Chapter 2: Existing tests of the human capital and screening theories of the role of education in the labour market

2.1 Introduction

The first Chapter contained a summary statement of why it was difficult to test between human capital and screening theories of the role of education in the labour market. Under both theories, education leads to higher lifetime wages for individuals. Therefore, a positive correlation is observed between the wages of individuals and their education. In the human capital explanation, this occurs because education increases the productive capabilities of individuals. In screening explanations of the role of education, the relationship can arise solely because an individual’s education level is a reliable indicator of their ability and, hence, productivity.

The various tests undertaken between human capital and screening in the literature are described in this Chapter. To assist this discussion, the next Section describes a model where education both enhances productivity and serves a screening function. Some of the model’s properties and their implications for tests between the theories are described. The model is used to shape the description of these tests, which appears in the third Section. The fourth Section contains an assessment of the various tests, again informed by the model of the second Section. The conclusions from that assessment follow; principally that better tests are required to distinguish between the theories.

Before proceeding with this material, however, it is worth setting out an introductory ‘case study’ that summarises neatly the difficulties of testing between the theories. In Lazear (1977), the author criticised a paper by Wise (1975) that attempted to test between screening and human capital theories through various hypotheses based on school grades and college quality. Wise argued these hypotheses reflected differences in the predictions of the theories. Lazear disagreed and in so doing made a number of general observations about the difficulty of distinguishing between the theories. He argued that, in general, problems arose in testing between the theories because:

- first, under both theories, individual maximising-behaviour involved more able people acquiring more education and receiving higher wages;
second, despite assertions that the effect of qualifications on wages should decline over time under screening, any pattern of expanding or contracting wage relativities with increased experience could be explained under either theory by differences in skill growth – especially through training – or skill depreciation;

• third, tests based on individuals for whom screening considerations were purportedly irrelevant, such as the self-employed, assumed that individuals selected their education with self employment in mind and that their customers did not screen on the basis of credentials, which Lazear considered doubtful; and

• fourth, even examples of ‘surprising’ behaviour under screening, such as employers offering full scholarships for ‘unproductive’ schooling for employees, could involve a screening dimension. In this example, employers would know that only those students/employees with the highest ability would take up such offers.

These comments anticipated the direction of a number of proposals for tests between the theories (these tests are described in Section 2.3) and summarised the problems with such tests neatly. Lazear described the first point alone as ‘a fact that has made it virtually impossible to come up with a valid test of the screening hypothesis’ (1977: 252).

Despite the difficulty of the task, it was argued in the previous Chapter that it was important to attempt it. This Chapter sets out the attempts of others to distinguish between the theories and assesses their success.

2.2 A model of schooling involving screening and human capital

2.2.1 Description of the model

This Section sets out a model developed by Spence (1979) and also draws on the work of Riley (1976, 1979a, b). The model is used to inform and shape the description and assessment of published tests of human capital and screening theories that appear in subsequent Sections.
the model, individuals invest in education both as a signalling mechanism and to increase their productivity.¹

Employers observe individuals’ schooling levels but not their productivity in jobs, either before they are hired, or necessarily afterwards. Individuals know their own productivity,² and invest optimally in schooling to maximise their utility, which increases with their wage net of schooling costs. Schooling costs vary by individual and are lower for those with more ‘ability’, and hence, expected productivity. Employers pay individuals a wage equal to their expected productivity, conditional on their schooling level, and these expected productivities are realised.

Some rationing in the jobs filled by graduates takes place. This might occur through the operation of internal labour markets within firms. That is, only individuals with specific qualification levels may be considered for selection for designated intake points in organisations’ career ladders. For whatever reason, employers may ration the number of such positions. Employers endeavour to have these rationed positions filled by the most able individuals, or at least those with the lowest training costs, and they use observed schooling to achieve this. That is, they use schooling to sort between individuals.³

The model is described in detail in Appendix 2. It is not set out in a formal, game-theoretic way since it has already been described in the literature. Such signalling models can have multiple

¹ Game-theoretic aspects of the model are by-passed, with little emphasis given to the role of employer beliefs in supporting equilibria. These are dealt with elsewhere, for example Gibbons (1992), and are secondary to the issue of how to test the theories.
² Individuals know their own productivity in Spence’s model, but not in Riley (1979b). The signalling mechanism differs slightly between the models.
³ However, the Spence (1979) model departs in one important way from descriptions of the job competition model put forward by some of its proponents, such as Maglen (1991). Spence assumes that employers’ expectations about the productivity of individuals with specific levels of education are realised on average. While employers may not predict the average productivity of individuals with any educational level correctly at some point in time, over time it might be expected that any error would be eliminated.
only separating equilibria are analysed here, where those with different levels of ability acquire different levels of education, since individuals do appear to differentiate themselves from at least some others in practice by acquiring differing levels of education. Further, only the most efficient separating equilibrium is analysed, that is, the one where the lowest level ability group gets the schooling it would receive if productivity was observable. Following Spence (1979), let individual (discounted lifetime) productivity \( P \) be determined as

\[
P = AJS^\alpha
\]

where \( A \) is the specific element of ability that determines individual productivity, \( J \) is some productivity characteristic of the job, \( S \) is the individual’s years of schooling and \( \alpha \) is a parameter such that \( 0 \leq \alpha < 1 \).

Schooling is costly to acquire, with the costs varying between individuals. Specifically, costs vary according to the individual’s ‘type’ (general ability), with individuals of type \( T \) incurring discounted costs of \( C(S,T) \) to undertake \( S \) years of schooling, where \( C(.) \) is a differentiable cost function. As in all signalling models of this type, \( C_S > 0, C_T < 0 \), and \( C_{ST} < 0 \) (subscripts denote partial derivatives). That is, the costs of acquiring schooling increase with the years of schooling, fall with increases in the individual’s general ability or type, and the marginal costs of acquiring any specific level of schooling are lower for individuals of higher general ability. For convenience, in Spence’s model, \( C(S,T) = S/T \).

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4 An accessible formal presentation of the various equilibria in labour market signalling models appears in Gibbons (1992: 190 – 205).

5 The schooling variable is also treated as a ‘years of schooling’ variable. It is often treated formally as an education quality or achievement measure, since the ‘years of schooling’ approach involves dynamic decision-making. Noldeke and van Damme (1990) analysed such a dynamic process and found that the most efficient equilibrium is similar to the one described here.

6 It is more common in these models to also require \( C_{SS} > 0 \). That is, the marginal cost of education increases with the level undertaken. This would mean specifying \( C(S,T) = S^\phi/T \), with \( \phi > 1 \). In this example, it would result in another term in the schooling coefficient and the constant in equation (2.5), but it would not alter the nature of the results.
Let $U(W(S),S|T)$ denote the utility of a type $T$ worker choosing schooling level $S$ and receiving $W(S)$. The present value of individuals’ lifetime wage is given by $W(S)$, and it is assumed that individuals select their schooling to maximise their discounted lifetime wage net of schooling costs. That is

$$U(W(S),S|T) = W(S) - C(S,T).$$

The job-specific ability, $A$ is related to the individual’s general ability or type, $T$ such that

$$A = \left[ T' K(\varepsilon) \right] u$$

where $u$ is an error term with a mean of unity, distributed over the interval from $u_l$ to $u_h$ and $\varepsilon$ is a parameter, such that $\varepsilon \geq 0$. $K(\varepsilon)$ is the expected value of $T'$.

The unconditional expected value of $A$ is one and the parameter $\varepsilon$ is the elasticity of the conditional mean of $A$ with respect to $T$. It reflects the power of any signal of ability, while the dispersion of $u$ determines the noise in the signal. The cumulative distribution of $T$ is given by $H(T)$. The rationing or sorting process involves employers picking high ability individuals, that is, those with low training costs. They choose them for jobs with varying levels of $J$, some productivity-augmenting characteristic. The distribution of the productivity characteristic, $J$, is described by $G(J)$, where $G(.)$ is its cumulative distribution function. For example, $J$ could reflect firm-provided job-related training to workers.

