EXAMPLE OF LITERATURE

REVIEW:

FIRM-SPECIFIC HUMAN CAPITAL:

A NEW PERSPECTIVE

ABSTRACT

In response to the difficulty in finding substantial examples of firm-specific skills a model of human capital accumulation based upon Lazear’s (2003) skill-weights approach is presented and analysed. In this model two improvements are made to Lazear’s (2003) framework: the firms’ skill-weights are endogenised and firm investment in human capital is incorporated. It is found that a unique SPNE exists for any value of the parameters of the model. From this finding three key implications of the model are derived. Firstly, it is found that Lazear’s (2003) approach is consistent with Becker’s (1962) prediction that with complete information only workers will finance the accumulation of general human capital, while firms and workers will share investment in firm-specific human capital. Secondly, it is found that firms can influence the firm-specificity of the human capital that they use in their production process. Thirdly, a previously unexplored relationship between a firm’s labour market and product market choices is revealed. The model is then applied to the aerospace industry and its predictions are seen to be consistent with empirical observations.
LITERATURE REVIEW

Modern human capital theory is based on the distinction between general and firm-specific skills developed by Becker (1962, 1964), Mincer (1962) and Schultz (1963). General skills are those skills that are useful at many firms, and specific skills are skills that have value at the worker’s current firm and nowhere else.

In competitive labour markets investment in general skills increases the worker’s marginal product by the same amount at other firms. Labour market forces cause the worker’s wage to equal their marginal product and workers capture all the return from this type of investment. Therefore, workers and not firms will invest in general human capital.

In contrast, investment in and return to firm-specific human capital is shared by the worker and the firm. Investment in specific human capital increases the worker’s marginal product at their current firm but nowhere else. Therefore, the worker’s current firm is not forced by outside wages offers to offer a post-training wage that reflects the worker’s increased productivity, and the firm is able to capture all the returns from investment in firm-specific human capital. However, these returns are lost if the worker leaves the firm. To reduce the quit rate and improve the expected return to training, firms are likely to share the cost and return to specific training with the worker. This sharing typically takes the form of the worker accepting a wage lower than their marginal product during the training period, and receiving a wage higher than their productivity from general human capital in the subsequent periods.
A substantial literature has grown out of Becker’s (1962) human capital theory. Hashimoto (1981) developed Becker’s (1962) concepts by analysing the financing of firm-specific human capital investments when uncertainty concerning the worker’s post-training productivity is present. Hashimoto (1981) found that the decision to share investment in specific human capital with the worker depends on whether the firms face labour market transaction costs, specifically costs incurred evaluating a worker’s productivity at its firm and elsewhere. He also showed that when the post-training wage is decided prior to the realization of worker productivity (due to uncertainty) it is efficient for the firm and the worker to share both the cost and the return to training as this minimises the probability of separation.

Becker’s (1962, 1964) theory has been extended in many other ways by relaxing the assumption of perfect labour markets. Malcomson (1997) argued that a more realistic model of human capital could be produced under the conditions that the level human capital investment is determined non-cooperatively and is non-contractible. Further, he reasoned that a model combining these conditions with a compensation scheme whereby the post-training wage is determined by Nash bargaining after productivities are revealed, would yield predictions more consistent with empirical observations. Hart and Moore (1988) followed these conditions and discovered that firms and workers will choose to under invest in specific human capital. For in the post-training period neither the worker nor the firm can fully capture the increase in productivity due to training because of the Nash bargaining over wages; as a result both parties have an incentive to under invest in firm specific human capital.
Another way in which Becker’s framework has been developed is through the introduction of information asymmetries. These information asymmetries refer to the situation in which the firm who trains the worker learns more about the worker’s productivity than other potential employers do. More specifically this information could be about a worker’s accumulation of human capital, their innate ability, or a combination of the two. In Chang and Wang (1996) human capital is non-contractible and information asymmetry is introduced through assuming that potential employers can not observe the current firm’s investment decision. Chang and Wang (1996) discuss how this information asymmetry can cause an externality distortion in human capital investment because higher productivities resulting from human capital investment are not recognised and rewarded by the market. Additionally, they show that the severity of this distortion is more pronounced when human capital is general than when it is firm-specific; and that investment in human capital is negatively related to the separation rate. In this way Chang and Wang (1996) demonstrate that general human capital is not independent of the probability of separation, a finding contrary to Becker’s (1962) original theory.

