INTERPRETING EVIDENCE ON RETURNS TO TENURE:

THE SIGNIFICANCE OF QUASI-SPECIFIC HUMAN CAPITAL

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ABSTRACT

There is a vast empirical literature which finds a strong positive relationship between tenure and wage rates. However, recent papers by Topel (1986), Abraham and Farber (1987), Altonji and Shakotko (1987), and Marshall and Zarkin (1987) have found that after carefully controlling for biases that arise due to factors such as unobserved heterogeneity and job matching, much of the positive relationship between tenure and wage rates disappears. This paper shows that these recent results do not necessarily imply that the labor market exhibits an insignificant level of specific human capital, but rather they may simply indicate that the specificity which does exist typically takes a "quasi-specific" form.

I. Introduction

Since the seminal work of Becker (1962), economists have distinguished between two types of human capital. General human capital increases the productivity of a worker by an identical amount across all, or at least many firms in the economy, while specific human capital loses its value if a worker switches employers. As Becker clearly realized, however, these are only the two polar cases of how human capital can increase productivity.[1] That is, in many cases human capital will increase productivity across many firms, but the increase will not be the same for the firm providing it as for other potential employers. Since the standard here is likely to be that on average the productivity increase will be smaller for these other firms, this intermediate case will be referred to as quasi-specific human capital. In this paper I consider some of the implications of quasi-specific human capital and, in particular, its significance for the recent empirical literature which attempts to measure returns to tenure.[2]

There is a vast literature which measures returns to tenure, and until recently the evidence of a strong positive relationship between tenure and wage rates seemed overwhelming.[3] Papers by Topel (1986), Abraham and Farber (1987), Altonji and Shakotko (1987), and Marshall and Zarkin (1987), however, have thrown doubt on many of the earlier studies. These authors have found that after more carefully controlling for biases that arise due to factors such as unobserved heterogeneity and job matching, much of the positive relationship between tenure and wage rates disappears.[4] The subsequent conclusion has been that the accumulation of specific human capital is not an important feature of most employment relationships.[5]

In this paper I will show that the above conclusion is unwarranted if the

environment is characterized by quasi-specific human capital. That is, in the presence of quasi-specific human capital, the return to tenure in the data will likely understate the importance of specific human capital in the environment. Hence, the results of Topel, Abraham and Farber, Altonji and Shakotko, and Marshall and Zarkin do not necessarily imply that the labor market exhibits an insignificant level of specific human capital, but rather these results may simply indicate that the specificity which does exist typically takes a quasi-specific form.[6]

One might wonder why the previous literature has focused so little attention on the possibility that human capital may be quasi-specific. The probable reason is that for the simplest case nothing of importance would be derived from the analysis. Consider a world where human capital is quasi-specific, and where the increased productivity associated with human capital does not vary across "other employers." For this case having human capital be quasi-specific is of no importance, because such a world would be observationally equivalent to a world characterized solely by a mix of general and specific human capital.

Now consider an environment where human capital is quasi-specific, but where the increased productivity associated with human capital <u>does</u> vary across other employers. In a world characterized by a mix of general and specific human capital, the amount of human capital lost by workers who choose to move will be the same as the amount of human capital which is specific for similar workers who decide to stay. This would not be the case, however, in the type of quasi-specific human capital environment we are now considering. In that type of environment, a worker who switches employers will on average be a worker who received a wage offer from a firm that attached a high value

to the quasi-specific human capital the worker had already accumulated. That is, in this case, the amount of human capital lost by workers who choose to move will on average be less than the amount of human capital which is specific for similar workers who decide to stay.