The problem is to find an equilibrium wage schedule $W(S)$. In equilibrium, three conditions must be satisfied: individuals equate the marginal benefits and costs of schooling; the number of jobs with some productivity level must equal the number of individuals with the relevant schooling level (reflecting their type or training costs); and salaries are equal to expected productivity for individuals at each level of schooling. The first condition is just the usual individual first order condition for optimal schooling choices, while the third is a zero profits condition for competitive employers. The second condition simply means that employers offer as many jobs for each ability type (represented by schooling level attained) as there are members of that type.
in the workforce. Combining these conditions and specifying the functions $G(.)$ and $H(.)$ as having a Pareto distribution\(^7\), gives

\[
W(S) = [S^\alpha K(\varepsilon)] [\pi \theta]^{1/\beta} W^{-\gamma/\beta}
\]

or

\[
= [S^\alpha K(\varepsilon)] [\pi \theta]^{1/\beta} W^{-\gamma/\beta}
\]

where $\pi$ and $\beta$ are parameters of the distribution of job characteristics and $\theta$ and $\gamma$ are parameters of the distribution of types or marginal schooling costs. The solution to this first-order differential equation provides an equilibrium wage schedule, with one wage rate for each level of education.\(^8\) The solution, after integrating (2.4), gives

\[
W(S) = D K(\varepsilon)^{-1/(1+\phi)} S^{\alpha+\phi/(1+\phi)}
\]

where $\phi = \varepsilon + \gamma/\beta$ and $D = [(1+\phi) / (\alpha+\phi)]^{\alpha/(1+\phi)} [\pi \theta]^{1/\beta(1+\phi)}$.

2.2.2 Implications of the model

Some implications of the model are now summarised. These implications are derived more formally in Appendix 2. The purpose in emphasising these particular implications is twofold. Some highlight the common implications of the human capital and screening models, indicating how difficult it is to test between them. Other implications, however, have formed the basis of tests between human capital and screening used in the literature. The implications of note include:

\(^7\) That is, the cumulative distribution function $G(.)$ is given by $G(J) = 1 - \pi J^{-\beta}$, with the parameters satisfying the conditions $\beta > 0$ and $J \geq \pi^{1/\beta} > 0$ so that $G(.)$ possesses the properties of a cumulative distribution function (see Johnson and Kotz 1970: 234).

\(^8\) Spence, like others, assumed that when $u = u_c$, so $A = [T' / K(\varepsilon)] u_c$, then $S = 0$. That is, those of lowest ability do not undertake any education, which mirrors their choice in the presence of full information. Spence allowed $u_i$ to equal zero, so those with the lowest ability level had zero productivity.
(a) Wages increase with schooling, \( \frac{\partial W(S)}{\partial S} > 0 \) in equation (2.5).

The elasticity of the wage with respect to schooling in equation (2.5) includes the productivity-augmenting component, \( \alpha \); the signalling effect, \( \varepsilon \); and a sorting effect, \( \gamma / \beta \), incorporating the parameters from the distributions of the job productivity characteristic \( \beta \) and marginal schooling costs \( \gamma \). This last effect can be thought of as the productive component of education’s information role, representing its role in assigning high ability types to the most demanding jobs. If \( \beta \) is large relative to \( \gamma \), then there is little variation in the job characteristic and this rationing or sorting effect is minimal.

The positive relationship between wages and schooling does not arise solely from the fact that schooling increases productivity. This result also arises when \( \alpha = 0 \) in equation (2.1). Providing employers (or the market) hold beliefs that schooling reveals an individual’s ability, then \( W \) will be a function of \( S \) in equilibrium in equation (2.5), with the elasticity of wages with respect to schooling \( \phi / (1 + \phi) \). Hence, in any cross section, wages will be observed to rise with individuals’ levels of schooling. The presence of rationing with educational sorting reinforces the effects of screening on private returns to schooling and on schooling levels.

(b) Individuals with higher levels of ability undertake more schooling.

This result follows directly from the assumed schooling cost function where it is cheaper for more able individuals to acquire any given level of education. For any specified return to schooling, more able people therefore acquire more of it.

Like the previous implication of the model, implication (b) is common to both of the extreme cases: firstly, where schooling has no signalling or sorting role (productivity is observable); and secondly where schooling has only a signalling or a sorting role (schooling adds nothing to productivity, which is not observed). Hence, it cannot be used to distinguish between the theories.
(c) Individuals tend to over-invest in schooling where signalling and job rationing with sorting occur.

Implication (c) means that the equilibrium wage schedule, \( W(S) \), for some particular sector or occupation lies to the right of the relationship that would exist between schooling and wages if individual productivity was observable in the sector. That is, individuals tend to undertake more schooling than they would if productivity was observable.

This situation is depicted in Figure 2.1(a). The wage schedule with productivity observable is denoted by \( P(S) \). It traces out the series of optimal wage and schooling outcomes for average individuals of each type (with \( u = 1 \)). Their productivity functions (that is, equation (2.1) for each type) lie below that of the highest type, (denoted by the subscript ‘\( h \)’ in Figure 2.1(a)) and their schooling cost functions are steeper than that depicted for the highest ability type. Consequently they undertake less schooling than the highest ability types.

**Figure 2.1:**
(a) Same sector: with and without screening  
(b) Different sectors: screening in one sector; common \( \alpha \)

With both screening and sorting operating, the highest ability group undertakes schooling of \( S_{SC} \), which exceeds the level it would acquire if productivity was observable. All lower ability level
groups, other than the lowest, also obtain more schooling with screening and sorting operating than they would if productivity was observable. The lowest ability group obtains the same level of schooling in both situations by assumption, so although it is not depicted, both the $W(S)$ and $P(S)$ schedules in Figure 2.1(a), pass through the same point on the wages axis.

(d) The return to schooling is higher with signalling when operating together with job rationing and sorting than is the case where they do not operate. That is, the elasticity of wages with respect to education, $(\alpha + \phi)/(1+\phi)$, exceeds the productivity effect, $\alpha$, and this difference translates into higher rates of return to education.

Implication (d) has been used to test between the theories where researchers have argued that screening is more likely to operate in one sector of the economy than another (for example, the public sector compared with the private sector). In those circumstances, it has been used to argue that if

- individuals of at least one type are indifferent between working in the two sectors, so that some of them are found in both the screened and the unscreened sectors, and

- schooling adds to individual productivity in a similar way in both sectors ($\alpha$ is not smaller in the screened sector than the competitive sector)

then returns to schooling should be greater in the sector where screening operates.

This situation is depicted in Figure 2.1(b) for a representative individual of general ability level $t^*$. The individual is assumed indifferent between working in the unscreened sector and the screened one. The productivity function for the representative individual in the unscreened sector has a flatter shape at its optimum (at $S_{HC^{t^*}}$) than the screened sector equilibrium wage schedule, $W(S)$, which lies to the right of the unscreened sector’s productivity function.\(^9\) In the

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\(^9\) The two schedules no longer need to pass through the same point of the wages axis in Figure 2.1(b), since the average value of $J$ may differ between the sectors.
screened sector, workers of type \( t^* \) undertake \( S_{SCt^*} \) years of schooling and receive \( W(S_{t^*}) \) in lifetime income.\(^{10}\)

The optimum wage-schooling outcome in the unscreened sector lies to the left of the screened sector’s wage schedule, in order for the representative worker to be indifferent between the lifetime wages and schooling requirements of the sectors. This means that the wage schedule in the unscreened sector, \( P(S) \) (not shown) which passes through the optimal schooling level for the representative worker \( (S_{HCr}) \), lies to the left of the wage schedule of the screened sector, \( W(S) \). Therefore, for a given level of schooling, productivity and lifetime earnings are higher in the unscreened sector than the screened sector, reflecting the differences in the types who choose that schooling level in each sector.

Both implications (c) and (d) have been used to test between screening and human capital. In the former case, researchers have argued that observed levels of schooling should also be greater in sectors where screening operates than in others where it does not. Figure 2.1(b) illustrates this argument in part – individuals require higher schooling levels in the screened sector than the unscreened one to generate the same income. The observations based on implications (c) and (d), explicitly or implicitly, form the basis of many of the tests between the screening and human capital theories proposed in the literature. There are two mirror-image implications to these two, however.

