different ways to protect product and process innovations was related to the firm's innovative stance. Combining both variables provided the most satisfactory result, as together and separately one variable was either not significant or incorrectly signed. If each variable was included on its own, it was significant and correctly signed. Measures of firms' abilities to appropriate the returns from their inventions have shown in previous studies to have a positive, reliable and robust effect on the intensity of innovation (Arvanitis and Kleinknecht 1996, Arvanitis 2002).

Conclusion

Many earlier studies on the determinant of innovation followed the Schumpeterian tradition, and focused on size and market structure as possible causes of innovativeness, however with the event of new qualitative measures of industry knowledge and managerial styles, these factors have been found either to be insignificant or to operate in ways that were not expected. Furthermore, our results, and those emanating from overseas over the last few years, are also showing that factors common to all industries, such as the extent of learning, knowledge spillovers, appropriability and managerial style, are more important than industry specific forces. Among all the independent variables that were measured on the Likert scales – and thus can in some sense be compared – knowledge spillovers and managerial aggression had much higher coefficients (by a multiple of more than 4) meaning that these two attributes are the most important determinants or complementary instruments.

What this implies for industry policy is unclear for it does not necessarily follow that more innovation is socially preferred. However, it does suggest that policy makers who believe that industry levels of innovation, in the sense of invention, imitation and adoption, is too low, should consider enhancing the effectiveness of avenues for learning, industry knowledge spillovers and the private means by which firms protect the advantages arsing from their innovations (bearing in mind however that the last two factors conflict).

References

Arvanitis, S. (2002) Explaining innovative activity in service industries: Micro data evidence for Switzerland,, 56, Swiss Institute for Business Cycle Research, Swiss Federal Institute for Technology.

Arvanitis, S. and Kleinknecht, A. (1996) Industrial innovation in Switzerland: A model-based analysis with survey data, In *Determinants of Innovation. The Message from New Indicators*(Ed, Kleinknecht, A.) Macmillan, Hampshire and London, pp. 13-62.

Athreye, S. (2001) 'Competition, Rivalry and Innovative Behaviour', *Economics of Innovation and New Technology,* **10,** 1-23.

Brouwer, E. and Kleinknecht, A. (1996) Determinants of innovation: A microeconometric analysis of three alternative innovation output indicators, In *Determinants of Innovation. The Message from New Indicators*(Ed, Kleinknecht, A.) Macmillan, Hampshire and London, pp. 99-124.

Covin, J. G., Slevin, D. P. and Heeley, M. B. (2001) 'Strategic decision making in an intuitive vs. technocratic mode: structural and environmental considerations', *Journal of Business Research,* **52,** 51-67.

Crepon, B., Duguet, E. and Kabala, I. (1996) Schumpeterian conjectures: A moderate support from various innovation measures, In *Determinants of Innovation. The Message from New Indicators*(Ed, Kleinknecht, A.) Macmillan, Hampshire and London, pp. 63-98.

Dosi, G. (1988) 'Sources procedures and microeconomic effects of innovation', *Journal of Economic Literature,* **26**.

Felder, J., Licht, G., Nerlinger, E. and Stahl, H. (1996) Factors determining R&D and innovation expenditure in German manufacturing industries, In *Determinants of Innovation. The Message from New Indicators*(Ed, Kleinknecht, A.) Macmillan, Hampshire and London, pp. 125-154.

Geroski, P. and Walters, C. (1995) 'Innovative activity over the business cycle', *Economic Journal,* **105,** 916-28.

Hall, P. (1994) *Innovation, Economics and Evolution,* Simon & Schuster International Group, Hemel Hempstead.

Hollenstein, H. (2002) Determinants of the adoption of information and communication technologies (ICT),, 60, Swiss Institute for Business Cycle Research, Swiss Federal Institute for Technology.

Huselid, M. A. (1995) 'The Impact of Human Resource Management Practices on Turnover, Productivity, and Corporate Financial Performance', *Academy of Management Journal,* **38,** 635-672.

Jorgenson, D. W. (1971) 'Econometric studies of investment behaviour: A survey', *Journal of Economic Literature,* **9,** 1111-47.

Keynes, J. M. (1937) 'The general theory of employment', *Quarterly Journal of Economics,* **51,** 209-23.

Kleinknecht, A. (1996) New indicators and determinants of innovation: An introduction, In *Determinants of Innovation. The Message from New Indicators*(Ed, Kleinknecht, A.) Macmillan, Hampshire and London, pp. 1-12.

Knight, F. H. (1921) *Risk, Uncertainty and Profit,* Houghton Mifflin company, The Riverside Press Cambridge, 1946, Boston, New York.