Given the above discussion, it is now possible to see why the presence of quasi-specific human capital can cause the return to tenure in the data to understate the importance of specific human capital in the environment. As will be demonstrated, rather than purely being a measure of how much human capital is specific for workers who do not move, the return to tenure in the data is to some extent a measure of how much human capital is lost when workers do move. In a world characterized by a mix of general and specific human capital this is not a problem, because the amount of human capital lost by workers who move is the same as the amount of human capital which is specific for similar workers who decide to stay. However, if human capital is quasi-specific and the productivity of the human capital varies across other employers, then a problem clearly does arise. As discussed, in such a setting the amount of human capital lost by workers who move will on average be less than the amount of human capital which is specific for similar workers who decide to stay. Hence, given that the return to tenure in the data is to some extent a measure of how much human capital is lost when workers move, this return will typically understate the importance of specific human capital in the environment.[7]

Possibly the reader would find the above argument clearer if there was some simple real world example to focus on. Consider the following story. Two workers – call them Smith and Jones – are hired in your department as secretaries at approximately the same date. Over a course of two to three

years both workers accumulate a variety of skills, some of which are potentially specific to working in your department. Examples of such skills include a working knowledge of the word processing system used in your department, and a working familiarity of the jargon typically employed by economists. At the end of the two to three year period each worker gets married and moves in with his/her new spouse. Unfortunately, in each case the spouse's home is located far from your department, and staying at the old job would entail a long commute. The subsequent result is that each worker undertakes a job search in the area near his/her new home. Smith is very fortunate and happens to find a job at an economics department which, in fact, uses the same word processing system as does your department. Smith takes the job and because basically no skills are lost during the move, from the standpoint of Smith's age-earnings profile it is as if no job switch had occurred. Jones is less fortunate. In the area Jones looks in there are no academic jobs available (let alone one in an economics department which uses the same word processing system), and Jones realizes that switching jobs would entail a substantial loss of human capital. Jones decides to stay in your department.

This story captures exactly what I have in mind. Since Smith and Jones have identical age-earnings profiles, one might conclude from looking at the wage data that all human capital is general. However, this would clearly be incorrect since the only reason that Jones did not move is that in his/her case much of the human capital was specific. What is driving this result is exactly the argument described above. The amount of human capital lost by the worker who moved was less than the amount of human capital which was specific for the similar worker who decided to stay. In turn, because the return to

tenure in the data measured how much human capital was lost by the worker who moved, this return understated the importance of specific human capital in the environment.

In this paper I demonstrate the above point formally, and consider its implications for a variety of labor market issues. The outline for the paper is as follows. Section II presents a stylized example which demonstrates very clearly the intuition presented above. In particular, an example is presented in which the specific capital of workers who do not switch employers is positive, yet, because the capital takes a quasi-specific form, the return to tenure in the data is negative. Section III presents a more fully developed model. Besides showing how similar results can arise in a fuller model, it provides results which suggest how one might empirically test for the presence of quasi-specific human capital. Section IV considers the testing issue in more detail, and also discusses the implications of quasi-specific human capital for the following related issues: (i) measuring the costs of worker displacement; and (ii) measuring the total returns to human capital versus the total returns to job matching. Section V presents some concluding remarks.

II. A Stylized Example

Suppose there are N workers who live for two periods. In period 1 each worker produces x units of output and acquires some human capital. The human capital is such that if the worker remains with his first period employer he produces an amount $x+\delta$ in the second period. It is also assumed the human capital has value at firms other than the first period employer, but that the value is different than the value of the capital at the first period employer, i.e., the human capital is quasi-specific. In particular, assume that at

other potential employers output can equal either $x+\lambda$ or $x+\sigma$, where $\lambda>\delta>\sigma$. Finally, assume this is a search model. At the end of the first period each worker elicits a wage offer from one other firm, where with probability p this other firm values this worker's human capital an amount λ and with probability (1-p) the valuation equals σ.[8]

If, as is sometimes assumed in search models, each firm's wage offer simply equals the marginal product of the worker at that employer (see e.g., Jovanovic (1979)), then the above model works in a straightforward fashion. After the first period each worker compares two wage offers, and goes to the firm offering the higher wage. That is, some workers will have elicited an alternative wage equal to $x+\sigma$, in which case the worker remains with his initial employer and earns $x+\delta$. On the other hand, other workers will have elicited an alternative wage equal to $x+\lambda$, in which case the worker switches employers and earns this alternative wage.