(e) The elasticity of wages with respect to schooling in equation (2.5), \( (\alpha + \phi)/(1 + \phi) \), where schooling is productive and signalling and job rationing with sorting operate, is higher than the case where schooling is not productive and individual productivity is unobserved, \( \phi/(1 + \phi) \).

\(^{10}\) Note that there is no tangency condition between the indifference curve and the equilibrium wage schedule in the screened sector, \( W(S) \). \( W(S) \) identifies the sole wage-schooling combination available for each type. Once their schooling is obtained, individuals do not choose where to situate themselves on the \( W(S) \) schedule. The indifference curve is a positively-sloped straight line, since \( (dW/dS)_{t^*} = C_S = 1/T > 0 \), using equation (2.2) and the specification of the education cost function.
Where schooling is not productive and individual productivity is unobserved, individuals undertake less schooling than when signalling, sorting and human capital operate together.

Implication (e) of the model means that the return to schooling from this screening model with productive schooling is greater than if only one of the effects operate, while (f) means that individuals will tend to over-invest in education. Discussion in Section 2.4, will show that these implications confound many of these tests that have been based on implications (c) and (d).

One point of note from equation (2.5) for tests of the theories is that signalling and job rationing with sorting of the kind specified here have similar effects on the elasticity of wages with respect to schooling and on the optimal level of schooling. That suggests that any suitably specified tests of whether signalling operates in the labour market based on income or schooling levels will also test whether rationing might also be operating. No such test will be able to tell these effects apart, but a rejection of the operation of signalling will also be a rejection of rationing with sorting.\textsuperscript{11}

2.3 Tests of screening

Since actual individual productivity is rarely observed, most tests of the extent to which schooling adds to productivity have been indirect, with the studies typically utilising wages or earnings data as representative measure of productivity.

Before describing these indirect tests, it is worth noting that that a few direct tests of the role of schooling in increasing productivity have been undertaken. One is Boissiere \textit{et al.} (1985), reported in more detail than in the original in Knight and Sabot (1990), where the authors used data from Tanzania and Kenya that included independent measures of the reasoning and cognitive skills of urban workers. They found that schooling did contribute to individuals’ cognitive skills, as well as their earnings. Other tests have looked at the role of schooling in increasing individual productivity in agriculture in low-income countries and found a positive

\textsuperscript{11} It is possible to distinguish these effects based on changes in the distribution of jobs with the productivity characteristic. These changes would identify the sorting effect.
effect. These studies are summarised in Carnoy (1995). For developed countries, Carnoy (1995) argued that tests of the impact of schooling on productivity in non-agricultural sectors have been rarely undertaken and are inconclusive.

The following simple descriptive framework involving two similarly structured wage equations is used to describe the various indirect tests proposed in the literature.¹² Whether an individual is accounted for in the first or second equation depends on an indicator variable, \( F \), which takes the value of one or two. This indicator variable is just a device that aids the description of the various tests. For example, \( F = 1 \) might correspond with self-employed workers, while \( F = 2 \) corresponds with employees. In other cases, the two categories might reflect whether individuals have jobs in the private or government sectors, respectively.

For expositional purposes, let an individual’s wage \((W)\) be associated with their schooling \((S)\), their experience \((E)\), their true ability \((A)\), the type of job they work in \((J)\), their individual characteristics \((Z)\) and let \( X \) be an imperfect measure of an individual’s ability.

If \( F = 1 \), then

\[
\ln W_1 = \eta_1 + \alpha_1 J_1 + \beta_1 S_1 + \gamma_1 E_1 + \phi_1 X_1 + \theta_1 Z_1
\]

where the Greek letters are parameters.

If \( F = 2 \), then

\[
\ln W_2 = \eta_2 + \alpha_2 J_2 + \beta_2 S_2 + \gamma_2 E_2 + \phi_2 X_2 + \theta_2 Z_2
\]

The various tests proposed in the literature that aim to distinguish between human capital and screening are described in the following sub-sections and are summarised in Table 2.1. The summary assessments of the tests in Table 2.1 are based on discussion in Section 2.4. In the

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¹² In most studies, a single equation is estimated, with the difference between the groups picked up through a dummy variable. Most studies ignore the potential endogeneity of the dummy variable, which would require estimation of regime switching models.
description of the tests in this Section, most emphasis is given to those tests with the largest number of applications. The various indirect tests in the literature between screening and human capital are characterised as belonging to three groups:

- Tests of whether the returns to schooling or aggregate earnings differ by job type or individual characteristics;

- Tests of whether the level of schooling obtained by individuals differs according to their occupations or job types; and

- Tests incorporating the quality of the signal provided by education.

The model described in the previous Section was one in which schooling had both a productivity enhancing and a screening or an information role. If human capital and screening can operate simultaneously, evidence in support of one of them does not necessarily reject the operation of the other. In fact, very few of the tests specifically involves any assessment of whether schooling enhances productivity (i.e. $\alpha > 0$ from Section 2.2). More often, the tests are of whether screening operates in some form. The problems identified with the tests are discussed in Section 2.4.

2.3.1 Tests of whether the returns to schooling or aggregate earnings differ by job type or individual characteristics

P Test (Psacharopoulos 1979)

Psacharopoulos drew a distinction between ‘strong’ screening, where schooling did not add to individual productivity, and ‘weak’ screening, where employers used schooling levels in determining individuals’ starting wages, in the absence of better information about their productivity. Psacharopoulos proposed two tests of strong screening.
Table 2.1: Summary of tests between human capital and screening