Levin, R. C., Klevorick, A. K., Nelson, R. R. and Winter, S. G. (1987) 'Appropriating the Returns from Industrial Research and Development', *Brookings Papers on Economic Activity,* **3,** 783-820.

Martinez-Ros, E. and Labeaga, J. (2002) 'The relationship between firm size and innovative activity: A double decision approach and an application to Spanish manufacturing firms', *Economics of Innovation and New Technologies,* **11,** 35-50.

Miller, P. (1994) 'Wage subsidies', *Economic and Labour Relations Review,* **5,** 1-10.

Nelson, R. R. (1959) 'The simple economics of basic scientific research', *Journal of Political Economy,* **67,** 297-306.

Nelson, R. R. and Winter, S. G. (1982) *An Evolutionary Theory of Economic Change,* Belnap Press of Harvard University Press., Cambridge Mass. and London.

Schmookler, J. (1966) *Invention and economic growth,* Harvard University Press, Cambridge, Mass.

Shackle, G. L. S. (1961-62) The description of uncertainty, In *The Nature of Economic Thought* Cambridge University Press, [1966], Cambridge, pp. pp. 85-99.

Webster, E. and Loundes, J. (2003) The Industrial Relations Climate in Large Australian Organisations,, mimeo, Melbourne Institute of Applied Economic and Social Research, University of Melbourne.

Webster, E. M. (1999) *The Economics of Intangible Investment,* Edward Elgar, Cheltenham.

Table 1: Organisation characteristics, Australia 2001

	Respondent percentage	Top 1000 percentage
Major industry group		
Agriculture, Forestry & Fishing	0.4	0.8
Mining	2.8	4.5
Manufacturing	26.2	25.2
Electricity, Gas & Water Supply	8.2	4.8
Construction	2.5	2.9
Wholesale Trade	9.2	15.6
Retail Trade	6.0	6.4
Accommodation, Cafes & Restaurants	0.7	0.2
Transport & Storage	5.3	3.8
Communication Services	0.4	1.3
Finance & Insurance	11.0	15
Property & Business Services	8.2	8.1
Government Administration & Defence	0.7	0.4
Education	5.7	2.6
Health & Community Services	3.9	4.0
Cultural & Recreational Services	2.5	3.1
Personal & Other Services	2.5	1.3
Missing	3.9	-
Total	*100.0*	*100.0*
Location		
ACT	0.7	1.2
NSW	43.6	49.9
NT	0.0	0.1
QLD	11.4	7.8
SA	7.8	5.3
TAS	0.4	0.9
VIC	27.3	28.0
WA	5.0	6.8
Missing	3.9	-
Total	*100.0*	*100.0*
Employment size		
Under 200	11.4	16.4
200 to under 500	14.9	17.6
500 to under 1000	18.1	19.6
1000 to under 5000	39.4	34.7
Over 5000	16.3	11.7
Total	*100.0*	*100.0*

Note: The author would like to thank Joanne Loundes for collating this table.

Source: Melbourne Institute Business Survey 2001

Table 2: Variable definitions and descriptive statistics[a]