In the Introduction it was stated that in the presence of quasi-specific human capital, the return to tenure in the data will likely understate the importance of specific human capital in the environment. This point is nicely illustrated by the above example. Suppose one were to take data generated by this example and regress wages on both tenure and experience. The coefficient on experience would equal λ, while the coefficient on tenure would equal $\delta-\lambda$ which is less than zero. This coefficient on tenure is a correct estimate of the return to tenure in the data. However, one would be wrong to take this as an indication that stayers have no tie to their current employers. Clearly, stayers have accumulated a positive amount of specific human capital equal to $\delta-\sigma$.

What is driving this result is exactly the problem discussed in the

Introduction. The return to tenure in the data is to some extent a measure of how much human capital is lost when workers actually switch employers (in this example it is an exact measure). We also know that if quasi-specific human capital is present and the productivity associated with the human capital varies across other employers, then workers will switch employers when on average not much human capital needs to be sacrificed (in this example a move only occurs when the human capital becomes more valuable after the move). The result is that the return to tenure in the data understates the importance of specific human capital, i.e., in this example the return to tenure is negative even though stayers clearly have accumulated a positive amount of specific human capital.

One might argue at this point that cross sectional empirical studies have not found a negative return to tenure, and hence, that the current analysis is inconsistent with the empirical evidence. Such a view, however, would be missing the point of the exercise. There are a number of factors not captured in this example whose presence would have the effect of making the return to tenure in the data positive. For example, the return could be positive if some workers switched jobs for a reason other than that they received higher wage offers at the new positions. Also, in a world of job matching, the return could be positive because longer jobs are associated with better matches.[9] In the stylized example I have purposely abstracted away from such factors. The reason is the ease with which one can view the example, and see why the presence of quasi-specific human capital can cause the return to tenure in the data to understate the importance of specific human capital in the environment. In the following section I present a more fully developed

model for which the return to tenure in the data would be positive, and show that similar results persist.

III. A More Fully Developed Model

This section considers a simple search model in which workers live for T periods, and human capital takes a quasi-specific form.[10] It is assumed that the productivity of worker i at firm j equals $\mu_{ij}+k(t)$, where $k(0)=0$, $k'>0$ and $k''\leq 0$. μ_{ij} is the quality of the match between worker i and firm j, where μ_{ij} can be thought of as a draw from a random variable which has a cumulative distribution function F(.): $F(\underline{\mu})=0$, $F(\bar{\mu})=1$, $F'(\mu)>0$ and $F''(\mu)$ exists for $\mu\epsilon(\underline{\mu},\bar{\mu})$. k(t), on the other hand, is the productivity of the worker's human capital where t – which will be referred to as the worker's true value for tenure – is related to but not identical to the worker's tenure at his current employer. In particular, if the worker is either at his first job or if his previous job utilized a different type of human capital than his current job, then his true value for tenure does equal the worker's tenure at his current employer. However, if his previous job utilized the same type of human capital, then t equals the worker's tenure at his current employer plus the value for t after the worker's last period of employment at his previous employer. This is a very simple way of capturing the notion that human capital takes a quasi-specific form. That is, there are a variety of types of human capital such that if a worker switches to a new job which uses the same type of human capital as his previous job, then in terms of the productivity of his human capital it is as if the worker did not switch employers. However, if the switch is to a job which uses a different type of human capital, then the value of the worker's human capital falls to zero.[11]

It is assumed that in the first period of employment each worker receives a wage offer from a firm drawn randomly from the pool of firms. In all succeeding periods each worker receives two wage offers. One offer is from the worker's current employer. The other is from a firm which is again drawn randomly from the pool of firms, where with probability Y this new job uses the same type of human capital as the worker's current job. Finally, it is assumed that workers are risk neutral, that both workers and firms discount the future by a factor β, and that the wage offered to a worker is always equal to the worker's productivity at the offering firm. As pointed out by Jovanovic (1979) for a somewhat similar model, this wage policy results in efficient turnover.[12]

We can now proceed to the analysis. The first proposition suggests that, as in the stylized example, the return to tenure in the data will understate the importance of specific human capital in the environment.