<table>
<thead>
<tr>
<th>Nature of Test: Supports screening if:</th>
<th>Studies</th>
<th>Typical Results</th>
<th>Problems with test</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Tests based on comparisons of earnings or rates of return to schooling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rates of return should: be higher in</td>
<td>Psacharopoulos (1979); Cohn et al. (1987); Lambropoulos (1992); Ziderman (1992); Arabsheibani and Rees (1998); Oosterbeek (1993), Fredland and Little (1981); Tucker (1985, 1986); Grubb (1993, 1995); Brown and Sessions (1999)</td>
<td></td>
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<tr>
<td>the uncompetitive sector (public sector or employees) than the competitive sector (private sector or the self-employed); and should fall with experience.</td>
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<tr>
<td>Rates of return are lower in the public sector than the private sector and do not fall with experience. Returns tend to be higher for the self-employed.</td>
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<tr>
<td>Rates of return need not be higher in the uncompetitive sectors under screening; studies tend to ignore selection/ability bias issues; second test ignores screening prediction that productivity will increase with schooling levels, which reflect ability levels.</td>
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<tr>
<td>Earnings should be higher for the (competitive) self-employed than employees.</td>
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<tr>
<td>Riley (1979b); Shah (1985); McNabb and Richardson (1989);</td>
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<tr>
<td>Earnings are higher for the self-employed in screened occupations.</td>
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<tr>
<td>Unconvincing split of occupations into screened and unscreened. Over all tests undertaken, the support for screening was quite modest.</td>
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<tr>
<td>Graduates working in their field earn no more than those outside.</td>
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<tr>
<td>Miller and Volker (1984); Arabsheibani (1989);</td>
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<tr>
<td>Only first study supported screening.</td>
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<tr>
<td>Ignores the role of graduate preferences that might reduce the wages of those in their fields.</td>
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<tr>
<td>(b) Tests based on schooling levels</td>
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<tr>
<td>Schooling levels of the self-employed &lt; employees.</td>
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<tr>
<td>Wolpin (1977); Riley (1979b)</td>
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<tr>
<td>Little difference between the groups.</td>
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<tr>
<td>Neither returns nor schooling levels need be different between the groups.</td>
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<tr>
<td>In high(low) skill jobs, self-employed schooling levels &lt; (&gt;) employees.</td>
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<tr>
<td>Katz and Ziderman (1980); Cohn et al. (1987)</td>
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<tr>
<td>First study supported screening, second human capital.</td>
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<tr>
<td>Little theoretical justification. Neither returns nor schooling levels need be different between the groups.</td>
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<tr>
<td>(c) Tests incorporating the education signal</td>
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<tr>
<td>Slow (fast) completion of schooling should be penalised (rewarded).</td>
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<tr>
<td>Layard and Psacharopoulos (1974); Hungerford and Solon (1987); Oosterbeek (1992); Frazis (1993); Groot and Oosterbeek (1994)</td>
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<tr>
<td>Slow completion is not penalised; though returns are greatest in diploma years; fast completion is not rewarded.</td>
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<tr>
<td>Ignores selection effects - completers and non-completers may be different, with penalties under both theories.</td>
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<tr>
<td>Returns to certificate years &gt; non-certificate years; return to qualifications fall with experience/tenure.</td>
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<tr>
<td>Lui and Wong (1982); Ziderman (1990)</td>
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<tr>
<td>Separate from returns to years of education, returns to specific qualifications do fall over time.</td>
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<tr>
<td>If knowledge or schooling costs are ‘lumpy’, returns between certificate and non-certificate years may differ under human capital. Studies draw life cycle inferences from cross sections and qualifications may differ across cohorts.</td>
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<tr>
<td>Other information on applicants should supplant education’s role in hiring decisions.</td>
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<tr>
<td>Albrecht (1981)</td>
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<tr>
<td>Other information did not reduce education’s role.</td>
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<tr>
<td>Other information variable was itself not significant - possibly a poor measure of information.</td>
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<tr>
<td>Individuals act to maintain their educational attainment ranking in their cohort. Minimum schooling age increases will increase older groups’ schooling.</td>
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<tr>
<td>Lang and Kropp (1986); Kroch and Sjoblom (1994)</td>
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<tr>
<td>Older age participation is affected by minimum schooling laws. In the second study, rank had no effect on wages.</td>
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<td></td>
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<tr>
<td>Changed requirements may be linked with campaigns to increase participation or more school places. The educational ranking and years of schooling would be highly collinear.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education expansion should have no impact on income distribution or differentials between groups.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maglen (1991)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Results provided some support for both theories.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If employers discover worker productivity quickly, the screening component of the return to schooling must be small.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Altonji and Pierret (1997)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The learning process appeared to be quite fast, so that the screening element must be small.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exactly how much employers know is not identified – only the rate at which they know it. The authors assume that the knowledge is high after 15 years.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The first of Psacharopoulos’ tests involved comparisons of rates of return between the (unscreened) private and (screened) public sectors of the economy. Psacharopoulos argued that wages in the competitive private sector would be “more or less determined by economic variables” (1979: 183). However, he considered that in the public sector wages could deviate substantially and persistently from individuals’ true marginal productivity, presumably because productivity was either difficult to observe or bureaucratic rigidities entrenched poor decisions to promote some individuals and not others. He argued that returns to schooling should, therefore, be higher in the screened sector (as depicted in Figure 2.1(b)).

The second test involved comparisons of the wage-experience profiles of workers with different levels of schooling, based on an argument that employers should give less weight to workers’ schooling levels in setting their wages as firms had more opportunity to observe their productivity. He argued that strong screening implied that the observed returns to schooling for older workers should fall. Lower mid- to early-career earnings ratios for the more educated than the less educated, reflecting their slower wage growth as their true productivity was revealed, would be evidence of this phenomenon. The hypotheses can be formally stated as:13

(i) Let

\[ F = 1 \text{ if the individual is working in the ‘competitive’ or private sector, and} \]
\[ F = 2 \text{ if the individual is working in the public sector} \]

Then

\[ \beta_1 < \beta_2 \quad \text{[Support for screening]} \]
\[ \beta_1 = \beta_2 \quad \text{[Rejection of screening]} \]

(ii) Let

\[ F = 1 \text{ if workers have some high level of education, and} \]
\[ F = 2 \text{ if workers have some lesser level of schooling} \]

and let \( E^* < E^{**} \), that is workers at each schooling level have one of two levels of work experience, with associated wages \( W^* < W^{**} \).

13 The Greek letters and other symbols in the statements of the hypotheses in this and the following two sub-sections refer to equations (2.6) and (2.7).
Psacharopoulos found no support for screening in his study using English data. The earnings ratios showed no signs of convergence – that is, the wages of more educated individuals grew at least as fast as the wages of less educated ones. Psacharopoulos reported higher rates of return for the private sector than the screened public sector, as did Tucker (1986), Cohn et al. (1987) (both studies used US data), Lambropoulos (1992) (Greek data) and Ziderman (1992) in one set of results using Israeli data. Arabsheibani and Rees (1998) corrected for the self-selection of individuals into the English private and public sectors. They found that returns to schooling remained higher in the private than the public sector, as did the mid- to early-career earnings ratios.

Oosterbeek (1993), summarising results in Hartog and Oosterbeek (1993), reported that when they corrected for self-selection by Dutch individuals and differences in ability, returns became higher in the public sector than the private sector. Brown and Sessions (1999) report only the results corrected for self-selection and find that returns in the Italian public sector are higher than those for private sector employees, which in turn are higher than among the self-employed.

For Australia, Preston (1997) reported higher returns to male degree holders in the private than the public sector. McNabb and Richardson (1989) reported almost identical rates of return to schooling for males between the sectors, with the return in the public sector marginally higher than the private sector. Neither study claimed to be undertaking any test between the theories in reporting these results, however.

Riley (1979b) tests

Riley’s theoretical model predicted that for individuals with common levels of unobserved ability (and hence schooling), lifetime earnings in occupations he identified as unscreened should be higher than those identified as screened. This result relied on the assumption that an increase in productivity in the screened sector arising from an increase in schooling was not less than that found in the competitive sector.
Riley (1979b) estimated a wage equation on US data including a large number of occupational dummy variables. He used the coefficients on these occupational dummies and levels of schooling in the occupations, to split the occupations into four groups, depending on whether the coefficients were positive or negative and whether schooling was above or below average. Those occupations with low schooling and high lifetime earnings (represented by the occupational dummies) were considered the unscreened occupations. Those with high schooling and low lifetime earnings were deemed the screened occupations. The former group consisted primarily of professional occupations. The latter, screened group of occupations was dominated by teaching professions. Riley made use of a diagram like Figure 2.1(a), and interpreted it for individual occupations where screening operated. He argued that within screened occupations, the self-employed know their productivity, so their wages trace out the schedule $P(S)$, which lies above the schedule $W(S)$ faced by employees in the same occupation.

Riley estimated earnings functions for each of these occupational groups. Riley tested whether

(i) within the designated screened occupations, the self-employed were paid more than those who were employees;

(ii) the wage equations provided a better fit of the data in screened than unscreened occupations; and

(iii) the variance of earnings in screened occupations increased with experience as individuals’ productivity levels were revealed over time.

Emphasis is given only to the first test here, since that was the one Riley focused on.

The hypothesis can be stated formally as:

---

14 With only the intercept varying through the occupational dummies, a higher coefficient for an occupational dummy translates into higher lifetime wages in Riley’s results.
Let

\[ F = 1 \text{ if the individual is self-employed,} \]

\[ F = 2 \text{ if the individual is an employee, and} \]

\[ J_1 = J_2 \text{ that is, if individuals are in the same occupations.} \]

\[ \begin{align*}
\eta_1 > \eta_2 & \quad \text{[Support for screening]} \\
\eta_1 = \eta_2 & \quad \text{[Rejection of screening]} 
\end{align*} \]

Riley found some support for the proposition that the self-employed individuals earn more than
the employed among the occupations that he classified as screened occupations. The self-
employed earned significantly less than employees among the unscreened occupations. Riley’s
other tests provided modest support for screening in conjunction with schooling that enhances
productivity.

McNabb and Richardson (1989) replicated Riley’s approach using Australian data. They used
1981-82 income survey data on males. Their list of screened occupations included: nurses;
insurance and real estate salesmen; mechanics, plumbers and metal machinists; leather sewers;
and compositors, printing machinists and engravers. The unscreened group consisted of: miners;
railway guards and conductors; telecommunications workers; fire brigade, police and other
protective services; potters, tobacco, chemical, sugar and paper production workers.