This paper is also related to the literature on quasi-specific human capital. Becker (1962) recognised that it is possible for training to be neither completely general nor completely firm-specific, however an in depth discussion of this in-between type of human capital was not made. This in-between type of human capital is termed quasi-specific human capital by Novos and Waldman (1997) and is defined as human capital that is valuable to many firms, but is most productive at a workers current firm. Novos and Waldman (1997, pp.338) found that when workers have some quasi-specific skills and there are costs associated with job search, the proportion of human
capital lost by a worker who chooses to change employers will be less than the proportion of human capital that is specific for the workers who stayed. Therefore, empirical estimate of returns to tenure will understate the specificity of the human capital. The concept of quasi-specific human capital presented by Novos and Waldman (1997) shares some of the same ideas as the model presented in this paper. Principally, in discussing the importance of quasi-specific human capital they note that “In reality … the increase in productivity associated with human capital often does vary across all alternative employers” (Novos and Waldman, 1997, pp.338), this variation in productivity is a feature captured by the model presented in this paper.

While the theoretical literature on human capital can provide reasons why wages may rise with tenure, empirical studies can show the extent to which wages actually rise with tenure. This empirical evidence is important as it provides insights on the degree to which specific human capital accumulation affects wage profiles and the validity of theoretical predictions.

In early empirical research on wage profiles, job mobility and firm tenure a number of studies found that firm-tenure had a strong positive relationship with wages (see for example Borjas (1981), Mincer and Jovanovic (1981) and Mellow (1982)). This evidence was interpreted as support for the human capital theory prediction that firm and worker sharing of specific human capital investment is a contributing factor to increasing wage profiles. Later the estimates generated in this early work were criticised for suffering from omitted variable bias and more sophisticated empirical models of wages and tenure were developed to deal with this problem. Abraham and Farber (1987) and Altonji and Shankotko (1987) controlled for relevant unobservable
variables and found that the worker tenure, and hence firm-specific skill accumulation, are not important sources of wage growth. Topel (1991) also incorporated unobserved worker and firm characteristics into his model, however, he found evidence that wages do rise with tenure.

The early empirical studies of wages and tenure (Borjas (1981), Mincer and Jovanovic (1981) and Mellow (1982) for example) found that there was a significant wage-tenure relationship. In Mincer and Jovanovic (1981) data from the National Longitudinal Surveys (NLS) and the Michigan Income Dynamics (MID)\(^1\) was used to empirically analyse the relationship between wages, job tenure and worker mobility. Mincer and Jovanovic (1981, pp.43) proposed that by regressing wages on worker experience and tenure separate estimates of the return to general and firm-specific human capital investments could be generated. They estimated that approximately 50\% of wage growth over a workers lifetime was due to the accumulation of general human capital and 25\% due to firm-specific human capital accumulation. Mincer and Jovanovic (1981) concluded that this finding provided supported for the theoretical prediction that shared investment in specific human capital contributes to the upward sloping characteristic of wage profiles.

There are several theories, besides those derived from human capital theory, as to why there is a positive relationship between wages and tenure. Wages may increase with tenure due to unobservable characteristics of the worker and the firm. For instance worker’s ability and match quality are likely to be positively related to wages. Also, some (ex ante unknown) firms may choose to pay their workers highly to reduce

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\(^1\) MID data is also known as the Panel Survey of Income Dynamics (PSID).
shirking and turn over. Abraham and Farber (1987), Altonji and Shankotko (1987) and Topel (1991) argue that it is important to consider these unobservable characteristics when econometrically modelling the wage-tenure relationship as they are likely to be correlated with tenure as well as wages. Therefore, ignoring the existence of these variables (ability, quality of the job, and match-quality) will result in inconsistent estimates of the tenure coefficient. As these variables are unobservable incorporating them into wage regressions is not straightforward. Abraham and Farber (1987), Altonji and Shankotko (1987) and Topel (1991) all use different methods to control for these variables in their econometric analysis of the wage-tenure relationship.