Proposition 1: Consider all workers who, at a given date, are characterized by some fixed level of experience, and some fixed level of t. For those workers who move in the subsequent period, the average loss of human capital will be less than the average amount of human capital which is specific for those workers who decide to stay.

Proof: See the Appendix.

What drives Proposition 1 is exactly the intuition initially presented in the Introduction. On average a mover will be an individual who has received a wage offer from a firm which uses the same type of human capital as the firm from which he moves, while a stayer will be an individual who has received a wage offer from a firm which uses a different type of human capital. The

result is that the average loss of human capital for workers who move is less than the average amount of human capital which is specific for similar workers who decide to stay. Or in other words, since the return to tenure in the data is to some extent a measure of how much human capital is lost when moving occurs, there is again a suggestion that this return will understate the importance of specific human capital in the environment.

We now turn our attention in a new direction. Given a fixed value for experience and a fixed value for t, there will be some critical value of the job match, denoted μ^*, which has the following property. Specifically, if a worker with that value for experience and that value for t has a current job match better than μ^*, then that worker will not move unless the new job employs the same type of human capital as the previous job. Proposition 2 considers how μ^* varies with t and with experience.

Proposition 2:

i) Holding experience fixed, an increase in t will cause μ^* to decrease (or remain the same if the initial value of μ^* was $\underline{\mu}$).

ii) Holding t fixed, an increase in experience will cause μ^* to decrease (or remain the same if the initial value of μ^* was $\underline{\mu}$).

Proof: See the Appendix.

The logic behind Proposition 2 is as follows. If a worker's current job match is better than μ^*, then the expected return from job match improvement can never be large enough that the worker would be willing to sacrifice his human capital. This in turn makes i) and ii) quite easy to understand. If t increases then sacrificing human capital is more costly, and clearly the critical value μ^* must decline. Similarly, if experience

increases then the maximum return from job match improvement falls (due to the fewer number of periods which would remain after the move), and again the critical value μ^* must decline.

Note that Proposition 2 is just one manifestation of a more general point. In a world where human capital is quasi-specific, the probability that during a move a worker will sacrifice his human capital should be negatively related to the amount of human capital accumulated, and to the potential returns from job match improvement. Hence, as suggested by Proposition 2, the probability human capital is sacrificed during a move should be negatively related both to experience and to the true value for tenure just prior to the move.[13]

This completes the analysis. In the following section I consider how one might test for the presence of quasi-specific human capital, especially in light of the above discussion, and then consider the implications of quasi-specific human capital for some other related issues.

IV. Related Issues

A) Testing for the Presence of Quasi-Specific Human Capital

A number of recent empirical papers have found that after more carefully controlling for biases that arise due to factors such as unobserved heterogeneity and job matching, the return to tenure in the data is very small. In this paper I have argued that these results do not necessarily imply that the labor market exhibits an insignificant level of specific human capital, but rather they may simply indicate that the specificity which does exist typically takes a quasi-specific form. Of course, the obvious next question is, how could one distinguish between these alternative explanations?

One such way is suggested by the discussion which concludes Section III.

Suppose quasi-specific human capital is present in an environment. The gist of that previous discussion is that the higher is experience and/or is the true value for tenure, the less likely is it that a worker will move and at the same time sacrifice his human capital. Remember, however, that the return to tenure in the data is to some extent a measure of how much human capital is lost when workers move. Combining these two ideas we have the prediction that the return to tenure should be negatively related both to experience, and to the workers' true values for tenure at the completion of their previous jobs. One could test this prediction with a longitudinal data set, where testing would involve interacting the tenure variable both with experience and with variables which proxy for the true value for tenure at the completion of the previous job.[14]