McNabb and Richardson found that the lifetime earnings of the unscreened group were above
those of the screened group, that the screened equation fitted the data much better and that the
observed return to schooling and experience were much higher among the screened group. These
findings supported the operation of screening, in an environment where schooling was
productive.

\begin{footnote}
Shah (1985) is an application of Riley’s approach to UK data. It provided qualitatively similar
results to Riley’s, implying some modest support for screening. The list of screened occupations
was more coherent than McNabb and Richardson’s, though it contained few professional
occupations.
\end{footnote}
Fredland and Little (1981)

Others, notably Fredland and Little (1981), Tucker (1985) and Grubb (1993, 1995), have tested the return to schooling between employees and the self-employed, arguing that the self-employed have no need to signal to potential employers and presumably know their own productivity. In such circumstance, the return to schooling for the self-employed will be zero if schooling does not enhance productivity. Whatever its level, it should be less than that observed for employees where their employers are unsure about their true productivity so that screening operates.\(^{16}\)

The hypothesis can be stated formally as:

<table>
<thead>
<tr>
<th>Let</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F = 1$ if the individual is self-employed,</td>
</tr>
<tr>
<td>$F = 2$ if the individual is an employee, and</td>
</tr>
<tr>
<td>Then</td>
</tr>
<tr>
<td>$\beta_1 &lt; \beta_2$</td>
</tr>
<tr>
<td>$\beta_1 = \beta_2 &gt; 0$</td>
</tr>
</tbody>
</table>

[Support for screening] [Rejection of screening and support for human capital]

Both Fredland and Little (1981) and Tucker (1985) rejected the screening hypothesis in their tests using US data, finding that the return to schooling was higher among the self-employed. Grubb (1993) undertook a similar test.\(^{17}\) In corrected results, Grubb (1995) found that having a

\(^{16}\) As Lazear (1977) noted, this argument assumes that the self-employed invest in education with that specific sector in mind and have no need to signal to potential customers. This seems unlikely in the case of many professional occupations, though Tucker (1987) did not find evidence of screening by consumers. Tucker tested whether the difference in the rate of return between highly-educated employed and self-employed individuals was higher among service-producers, where quality is hard to observe, than among all producers, including goods producers, where quality was more observable.

\(^{17}\) Grubb attributed the test to Wolpin (1977). Wolpin’s discussion of how estimated earnings functions might help disentangle the two theories was quite pessimistic, like that in Lazear (1977). Grubb drew on the work of Garen (1985) in developing his test. Garen (1985) looked at the effect of other screening mechanisms used by firms on observed returns to education. Grubb
college degree increased the earnings of the employed, but not the self-employed and interpreted this as evidence consistent with screening. He interpreted higher earnings among employees resulting from some other qualifications as also supporting screening. Mendes de Oliviera et al. (1989) reported results of a switching regression using US data, where the returns to schooling were higher among the self-employed than employees, though they did not discuss these results in the context of testing between human capital and screening.\footnote{McNabb and Richardson (1989) also undertook a test of this form, finding the returns to education were lower for the self-employed, but largely discounted their findings because other elements of the comparison were unsatisfactory.}

**Wiles (Miller and Volker 1984 version)**

Miller and Volker (1984) undertook a test of whether graduates working in occupations related to their field of study earn more than those working in unrelated fields. If they do, the authors argued that this must reflect employers’ positive valuation of graduates’ specific, education-acquired skills. If they do not, then only their qualification is important to employers, which would support screening.\footnote{Miller and Volker attributed this test to Wiles (1974). It is at least arguable on a close reading of Wiles’ paper that he had a slightly different test in mind. That test was whether within a specific occupation, graduates with related qualifications earned more than those whose qualifications were from other fields. This approach has not been implemented in the literature to date.}

The hypothesis can be stated formally as:

\[
\begin{align*}
\text{Let } & F = 1 \text{ if the individual is working in a job related to their qualification, and} \\
& F = 2 \text{ if the individual is not working in a job related to their qualification}
\end{align*}
\]
Then for $S_1 = S_2$ (both the schooling level and the field of study), the test is whether

\[
\begin{align*}
\beta_1 &= \beta_2 \quad \text{[Support for screening and rejection of human capital]} \\
\beta_1 &> \beta_2 \quad \text{[Support for human capital]}
\end{align*}
\]

Miller and Volker (1984) tested this for recent Australian graduates and found only one group among four where the return to schooling was higher for those working in an occupation related to their field of study. They interpreted this result as implying that schooling does little to increase productivity. Arabsheibani (1989) found that Egyptian graduates working in occupations related to their fields of study did earn more than those who were working outside their fields.

Grubb (1997) reported returns to different levels of schooling depending on whether individuals were working in occupations related to their fields of study or not, but did not discuss these results in the context of testing between human capital and screening. The study used US data and was not restricted to recent graduates. The estimated returns were higher in related occupations than unrelated ones. For qualifications below the degree level, returns in unrelated occupations were rarely significantly different from zero. Neuman and Ziderman (1999) reported that graduates of vocational schools in Israel had higher earnings than their counterparts from academic secondary schools providing they worked in occupations that were related to their vocational courses.

2.3.2 Tests of whether the level of schooling obtained by individuals differs according to their job types

Wolpin (1977) and Riley (1979b) test

Wolpin (1977) and Riley (1979b) argued that, for individuals with common ability levels in the same occupation, the self-employed would always undertake less schooling than screened employees. This test, therefore, compares the schooling levels of the self-employed and employees and reflects the discussion of Figure 2.1(a) on the implications of the model used in the Section 2.2.
The hypothesis can be stated formally as:

Let

\[ F = 1 \text{ if the individual is self-employed}, \]
\[ F = 2 \text{ if the individual is an employee}, \]

where \( J_1 = J_2 \) that is, for individuals in the same occupations (in Wolpin’s case, these were non-professional occupations) then

\[
\begin{align*}
S_1 < S_2 & \quad \text{[Support for screening]} \\
S_1 = S_2 & \quad \text{[Rejection of screening]}
\end{align*}
\]

Wolpin (1977) found very little difference in the years of schooling of the self-employed and the employed in US data and concluded that there was no evidence of ‘a predominant screening interpretation’ of education. McNabb and Richardson (1989) found that the mean level of schooling for the self-employed was 0.3 of a year less than the employed in Australia, concluding this particular finding provided little evidence of the operation of screening.

Katz and Ziderman (1980) test

In contrast to Wolpin (1977) and Riley (1979b), this test is based on the idea that the self-employed have greater flexibility over their schooling decisions than do employees. This flexibility means they undertake less schooling than employees in highly skilled occupations, but more in low skilled ones. The first case arises because employees must impress their employers, while the second occurs because the self-employed need to acquire self-employment skills. The hypothesis can be stated formally as:

Let

\[ F = 1 \text{ if the individual is self-employed}, \]
\[ F = 2 \text{ if the individual is an employee}, \]

\[ J \text{ indexes the skill level of jobs (the occupation)}, \]
\[ J > J*. \]

Then if \( J_1, J_2 > J** \)
\[
S_1 < S_2 \quad \text{[Support for screening]}
\]
if \( J_1, J_2 < J* \)
\[
S_1 > S_2 \quad \text{[Support for screening]}
\]
while if \( J_1, J_2 > J** \)
\[
S_1 = S_2 \quad \text{[Rejection of screening]}
\]
if \( J_1, J_2 < J* \)
\[
S_1 = S_2 \quad \text{[Rejection of screening]}
\]
Katz and Ziderman found support for screening from individuals’ schooling levels from Israeli data, while Cohn et al. (1987) did not from US data.

2.3.3 Tests incorporating the quality of the signal provided by education

Layard and Psacharopoulos (1974)

Layard and Psacharopoulos (1974) argued that, under screening, slow completion of qualifications is a poor signal to employers that should be penalised in the wages individuals receive. That is, if individuals take longer than normal to complete their highest qualification (e.g., through repeats or if they commence a qualification they do not complete), this indicates they are of low ability. Consequently, they should get no (or negative) value from these years of schooling – this argument is related to the so-called ‘sheepskin’ effect. The ‘sheepskin’ effect arises where either completed qualifications are of greater value than the same number of years of schooling without a qualification or there are discontinuities in the return to schooling at years that coincide with the completion of qualifications. With human capital, however, every year of schooling adds to an individual’s skills, so the returns to all years of schooling should be the same.