Abraham and Farber (1987) use data from the Panel Survey of Income Dynamics (PSID) (1968-1981) for their estimation. They reason that a worker's completed tenure is a good proxy for the previously mentioned unobservable variables. Hence, they extrapolate the expected duration of all job assignments not completed during the sample period and use them as a proxy in the estimation of the return to job tenure. Altonji and Shankotko (1987) also use data from the PSID, however they use instrumental variables to control for the unobserved variables correlated with tenure. The variation in tenure over a given job match is used as the instrumental variable for tenure. Using these different methods both Altonji and Shankotko (1987) and Abraham and Farber (1987) generate estimates that indicate that wages rise little with tenure when the ability of the workers, quality of the job, and match-quality are accounted for. Indeed Altonji and Shankotko (1987) find that tenure only accounts for 6.6% of the increases in wages over a 10 year period and conclude that it is the
accumulation of general experience and workers moving to better jobs, that primarily drives wage growth over time.

Contrary to other empirical studies that control for the unobservable characteristics of workers and firms Topel (1991) found that the average return to tenure is large. Using data from the PSID (1968-1983) Topel (1991) used a two-step estimation process to control for the unobserved variables and separate the returns to general and firm-specific human capital so that a consistent lower bound estimate of the return to tenure could be generated. First the determinants of wage growth are modelled (controlling for the unobserved variables), and the combined return to general and firm-specific human capital accumulation is estimated. In stage 2 a cross-sectional comparison is made between workers who start new jobs at different points in their career. This generates an estimate for the upper bound on the return to general human capital, which inturn enables estimation of the lower bound on the return to firm-specific human capital accumulation. Using this procedure Topel (1991) was able to provide evidence that the unobserved variables do not impact on wage growth as much as previous studies proposed. Further, he found that 10 years of tenure will on average raise a workers wage by at least 25 %, a result that he inferred provided support for the idea that the accumulation of firm-specific human capital is an important factor in the determination of workers’ wages.

Given that Topel (1991) used a very similar data set to Abraham and Farber (1987) and Altonji and Shankotko (1987) (all were sourced from the PSID) he concluded that the significant difference in results concerning the effect of tenure on wages was due to the different econometric methods used.
Topel (1991, pp. 166) proposed that the methodology used by Altonji and Shankotko (1987) produced inconsistent results because they did not correct for the significant measurement error in the PSID data, and because they used a linear time trend to capture aggregate changes in real wages when wage growth may not have been linear. Topel (1991) also pointed out that using the time trend may also cause inconsistent estimates because unobserved ability may be correlated with wages and the trend term. Additionally, the instrumental variable technique they use is claimed to create a stronger upward bias on the return to experience than the method used by Topel (1991). Topel (1991) also discussed the estimation methodology used by Abraham and Farber (1987). Topel (1991) found fault with their use of expected job duration as a means to capture the unobservable factors (ability, match-quality and job quality) and demonstrated how their technique leads to biased estimates of the experience and tenure effects.

In accounting for the differences between his results and those found in the contemporaneous literature, Topel (1991) presented a strong case for the validity of his result and thus for the finding that tenure has an important effect on wages.

Thus far we have discussed Becker’s (1962) human capital accumulation framework, important theoretical extensions to this framework, and relevant empirical evidence. A key motivation of this thesis is Lazear’s (2003) statement that Becker’s (1962) theory of human capital can not adequately explain the high tenure coefficients often observed in empirical studies. We have examined how Becker’s (1962) theory implies that high tenure coefficients are generated by skill sets in which productivity is
generated largely from firm-specific skills. However, it is difficult to find examples where firm-specific skills are important enough in a workers skill set to produce these high tenure coefficients. If firm-specific human capital does not cause the tenure effect then what does?