An interesting point to note is that Light (1987) already contains some results consistent with the prediction concerning experience. First, looking at a data set composed solely of young workers, she uses an approach similar to that employed by Altonji/Shakotko and Abraham/Farber, and finds a larger return to tenure. Second, in some of her regressions she interacts tenure with an experience variable, and the typical finding is that the coefficient is both negative and statistically significant (see also Brown (1983)). Note that, one might at first think the negative relationship found by Light could also be explained by a more standard human capital story. That is, investment in human capital should be lower when there are fewer periods over which to recoup the investment (see Ben-Porath (1967)). This reasoning, however, is incorrect. It is true that as experience increases, the maximum number of periods a worker can spend at any new job must fall. On the other hand, the typical finding is that for young workers there is a positive relationship

between experience at the start of a new job and expected job duration at the new job (in particular, this positive relationship holds for the workers studied by Light). Hence, at least for young workers, this more standard human capital story actually predicts a positive relationship between experience and return to tenure.

B) Quasi-Specific Human Capital and the Costs of Worker Displacement

An issue of significant current interest is the societal costs due to worker displacement (for a recent survey see Hamermesh (1987b)).[15] One obvious component of such costs is the loss of workers' firm specific human capital. This sub-section will discuss the implications of the presence of quasi-specific human capital for this issue.

One might think that the loss of specific human capital which is due to worker displacement, should simply be the magnitude of specific capital for those workers independent of whether displacement is to occur.[16] In the presence of quasi-specific human capital, however, this is incorrect. The value of human capital which is properly considered as firm specific is the difference between the value of the capital at the current firm and the value of the capital at the worker's next best employment opportunity. Given this, consider a randomly chosen worker who is currently employed. Suppose that if this worker were to be laid off – and no one else in the firm were laid off – he would move to a firm which values his human capital half as much as the initial employer, i.e., from the standpoint of a layoff half of this worker's capital is firm specific. Now suppose the worker were to lose his job because of a plant closure. In looking for a new job the worker will be competing against his former co-workers who will have accumulated similar skills. The result is that, on average, we would expect the worker to move to a new job

which values his human capital less than half as much as his initial employer, i.e., more of the human capital is specific when the standpoint is that of a plant closure than when the standpoint is that of a layoff. In other words, one should be hesitant to take estimates of specific capital calculated for workers not subject to a plant closure (or estimates calculated from data on displaced workers where the data is solely from dates prior to the displacement), as a measure of the specific capital which is lost due to worker displacement.[17]

C) Measuring Total Returns to Human Capital Versus Total Returns to Job Matching

The two most accepted explanations for why age earnings profiles are typically upward sloping is the accumulation of human capital, and that worker-firm matches improve with experience. Recent papers have attempted to explore the relative importance of the two explanations by directly measuring how much of wage growth can be attributed to the accumulation of human capital, and how much can be attributed to job matching. For example, Topel finds that "the matching process accounts for 25 percent or more of the observed relation between earnings and labor market experience." In this sub-section I explore the implications of quasi-specific human capital for such an endeavor.

The first point I would like to make is that in the presence of quasi-specific human capital, the whole endeavor lacks a theoretical underpinning. That is, in such a world, when a worker searches for a new job he is not only searching for a good match for his innate characteristics, but he is also searching for a good match for the human capital which he has already accumulated. Hence, the type of decomposition described above has no firm theoretical basis, since clearly the total returns to human capital will

depend on the extent to which the worker searches.

Suppose that we now ignore the theoretical problems discussed above, and ask what are current estimates of the returns to job matching likely to be capturing. Suppose that, as in the stylized example, quasi-specific human capital has the property that it is sometimes worth more at a new firm than at the firm at which it was originally accumulated.[18] If this is the case, then current estimates of the returns to job matching are likely to be overstating the returns due to improvements in the match between firms and the innate characteristics of workers. The logic is as follows. Under existing theory, a worker's wage can rise during a move only because the worker has found a better match for the worker's innate characteristics. Given quasi-specific human capital, however, such a wage increase will also frequently occur because the worker has found a better match for his human capital. Hence, because current attempts at decomposition are based on existing theories, there will be a tendency for wage increases which are due to better matches for the workers' human capital to be attributed to better matches for the workers' innate characteristics.