The hypothesis can be stated formally as:

\[
\begin{align*}
    F &= 1 \text{ if individuals reach some qualification level in the ‘normal’ time,} \\
    F &= 2 \text{ if individuals take longer to complete their highest qualification level than normal,} \\
\end{align*}
\]

and

\[
S^*_2 = S_{\text{actual}} - S_{\text{normal}}, \text{ so that } S^*_2 \text{ is positive if the individual’s learning was slow or they failed to complete some qualification (a signal of lower ability) and let } \delta_2 \text{ be the coefficient on the additional schooling } S^*_2.
\]

Then

\[
\begin{align*}
    \delta_2 < \beta_2 & \quad \text{[Support for screening]} \\
    \delta_2 = \beta_2 & \quad \text{[Rejection of screening and support for human capital]}
\end{align*}
\]
A corollary of this argument was proposed by Groot and Oosterbeek (1994). Under a screening model, skipped years signal ability and hence should be rewarded. That hypothesis can be stated as:

\[
\begin{align*}
&\text{If } S^*_2 < 0 \text{ (that is, the individual’s learning was accelerated)} \\
&\text{then } \delta_2 < 0 \quad [\text{Support for screening}] \\
&\delta_2 = 0 \quad [\text{Rejection of screening and support for human capital}]
\end{align*}
\]

Layard and Psacharopoulos (1974) on UK data, Oosterbeek (1992) and Groot and Oosterbeek (1994) on Dutch data rejected the screening hypothesis in their studies using tests of this kind. Hungerford and Solon (1987), using US data, found evidence of large upward steps in returns in diploma or certificate years, as well as for the first year of college, supporting the existence of diploma or ‘sheepskin’ effects, but acknowledged the possibility that differences between completers and non-completers might explain these diploma effects. Grubb (1997) also reports significant diploma effects. Frazis (1993) found that the estimated diploma effects remained after correcting for differences between completers and non-completers.

\textbf{Lui and Wong (1982) and Ziderman (1990)}

Both Lui and Wong (1982) and Ziderman (1990) tested whether the observed returns to specific educational qualifications fell with labour market experience. The authors argued that if they did, this suggested that employers used the qualification to select individuals and that the qualifications did not convey any productivity advantage to workers. Both papers included a separate years of schooling variable, so the test aimed to focus on the information content of specific qualifications. The hypothesis can be stated formally as:

Let
\[
F = 1 \text{ if } E > E**, \text{ that is workers with considerable experience, and} \\
F = 2 \text{ if } E < E*, \text{ that is workers with little experience, and}
\]

Then
\[
\beta_1 < \beta_2 \quad [\text{Support for screening}] \\
\beta_1 = \beta_2 \quad [\text{Rejection of screening}]
\]
Ziderman (1990) found evidence that the returns to qualifications were lower for more experienced workers than more recent labour market entrants in Israel. The coefficient on the years of schooling variable was also insignificant for older age groups. Lui and Wong (1982) also found that the return to specific qualifications diminished with experience or job tenure in Singaporean data, but that years of schooling contributed a continuing positive effect on earnings (in fact, an effect that increased with experience and tenure).

**Albrecht (1981)**

Albrecht (1981) tested whether other sources of reliable information (e.g., where applicants are already employed or have been recommended by someone already in the firm), supplanted education’s informational role in screening applicants. In such cases, the effect of schooling on the probability of obtaining a job should be lower than where no reliable information is available.

The hypothesis can be stated formally as:

| Let $W$ now represent the probability of being selected to fill a position in a firm and let |
| $F = 1$ if individuals have been recommended to the firm by an employee, |
| $F = 2$ if individuals applied via an open recruitment process |
| then $\beta_1 < \beta_2$ [Support for screening] |
| $\beta_1 = \beta_2$ [Rejection of screening] |

Albrecht found that Volvo, the Swedish firm under study, preferred applicants with more schooling but that schooling was not used as a substitute for other information. Albrecht estimated an equation explaining the probability of individuals being hired. The regressors included education, information and interaction terms. If reliable, additional information about individuals supplanted education’s role in hiring, the interaction term would be negative. The interaction term was insignificant, so Albrecht rejected the screening hypothesis in his study.
Lang and Kropp (1986)

Lang and Kropp (1986) argued that the passage of compulsory attendance laws provided an opportunity to test between screening and human capital theories. Under screening, if low ability, early leavers were forced to stay on at school longer, other groups of individuals would need to increase their schooling to differentiate themselves from those affected by the attendance laws. Under human capital, the decisions of the low ability group should not affect other groups.20

A conceptually related approach, from Kroch and Sjoblom (1994), involved adding a variable to a wage regression equation to take into account the individual’s ranking in their cohort’s distribution of educational attainment. The authors argued this captured the signal employers might use in assessing individual ability.

The Lang and Kropp (1986) hypothesis can be stated as:

Let

\[ F = 1 \text{ if } X > X^*, \]
\[ F = 2 \text{ if } X \leq X^*, \]

so the individuals in equation (2.1) are of higher ability than those in equation (2.2) and undertake more schooling.

\[ \frac{dS_1}{dS_2} > 0 \quad \text{[Support for screening and rejection of human capital]} \]
\[ \frac{dS_1}{dS_2} = 0 \quad \text{[Rejection of screening]} \]

Lang and Kropp (1986) found that school participation rates increased for older age groups following increases in compulsory attendance ages in the United States. The compulsory attendance law variables were all positive and were jointly significant, though none of the critical parameters were significantly different from zero in their own right. Since the differentiation

20 A related observation makes use of changes in school leaving ages as an instrument to overcome the endogeneity of schooling in wage equations of individuals in cross-sectional data. For example, see Harmon and Walker (1995), Callan and Harmon (1999), Vieira (1999) and Levin and Plug (1999).
between groups was maintained, the authors concluded that this provided evidence that supported screening at the expense of human capital. Bedard (2001) builds on the Lang and Kropp (1986) model to consider how the lowest ability group might change their behaviour with the relaxation of a constraint that prevents some high ability types from obtaining the highest level of education. The model predicts that the lowest ability would lower the amount of schooling they acquire with any relaxation of the constraint. Bedard (2001) found evidence that supported this prediction in empirical tests of US data where the constraint involved proximity to college. Bedard found that areas with colleges had both higher college participation and school drop-out rates and lower school completion rates than other regions in the late 1960s.

Kroch and Sjoblom (1994) found that their test variable, the schooling rank variable, was rarely positive and significant in wage equations for four demographic groups in two US data sets. Of course, the variable is collinear with years of education, but the authors report an extensive specification search that provided little support for screening. Vella and Karmel (1999) made use of a similar idea in assessing the impact of an expansion in educational attainment in Australia on young peoples’ occupational outcomes. They found that the occupational distributions of 21 year olds in 1982 and 1991 were practically identical, despite the latter group having higher levels of educational attainment. While Vella and Karmel (1999) did not describe their analysis as a test between human capital and screening, they interpreted their results as supporting the idea that it was the relative position of individuals in the ranking of educational attainment that determined their occupational outcomes.

Maglen (1991)

Maglen’s paper differs somewhat from those discussed to date and does not fit so neatly into the framework provided by equations (2.6) and (2.7). It analysed how an expansion of the education sector might affect the distribution of income in Australia. Consequently, Maglen’s paper can be considered, in part, as reflecting a situation where the signalling power of schooling is reduced in recent, more educated cohorts. As more people are educated, the educational distribution of the queue of workers may change, while the distribution of jobs may not.

The job competition model provided three clear predictions about the effect of an educational expansion according to Maglen:
• the average earnings of those with each level of schooling would decline, though the relativities would remain largely unchanged;

• the variability in earnings for the most qualified would increase (as some are forced into lower paying jobs), while that of the least educated would decline; and

• the overall income distribution would be unchanged.

Maglen also argued that the earnings differentials between those with different schooling levels would narrow under human capital.