One alternative explanation for the tenure effect is that it is predominantly generated by the accumulation of industry-specific skills, rather than accumulation of firm-specific skills. The notion of industry-specific human capital captures the idea that all firms in an industry may value a common set of skills highly, while firms outside the industry may not value these skills at all. Using the Displaced Worker Survey Neal (1995) found that while most displaced workers experienced wage loss, those that were displaced to a different industry suffered greater wage losses. He also found that post-displacement wages rise more sharply with pre-displacement tenure and experience when a worker is displaced within their current industry than when they move to another industry. Using data from the National Longitudinal Survey of Youth (1979-96) and the Panel Study of Income Dynamics (1981-91) Parent (2000) also analysed the impact of industry-specific human capital on workers’ wage profiles. Neal (1995) and Parent (2000) both found that when industry tenure is controlled for firm-specific tenure becomes insignificant, concluding that industry-specific human capital is far more important than firm-specific factors in the generation of the tenure effect on workers’ wages.

Kambourov and Manoskii (2002) argue that it is occupational-specific human capital, and not industry- or firm-specific human capital that primarily affects the wage profile of workers. They assert that occupational specificity of human capital has more
intuitive appeal than industry- or firm-specific human capital. They explain that employment in an industry can comprise of many different types of jobs, and it is very doubtful that the human capital of workers will be specific to the industry they work in rather than the job that they do. Using the Panel Study of Income Dynamics (1968-1980) Kambourov and Manoskii (2002) found that when tenure in an industry and tenure with an employer is controlled for, there are substantial returns to occupational tenure, and that industry tenure and firm tenure have little or no importance in explaining wage profiles when occupational experience is taken into account. Thus, they show that the tenure effect observed in empirical studies are not due to firm-specific human capital as Becker (1962) proscribes, but are due to occupational-specific human capital. Therefore, the fact that substantial examples of firm-specific skills are difficult to find does not compromise the validity of this approach to explain the tenure effect on wages.

Lazear (2003) provides a theoretical explanation of how the tenure effect can be generated without the presence of firm-specific human capital. To do this Lazear (2003) introduces the skill-weights approach to human capital. This approach allows all skills to be general skills in that they can be used at many firms. In this approach every firm requires a variety of general skills in its production process, and firms vary in their weighting of the importance of these skills. When a worker is displaced from their firm and must find a new job, the loss in wages that they face depends upon the thickness of the labour market, search costs and the mix of skills that he has accumulated.
The model that Lazear (2003) uses to illustrate this approach is characterised as follows: There are two skills, skill A and skill B, which the individual can acquire at a cost. Workers make their investment in their skills in period 1 and receive the payoff from work in period 2.

The worker with skill set (A,B) has potential earning at firm i given by

\[ y_i = \lambda_i A + (1 - \lambda_i) B \]

Where \( \lambda_i \) is the weighting on skill A at firm i. Each firm i may weight the two skills differently to another firm. The weights \( \lambda_i \) are exogenously determined.

The firm that the worker is initially at is called firm 1. Before the second period begins the worker finds out whether or not he will continue on at his initial firm or move to another firm. The probability that the worker will remain at his initial firm is denoted \( p \) and is exogenously determined.

The worker must choose his level of skill in A and B knowing that in the second period he may remain at his initial firm or move to another firm which may weight the skills differently. The skill-weight of other firms in the market, \( \lambda \), is a random variable with density \( f(\lambda) \). Thus, the worker chooses to invest in skills A and B to maximise

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\text{Net expected Earnings} = p \left[ \lambda_i A + (1 - \lambda_i) B \right] + (1 - p) \int_0^\infty \left[ \lambda A + (1 - \lambda) B \right] f(\lambda) d\lambda - C(A, B)
\]
Where $C(A,B)$ is the cost of acquiring skills A and B.

Lazear (2003) showed that the worker’s investment in skills A and B are weighted averages of the skill-weight of firm 1 and the expected skill-weight of an outside firm, with the weights of these averages determined by the probability of separation. When the probability of being retained is high the worker will invest with more consideration for firm 1’s skill-weight than the expected skill-weight of the market, and vice-versa for a low probability of being retained.

Using this model Lazear (2003) was able to show that in competitive labour markets, workers can experience loss from separation even when they only possess general skills, and that this loss from separation will increase with a worker’s tenure with the firm. The model also predicts that the more distinctive the initial firm’s (firm 1) skill-weights are, the greater is the loss from separation, and that the tenure coefficient should be negatively related to the thickness of the labour market. Lastly, consistent with the empirical literature already discussed, this model also predicts that the tenure effect will be reduced when industry and occupation effects are controlled for.