V. Conclusion

Economists typically distinguish between two types of human capital: general and specific. This paper has identified a third type of human capital – what is referred to as quasi-specific – and explored some of its implications. The main result of the paper is that in the presence of quasi-specific human capital, data may exhibit a very small return to tenure even if the specificity of human capital is quite substantial. Hence, rather than implying that the labor market exhibits an insignificant level of

specific human capital, recent results of Topel, Abraham and Farber, Altonji and Shakotko, and Marshall and Zarkin may simply indicate that the specificity which does exist typically takes a quasi-specific form. The paper also considers how one might empirically test for the presence of quasi-specific human capital, and the implications of quasi-specific human capital for the following related issues: (i) measuring the costs of worker displacement; and (ii) measuring the total returns to human capital versus the total returns to job matching.

Appendix

The proofs, although straightforward, are somewhat tedious, so I will just outline them here.

Proof of Proposition 1: For the proof of Proposition 1 it is assumed that there is a continuum of workers who work for T periods. This allows the proposition to be written in terms of average amounts, rather than expected average amounts.

Consider all workers with some fixed level of experience, some fixed level of t, and some fixed current value of μ_{ij}, denoted $\hat{\mu}$.[19] There are two cases. With probability Y a worker will get a wage offer from a firm which uses the same type of human capital as the worker's current employer. Clearly the worker would move in this case if and only if the new μ_{ij} was greater than $\hat{\mu}$ (the probability the two are equal is zero, and can therefore be ignored). With probability 1-Y the worker will get a wage offer from a firm which uses a different type of human capital. Here the worker would move if and only if the new μ_{ij} was greater than $\hat{\mu}$ plus some value δ, $\delta>0$. That is, because he will sacrifice his human capital by moving, such a worker will not move if the new job match is only slightly better than the old job match. It is assumed that the distribution of new μ_{ij}'s is independent of whether the new firm uses the same type of human capital as the old firm. Let L be the proportion of the human capital of movers lost during the move, S be the proportion of the human capital of stayers which is specific to the current firms, and f(.) be the density function which corresponds to the distribution function F(.). For this subset L is given by (A1) and S is given by (A2).

$$(A1) \qquad L = \frac{(1-Y)\int_{\hat{\mu}+\delta}^{\bar{\mu}} f(\mu)d\mu}{(1-Y)\int_{\hat{\mu}+\delta}^{\bar{\mu}} f(\mu)d\mu + Y\int_{\hat{\mu}}^{\bar{\mu}} f(\mu)d\mu}$$

$$(A2) \qquad S = \frac{(1-Y)\int_{\underline{\mu}}^{\hat{\mu}+\delta} f(\mu)d\mu}{(1-Y)\int_{\underline{\mu}}^{\hat{\mu}+\delta} f(\mu)d\mu + Y\int_{\underline{\mu}}^{\hat{\mu}} f(\mu)d\mu}$$

Given $\delta>0$, we now have $L<1-Y<S$. One can repeat this same argument for each different value of the current match, and show that for the whole subset of workers under consideration it is the case that $L<1-Y<S$. Finally, given that all workers in this subset have the same accumulation of human capital, we now have that the average loss of human capital for workers who move is less than the average amount of human capital for stayers which is specific for those workers who decide to stay.

Proof of Proposition 2: Hold experience and t fixed. If μ^* is greater than $\underline{\mu}$, it must be the value of the current job match for which a worker will be indifferent between moving and not moving given that the new job uses a different type of human capital, and that the new job match equals $\bar{\mu}$.

Consider two different values for t, denoted t_1 and t_2, $t_1>t_2$. Also, let μ_1^* and μ_2^* be the values for μ^* when t equals t_1 and t_2 respectively, where $\mu_2^*>\underline{\mu}$. The cost of the move is clearly some increasing function of the lost

human capital, and is therefore clearly larger when t equals t_1 than when t equals t_2. The return from the move is clearly some increasing function of the job match improvement. Hence, given that μ^* is defined in terms of the worker being indifferent between moving and not moving, it must be the case that $\mu_1^* < \mu_2^*$. This proves i), and ii) follows similarly.