Maglen found evidence to support both theories at the expense of the alternative in his analysis. Earnings differentials between the most educated and other groups fell (supporting human capital), the variance in earnings did not appear to increase (not supporting job competition), while earnings inequality was largely unchanged, supporting the contention of the job competition model.

Altonji and Pierret (1997)

The last study also differs from the others referred to above. It does not directly test between the theories. Rather, Altonji and Pierret (1997) focus on the rate at which employers learn about the productivity of workers. If this learning process were fast, individuals would face little incentive to behave as if screening operated. They estimated wage equations with US longitudinal data, where the learning process was revealed by the experience profiles of the coefficients on years of schooling and an ability test score. Altonji and Pierret found that the employer learning process was such that the ‘signalling component of the return to schooling is probably only a small part of the percentage difference in wages associated with education’ (1997: 190).
2.4 Assessment of the tests

2.4.1 Tests of differences in rates of return to schooling or schooling levels between different jobs or sectors

The various tests between human capital and screening are assessed in this Section. The model described in Section 2.2, which involved productive education, screening and rationing with educational sorting is used in this assessment. That model demonstrated both the difficulties in distinguishing between the various theories and pointed to some of the directions taken in tests between them. The implications of that model are used to assess the tests described in the previous Section. In effect, there are two major problems with the tests that compare earnings or schooling levels between sectors or jobs.

The first problem is that there is no reason for the true returns to schooling to be higher in the screened sector than the competitive sector. This observation follows from a comparison of implications (d) and (e) from Section 2.2. Those implications were that the observed return to schooling would be higher in the case where signalling and sorting operated and schooling was productive than where only one of the three effects operated. Comparisons of different sectors where only one of the effects operate do not lead to clear predictions about the relative returns to education.

In Table 2.2, the various implications of the model used in Section 2.2 for the elasticity of wages with respect to schooling under different productivity and signalling assumptions are summarised. These particular cases were selected because they are indicative of some of the problems with the tests described above.

In the first case, individual productivity is observable, so education’s true effect on productivity is also observable, at least to employers. In the other cases, productivity is unobservable, schooling may or may not be productive and signalling and sorting operate.\(^{21}\)

\(^{21}\) There are two cases like Case 3 where signalling and sorting operate separately. Since these have similar implications to Case 3, these are not described.
Table 2.2: Magnitude of the schooling elasticity under alternative education, signalling and sorting assumptions.

<table>
<thead>
<tr>
<th>Case</th>
<th>Productivity enhancing effect</th>
<th>Signalling effect</th>
<th>Rationing/Sorting effect</th>
<th>Schooling Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Productivity is observable, schooling is productive</td>
<td>$\alpha &gt; 0$</td>
<td>$\epsilon = 0$</td>
<td>$\gamma/\beta = 0$</td>
<td>$0 &lt; \alpha &lt; 1$</td>
</tr>
<tr>
<td>2. Productivity is unobservable, schooling is productive, with signalling and sorting</td>
<td>$\alpha &gt; 0$</td>
<td>$\epsilon &gt; 0$</td>
<td>$\gamma/\beta &gt; 0$</td>
<td>$0 &lt; (\alpha + \phi)/(1 + \phi) &lt; 1$</td>
</tr>
<tr>
<td>3. Productivity is unobservable, schooling is not productive, signalling operates with sorting</td>
<td>$\alpha = 0$</td>
<td>$\epsilon &gt; 0$</td>
<td>$\gamma/\beta &gt; 0$</td>
<td>$0 &lt; \phi/(1 + \phi) &lt; 1$</td>
</tr>
</tbody>
</table>

Where authors have proposed tests between potentially ‘screened’ occupations or sectors and ‘competitive’ sectors, they appear to have in mind (at least implicitly) the case depicted in Figure 2.1(b). That is, the competitive sector reflects Case 1 (productivity is observed) from Table 2.2, while the ‘screened’ sector reflects Case 2 (screening operates and schooling enhances productivity). Therefore, test proponents argue that screening implies the return to the screened sector (say the public sector or salaried employees) should exceed that found in the competitive sector (the private sector or the self-employed) – (for example, Psacharopoulos 1979).

However, other predictions about rates of return to schooling are possible from screening theories than that they are higher in sectors where screening operates. If only screening operates in the screened sector, that is Case 3 in Table 2.2, and only human capital operates in the competitive sector, Case 1, then the predictions from the model of the sizes of observed rates of return are indeterminate. The predictions depend on whether $\alpha$ is greater or less than $\phi/(1 + \phi)$. The situation is presented in Figure 2.2(a), where $\alpha$ is assumed greater than the screening effect. If this is the case, then the measured return to schooling should be greater in the competitive sector than the screened sector. Of course it is unlikely that schooling would be productive in one sector and not another. If its effect on productivity varies between sectors, such that it is
lower in the screened sector, which sector’s observed returns should be highest remains indeterminate.

If, however, the comparison is between two screened sectors, with schooling productive in only one, that is Case 3 with Case 2, then the predictions of the model are that observed returns to schooling would be higher in the sector where schooling is productive, since $(\alpha + \phi)/(1 + \phi) > \epsilon/(1 + \epsilon)$. This case is depicted in Figure 2.2(b). This may be a more accurate characterisation of the private and public sectors, for example, than that of Figure 2.1(b). Once more, if screening operates in both sectors and the effect of schooling is greater in the private sector, the observed return would be greater there.

**Figure 2.2:**

(a) Different sectors: screening in one sector  
(b) Different sectors: screening in both sectors but $\alpha = 0$ in one

![Diagram](image)

Seen in this light, Psacharopoulos’ use of results based on rate of return estimates to test ‘strong’ and ‘weak’ versions of screening against human capital was not well based. Psacharopoulos (1979: 182) was primarily concerned with testing the strong version of screening, that schooling does not add to productivity ($\alpha = 0$). From the above analysis, there is no necessary reason for returns to schooling to be higher there than the private sector, unless schooling is productive in the public sector and no screening takes place in the private sector. However, this is no longer a
test of ‘strong’ screening, since it must be assumed that $\alpha > 0$ in both sectors to generate the hypothesis Psacharopoulos tests.

As both Table 2.2 and the analysis above highlight, the same set of observed rates of return to schooling in two sectors can support a range of conclusions about the operation of screening, depending on the priors that the researcher brings to the task. Hence, a comparison of rates of return between different sectors is not an informative test of whether screening operates in some sector or not. Of course, this argument applies with equal force to any tests of the schooling level that individuals in different sectors might attain, since all of the diagrams are drawn with schooling and wages on the axes.

The second major problem with the tests of the theories that involve comparisons of earnings or schooling levels is an empirical one – even if the true returns should be higher in the ‘screened’ sector, those estimated by a researcher may show the opposite outcome. That is, researchers might incorrectly measure returns as being higher in the competitive sector than the screened sector, or between unscreened and screened jobs in the same sector. The arguments supporting this outcome take at least three forms, but all reflect the effects of biased rate of return estimates arising from unobserved individual ability. The first of these arguments is outlined here and the other two in Appendix 2.

In Figure 2.1(a), the equilibrium wage schedule in the presence of screening, $W(S)$, lies to the right of $P(S)$, the locus of schooling-lifetime income optimal choices of individuals of different types. The slope of the schedule $P(S)$ is greater than $W(S)$ and larger than education’s productivity enhancing effect. Since researchers do not have good measures of ability, in unscreened jobs they would estimate the schedule $P(S)$, rather than the true schooling-productivity relationship. Since $\partial P(S)/\partial S > \partial W(S)/\partial S$ for any level of $S$ in Figure 2.1(a), researchers will therefore tend to find that returns are higher in those jobs than in screened ones.22 This observation is also the basis of the argument in Lang (1994) that rate of return estimates calculated in the presence of screening ($\partial W(S)/\partial S$) may provide a better guide to the productivity enhancing effect of schooling than those provided by analysing unscreened jobs (that is, which give $\partial P(S)/\partial S$).