Variable	Description	Mean	Standard deviation
Human technologies			
Innovation mode	A 8-item, 7 point scale measuring the emphasis on creativity and innovation (α=0.82)	4.52	0.92
External conditions			
Physical technologies	A 2-item, 7 point scale measuring investment in new physical equipment and technologies (α=0.44)	4.39	1.18
Corporate structure & size			
Foreign owned	A dummy variable (1=yes, 0=no)	0.42	0.49
Single integrated business	A dummy variable (1=yes, 0=no)	0.48	0.50
Multiple related business	A dummy variable (1=yes, 0=no)	0.23	0.42
State Government authority	A dummy variable (1=yes, 0=no)	0.19	0.40
Public listed company (industrial)	A dummy variable (1=yes, 0=no)	0.02	0.15
Public listed company (mining)	A dummy variable (1=yes, 0=no)	0.19	0.40
Public not-listed company	A dummy variable (1=yes, 0=no)	0.35	0.48
Log of total revenue	Dollars	13.18	1.09
External product market			
17 major industry groups	A dummy variable (1=yes, 0=no) for each industry		
Volatile product market	A 5-item, 7 point scale measuring variability in demand, competitors, technologies (α=0.78)	3.85	1.03
Contestability	A 2-item, 7 point scale measuring ease of entry to product market (α=0.78)	3.70	1.31
Knowledge spillovers from industry – product advantages	8 item 7 point scales for each industry measuring how effective companies are in protecting their product advantages.	4.42 (average)	1.03 (average)
Knowledge spillovers from industry – process advantages	8 item 7 point scales for each industry measuring how effective companies are in protecting their process advantages.	4.26 (average)	1.03 (average)
External labour markets			
Tight labour market	A 7 point scale measuring how difficult it is to find suitable people (α=0.70)	4.04	1.51
Low turnover of skilled staff	A 7 point scale measuring turnover relative to other firms (α=0.12)	4.81	1.35
Liquidity constraints	Ratio accounting liabilities to total equity	0.58	0.26
Complementary practices			
Management style			
Inflexibility of management	An 8-item, 7 point scale measuring how difficult it is for the firm to change in response to external conditions (α=0.82)	3.41	0.85
Systematic style	A 6-item, 7 point scale measuring whether managers use systematic analysis rather than intuitive methods for making decisions (α=0.55)	4.53	0.74
Aggressive style	A 5-item, 7 point scale measuring how bold and aggressive managers are (α=0.71)	4.20	0.90
Communication techniques	A 4-item, 7 point scale measuring the extent to which management seek to communicate with workers (α=0.75)	4.33	1.02
Extent of learning	An 11 item, 7 point scale measuring the extent to which the firm learns about new processes and products (α=0.79)	4.08	0.87
Extent of appropriability (products)	An 8 item, 7 point scale measuring the effectiveness of protecting advantages from product innovations (α=0.80)	4.42	1.03
Extent of appropriability (processes)	An 8 item, 7 point scale measuring the effectiveness of protecting advantages from process innovations (α=0.80)	4.26	1.03

Notes: a. Only items with factor loadings with absolute values greater than 0.25 are included in the variable measure.

b. Median.

Source: Melbourne Institute Business Survey 2001

Table 3: Regressions results: Dependent variable = Extent of innovation

Independent variables	Coefficient	t	Coefficient	t
Physical technologies	0.244	6.690	0.242	9.030
Corporate structure & size				
Log of total revenue	-0.037	-1.000	-0.066	-3.220
Foreign ownership	0.138	1.300	0.150	2.460
Single integrated business	-0.140	-1.040		
Multiple related business	-0.163	-1.210		
Federal Government Authority	0.353	0.870		
State Government Authority	-0.057	-0.370		
Public listed company - industrial	0.260	2.250	0.262	3.620
External product market				
Mining	0.334	1.270		
Manufacturing	0.120	0.660		
Electricity, Gas and Water Supply	0.038	0.170		
Construction	-0.023	-0.070		
Wholesale Trade	0.309	1.550	0.120	1.350
Retail Trade	0.085	0.320		
Accommodation, Cafes and Restaurants	0.290	0.860		
Transport and Storage	0.306	1.280		
Communication services	-0.283	-0.530		
Finance and Insurance	0.020	0.090		
Property and Business Services	0.239	1.040		
Government Administration and Defence	0.027	0.070		
Education	-0.143	-0.580		
Health and Community Services	-0.262	-0.990		
Cultural and Recreational Services	-0.182	-0.750		
Volatile product market	0.130	3.430	0.093	3.390
Contestability	-0.011	-0.400		
Tight skilled labour market	-0.008	-0.310		
Low skilled labour turnover	0.020	0.780		
Few knowledge spillovers (products)			-0.392	-6.600
Few knowledge spillovers (processes)	-0.494	-4.26		
Liquidity constraints	-0.034	-0.220		
Management style				
Inflexibility of management	-0.059	-1.360	-0.106	-3.390
Systematic style	-0.046	-0.980		
Aggressive style	0.224	4.730	0.217	6.530
Communication techniques	0.108	3.070	0.060	2.370
Extent of learning	0.064	1.340	0.059	1.630
Extent of appropriability (products)	-0.130	-1.820	0.069	2.130
Extent of appropriability (processes)	0.136	2.260		
Adjusted R^2	0.683		0.688	
Root mean squared error	0.562		0.557	
N	171		235	

Method: non-linear estimation

Note: Personal and other services was the missing industry group

Table 4: Explanation of results: What factors are associated with more innovative firms

Associated factors
High rate of spending on physical plant and equipment
Corporate structure & size
Foreign owned
Larger size
Is a publicly listed industrial company (rather than government, private or mining company)
External product market
In wholesale trade (rather than another industry)
Operating in a more volatile product market
Receives more knowledge spillovers (both product and process advantages) from other firms in industry
Management style
More flexibility style of management
More aggressive style of management
Uses more forms communication within the firm
Senior manager report a higher rate of learning about new products and processes from outside the company
More successful in using measures to appropriate returns from their investments in product and process advantages

Figure 1: Human technologies flow chart