This thesis acknowledges Lazear’s (2003) criticism of Becker’s (1962) framework and uses Lazear’s (2003) approach to model human capital accumulation. There are two key differences between Lazear’s (2003) model and the model presented in this thesis. Firstly, in the model presented in this paper the skill-weight, $\lambda_j$, is endogenised through allowing firms to invest in technology that improves the productivity of a skill, and secondly, firms are now allowed to invest in their workers’ human capital
accumulation. These changes create a more enriched and realistic model that allows for more implications of the skill-weights approach to be revealed.

By enriching Lazear’s (2003) framework to allow firm investment in human capital it is now possible to show that the skill-weight’s approach can account for empirical observations of firm investment in general skills. The German apprenticeship scheme is often cited as an empirical example of firm sponsored general training, however many other examples have been identified, such as employer sponsored literacy programs in US manufacturing firms (Bishop, 1996) and computer training at temporary help agencies (Bishop, 1996). We can see that when all skills are general skills and firms are allowed to invest in human capital - as in the model presented in this thesis - it is clear that all instances of firm investment in general skills are fundamentally consistent with the skills-weights approach. A substantial literature on firm investment in general skills already exists, with most papers using Becker’s (1962) human capital theory to explain that this investment is the result of either labour market imperfections or incentive complementarity between general and firm-specific skills.

The explanation of firm investment in general skills derived from the skill-weights framework is an important departure from previous rationalisations. It is does not rely on labour market abnormalities and imperfections, nor on a complementarity between general and firm-specific skills to make observations of firm investment in general skills consistent with the model. These are important advantages as they allow for this phenomenon to be explained for a wider variety of labour market conditions and do not rely on firm-specific skills - existence of which is questioned in this thesis.
These earlier explanations are now discussed in more detail. These approaches have all used Becker’s (1962, 1964) human capital framework as the base from which to rationalize why firms may pay for general human capital accumulation.

One set of explanations are based on various assumptions concerning labour market imperfections. Katz and Ziderman (1990) reason that if the level of training provided by the firm is unobserved by the market, then an informational asymmetry occurs between the training firm and recruiting firms. This information asymmetry may then create sufficient incentive for the firm that provides training to invest in general human capital. Katz and Ziderman (1990) show that if recruiting firms face information costs due to outside workers skill level being unobservable (these costs include opportunity costs and exposure to risk) the workers will be worth less to them than to the firm that provided the training. Consequently, the net benefit that a worker with general skill can get from moving to another firm is diminished and its current firm may now find it feasible to finance part or all of the workers training in general skills.

Chiang and Chiang (1990) and Acemoglu and Pischke (1998) present a similar story to Katz and Ziderman (1990), except that now the information asymmetry arises from information regarding the ability of the worker rather than information regarding the worker’s skill level. Under this labour market imperfection it is argued that adverse selection occurs - firms are able to keep their more productive workers and dismiss their less able ones. As a result the mobility of the workers is restricted and firms are able to gain some of the return to training in general skills. Chiang and Chiang (1990)
and Acemoglu and Pischke (1998) claim this is the reason why firms and workers will share the cost of general training. Chiang and Chiang (1990) also note that under this asymmetry condition general human capital has almost the same lay-off and cost-sharing features of firm-specific human capital.

Acemoglu and Pischke (1998) argue that asymmetry arising from information concerning workers’ abilities is a closer match to some of the empirical observations of firm-sponsored general training than Katz and Ziderman (1990) explanation concerning information about a worker’s level of human capital. The widespread tradition of apprenticeships in Germany is often cited as an example of firm-sponsored general Training. Acemoglu and Pischke (1998, 1999a, 1999b) discuss numerous empirical studies that have shown that in these apprenticeships firms bear a substantial proportion of investment in general skills. They then reason that as German apprentices must undergo standardized testing and receive certification, it is implausible that the amount of human capital the apprentice acquires is not observed by the market. Thus, Katz and Ziderman (1990) approach is not appropriate in this situation.