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22 Riley (1979b: S240) makes this argument.
At least some authors have found that selectivity corrections to returns to schooling in Psacharopoulos-type tests result in the changed inferences, with the corrected return being higher for the ‘screened’ sector than the ‘competitive’ one (see, for example, Oosterbeek 1993, Hartog and Oosterbeek 1993 and Van der Gaag and Vijverberg 1988). However, Arabsheibani and Rees (1998) report results where the difference between the returns of the private and public sectors widened. These latter results would be consistent with the case in Figure 2.2 (a) and do not necessarily provide any refutation of screening.

In a sense, these problems underline an argument that as been made implicitly in Wolpin (1977) and explicitly by Lazear (1977) and Lang and Kropp (1986). That is, it is not possible to distinguish between the theories on the basis of earnings functions estimated from a single cross section of information on individuals. However, this criticism applies equally to the tests of Wolpin (1977) and Riley (1979b) that there may be some differences in the schooling levels of the self-employed and employees.

Taken together, these arguments suggest that none of the tests that exploit some particular job categorisation dealt with in the first two categories in Section 2.3 is very persuasive. Nothing in the theories provides a sound basis for predicting in which sector observed returns would be highest, especially once self-selection issues are incorporated.

2.4.2 Assessment of other approaches to testing between screening and human capital

Other comparisons of returns to education

Studies that escape the ‘sectoral comparisons’ criticisms set out in the previous sub-section, such as the Miller and Volker (1984) application of the ‘Wiles’ test of the wages of graduates who work in their field or not, have other problems. That approach ignores the preferences of graduates. If graduates have strong preferences to work in their field, they may well be prepared to trade-off working in their field for lower wages, particularly if working in their field is associated with additional training opportunities. These issues are taken up in Chapter 5.

23 As pointed out in the introduction to this Chapter, Lazear (1977) also argued that wage growth data would be similarly uninformative.
Psacharopoulos’ second test – that the wage growth of more educated workers should be lower than those with less schooling – has an equally fundamental problem. Its characterisation of screening theories appears to confuse the limited role for schooling in increasing individuals’ productivity with the idea that there is no difference in productivity between individuals with different levels of education. Screening models argue that the education process may contribute little to these productivity differences, not that they do not exist. Employers do not systematically over-estimate the productivity of educated individuals in a way that requires any downward adjustment of their wages over their careers.

Screening models could equally be extended to explain continuing differences in earnings over the careers of individuals with different schooling levels.\(^{24}\) That is, as Lazear (1977) points out, other potential influences on wages, such as training, could intervene.

The main test in Riley (1979b) – that the self-employed in screened occupations should be paid more than employees – is somewhat unsatisfactory since the categorisation of occupations as ‘screened’ or ‘unscreened’ is unconvincing and critical to the limited support screening receives in that study.\(^ {25}\) However, its application to Australian data in McNabb and Richardson (1989) was not persuasive. That no professional occupations other than nursing appear in the lists of screened or unscreened occupations meant they had quite a different character from Riley’s groupings. It is very hard to interpret what those results meant for occupations where the most educated groups, such as university graduates, were employed.\(^ {26}\)


\(^{25}\) Lang and Kropp (1986) suggest an interpretation where the identified split of occupations actually picks up attitudes to risk, rather than screening.

\(^{26}\) One plausible explanation for the unexpectedly high earnings for the unscreened group that appear unrelated to the observed characteristics of the workers might be the strength of the unions that covered these blue collar occupations at the time of the survey.
Tests that incorporate the quality of the signal provided by education

The remaining tests between screening and human capital in the literature have sought to exploit the information content of either the schooling that individuals have undertaken (that is, what is the quality of the signal it provides), or the individual’s work experience.

All of these studies can be criticised on some basis. Once more, selection issues seem critical in the test undertaken by Layard and Psacharopoulos (1974) – that course non-completers should receive the same return on that schooling as other individuals. Non-completers of courses may be fundamentally different from those who do complete and unless these differences are taken into account, the results of tests such as these may provide little guidance on the true role of education. While Oosterbeek (1992) and Frazis (1993) do take self-selection into account, the results do not lead to consistent conclusions.

The Lui and Wong (1982) and Ziderman (1990) approach of testing whether the economic pay-off to specific qualifications falls over time makes life cycle inferences from cross sectional data. The results may reflect changes in the nature of the qualifications obtained by different cohorts.27 In any event, Altonji and Pierret (1997) argued that there is no reason for the coefficient on individual schooling to fall with increased experience in the absence of some variable that picks up the process of employer learning about individual productivity. Altonji and Pierret (1997) used longitudinal data to identify this process. Hence while it may be possible to pick up some decline in the value of qualifications with experience, the specification of the wage equations in Lui and Wong (1982) and Ziderman (1990) do not match the requirements suggested by Altonji and Pierret (1997).

Albrecht (1981) tested whether other information on applicants supplanted the informational role of schooling in employer hiring decisions. The outcome of that test would have been more

27 Lang and Kropp (1986) also point out some problems in the interpretation of Lui and Wong’s results, which they argued implied some ‘irrational’ behaviour. Almost half the individuals in the data left in non-certificate years, yet Lui and Wong found these certificates to be critical screening mechanisms. This seems an unfair criticism, since the certificates could have no value as screening mechanisms in differentiating between individuals if everyone obtained one.
convincing had the coefficient on the alternative information variable itself been significant.\textsuperscript{28} It was therefore unclear that employers used that information in their hiring decisions either.

The Lang and Kropp (1986) test is intuitively appealing. If you require otherwise low-ability early leavers to stay on at school, you presumably force other individuals to ‘distance’ themselves from them by acquiring more education. While the authors checked for any endogeneity in the minimum schooling laws (low school participation rates may force legislatures to act), they do not report any controls in their equations other than time period dummy variables. In any event, as previously stated, finding evidence that supports an aspect of screening does not necessarily demonstrate that schooling is unproductive.

However, the results could be unreliable if the changed schooling requirements coincided with government campaigns to increase schooling at all ages, as seems at least possible. More fundamentally, in Australia at least, changes to the minimum schooling laws have been associated with substantial public high school building works, so that estimation of such equations would probably pick up some relaxation of supply constraints rather than changing student demand for high school places.\textsuperscript{29,30}

\textbf{2.5 Conclusion}

Two points are worth emphasising from this review of tests between human capital and screening. The first is that only a very small number of studies provide any support for the idea that schooling does not enhance productivity: Miller and Volker (1984), Lang and Kropp (1986) (on their interpretation) and, possibly, Ziderman (1990). While other studies (for example, Riley 1979b, Lui and Wong 1982, and Grubb 1993, 1995) may provide some support for the operation of screening in some form, those findings were not necessarily at the expense of the productivity-enhancing role of education.

\textsuperscript{28} Lang and Kropp (1986) make a similar argument.

\textsuperscript{29} See Barcan (1980) for a history of Australian education, which deals in passing with the history of compulsory attendance laws. For much of Australia’s history, education of older teenage students was undertaken in private (metropolitan) schools.

\textsuperscript{30} This approach is discussed further in Chapter 3.
The second point of note is that few of the tests are persuasive. Perhaps when two theories make very similar predictions about individual behaviour, it is inevitable that tests between them might prove unsatisfactory. This is particularly so when aspects of both theories are plausible. It is hard to imagine that employers would not use schooling to sort between workers to fill some positions. Why would they ignore such valuable information about workers? Equally, how can numeracy and literacy skills developed through schooling not be of use in most workplaces?

The quality of much of the analysis in this literature is surprising, however. Few of the tests are derived from formal models, with the consequence that the screening literature is often characterised in a way that is either misleading or naive. This criticism particularly applies to studies comparing the returns to schooling for screened and unscreened jobs. The tests are not well founded and the results of applications cannot really provide information on the role of education. The evidence from tests based on the schooling levels of individuals in those jobs is similarly uninformative.

The studies that incorporate elements of the signal that schooling provides to employers appear to offer more hope for disentangling the two theories. Of course, schooling measurement issues become of critical importance in this context. Studies such as Ashenfelter and Krueger (1994) and Miller et al. (1995) for Australian data, show how significant education reporting error can be by individuals and the effects that this can have on the estimation process.

Other approaches to testing between human capital and screening theories are developed in subsequent Chapters, and further attention is given to some of those discussed here. This Chapter makes the case that other approaches are necessary to determine properly the role of education in the labour market.