Acemoglu and Pischke (1999a, 1999b) widen the range of labour market imperfections that may induce firm-sponsored general training to include a variety of factors that cause wage compression. In addition to information asymmetry concerning worker ability and skill level, Acemoglu and Pischke (1999a, 1999b) also consider the presence of government regulations, transaction costs (eg. matching and searching costs), asymmetric information concerning the amount of effort exerted by the worker (and the need to pay efficiency wages), the interaction of specific and
general skills, and labour market institutions such as trade unions. They show that when the wage structures within firms are distorted, due to any or all of these sources, so that the wages of skilled workers are reduced relative to the wages of unskilled workers, the firms may find it optimal to make some investment in general human capital. For in this situation skilled workers are not paid their full marginal product from any type of training, thus firms can capture rents from investing in general human capital. Acemoglu and Pischke (1999a, 1999b) support their finding through data collected on the German apprenticeship programs mentioned earlier.

The range of relevant causes of labour market imperfections is once again increased in Booth and Zoega’s (2004) response to Acemoglu and Pischke (1999a, 1999b). Booth and Zoega (2004) show that firm investment in general training may also occur in the absence of wage compression as long as the condition that training increases the worker’s productivity by more than her wage holds. This analysis shows that firms that use compensation schemes not associated with wage compression, such as piece rates, may still make investments in general human capital.

Another rational for firm investment in general human capital can be inferred from Matouschek and Robert-Nicoud (2004). In their paper they discuss the relationship between firm location and investment in human capital. Primarily they look at whether or not human capital investment encourages the spatial concentration of an industry. Their key findings are that it is expected that firms will be less concentrated when investment in industry-specific human capital is made by the firms, and that an industry will be more concentrated when workers can make firm-specific and industry-specific investments than when they can only make industry-specific
investments. From their analysis it can be inferred that if workers incur sufficient cost from changing locations, then firms may find it optimal to invest in general human capital when the industry is spatially dispersed. This can be interpreted as a case of general human capital taking on features of firm-specific human capital as a result of a labour market imperfection.

Kessler and Lülfesmann (2002) and Balmaceda (2005) provide another approach to explain why firms invest in general human capital. Their approach is based on the idea that firm-specific and general human capital are strategic complements. Both of these papers show that even when there are no labour market imperfections and specific skills and general skills are not related in the production process, firms may still invest in general human capital due merely to the fact that firms are able to invest in firm-specific human capital.

The basic intuition behind Kessler and Lülfesmann (2002) and Balmaceda (2005) results are as follows: In perfect labour markets workers will receive all returns to general training, and the firm can capture all the return to specific training. Therefore, when a firm invests in specific human capital there is a divergence between a worker's wage and their productivity, with the firm capturing the residual surplus. If this residual surplus is sufficiently large relative to the return on general human capital, or the worker has significant bargaining power, the worker will hold-up its employer (with the threat of leaving and causing its employer to lose its investment in specific human capital) and capture some of the surplus. By investing in general human capital the firm can negate the hold-up problem by reducing the workers' incentive to hold-up its employer. Therefore, while the surplus from human capital investment is
determined by specific training, the way in which it is divided between worker and firm is partially determined by the relative level of general training. Thus, firms may find it optimal to invest in general human capital. It is also shown that the higher a firm’s investment in specific human capital, the greater is their incentive to provide general training, and as the firm provides general training their incentive to provide specific training increases – they are strategic complements.

This new specification of the skill-weights approach provides an enriched framework of human capital that yields many new insights and explanations of key labour market phenomena. It provides new reasons to explain Topel’s (1991) finding that there are significant positive returns to tenure when ability, job mobility and match-quality and experience are controlled for. Rather than supposing that this positive relationship is partially due to the investment in specific skills, it could now be supposed that the accumulation of specific skills does not drive wages at all. In addition to supplying a new interpretation for the wage-tenure relationship this model also provides a new explanation of firm investment in general skills. This new explanation does not rely on labour market imperfection or the existence of specific skills unlike the other propositions to date. Thus, this new specification of this skill-weights model can be seen as a new framework for capturing and describing human capital phenomena.
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