Footnotes

[1]For example, Becker states that

> "Completely general training increases the marginal productivity of trainees by exactly the same amount in firms providing the training as in other firms...Completely specific training can be defined as training that has no effect on the productivity of trainees that would be useful in other firms. Much on-the-job training is neither completely specific nor completely general..." (Becker (1962), p. 17)

[2]One might ask what the relationship is between quasi-specific human capital and industry or occupation specific human capital. The answer is that industry or occupation specific human capital is general human capital if a worker will never move outside the industry or occupation. However, if the probability of such a move is greater than zero, then industry or occupation specific human capital falls under the heading quasi-specific. See footnote 17 for further discussion.

[3]Examples include Mincer (1974), Mincer and Jovanovic (1981), and Bartel and Borjas (1981).

[4]The focus of Marshall and Zarkin is somewhat different than the other papers. They consider the idea that wage offers can be acceptable or unacceptable, and that OLS regressions only capture how tenure affects acceptable wage offers.

[5]A recent study by Light (1987) makes some of the same corrections as the studies mentioned above, and finds a stronger positive relationship between tenure and wage rates. See Section IV for a further discussion of that paper.

[6]Topel (1986) provides an argument for why job matching can cause the return to tenure in the data to understate the importance of specific human

capital in the environment, while Bull and Jovanovic (1988) show how such a result can arise in the presence of demand shocks across firms. The argument in the current paper is that, even if one completely controls for all the effects of job matching and demand shocks, the presence of quasi-specific human capital can cause this same result.

[7]This discussion is somewhat imprecise. Even if the increased productivity associated with human capital were not to vary across other employers, the presence of quasi-specific human capital could still cause the return to tenure in the data to understate the importance of specific human capital in the environment. This would occur if the increased productivity of human capital at other employers were stochastic (see footnote 8).

[8]As suggested by footnote 7, an alternative which yields the same final result is to assume that this is not a search model, but that the return at other firms is stochastic. In particular, with probability p the return at other firms would be λ, while with probability (1-p) the return would be σ.

[9]It has frequently been suggested that this factor would cause the return to tenure in the data to overstate the importance of specific human capital in the environment. Abraham and Farber (1987) and Altonji and Shakotko (1987) have analyzed longitudinal data sets and attempted to control for this bias. As indicated, the result is that they find a very small return to tenure. Note further, Topel (1986) has pointed out that job matching could actually cause a bias in the other direction.

[10]Previous papers which model the job search process include Burdett (1978), Johnson (1978), and Jovanovic (1979, 1984).

[11]It is also assumed that if, for example, the worker later moves to a third firm which uses the same type of human capital as the first, then the

value for t again falls to zero. That is, in this model human capital completely depreciates if it is not used. This assumption is not crucial, but rather serves to simplify the mathematics.

[12]If we were instead to assume that the rents associated with a good match are shared between the worker and the firm (see Becker (1962), Oi (1962), Kuratani (1973), Mortensen (1978), and Hashimoto (1981)), then we would have another reason why the return to tenure in the data would be a poor measure of the specificity of human capital in the environment.

[13]The negative relationship concerning experience is actually due to three factors. The first is that which drives the experience result in Proposition 2. That is, the potential returns from job match improvement fall with experience because there are fewer working periods which follow a move. The second factor is due to the fact that an increase in experience increases the average quality of job matches. That is, given an increase in experience, the potential returns from job match improvement will be smaller on average because the initial matches are better. Finally, the third factor is that experience may be a good proxy for the true value for tenure.

[14]Possible proxies include completed job tenure at the previous job, the maximum completed job tenure among all previous jobs, and experience (see footnote 13).

[15]Following Hamermesh, worker displacement will refer to workers who lose their jobs due to plant closures.

[16]Even in the absence of quasi-specific human capital, this statement would be incorrect if workers who were eventually to be displaced anticipated displacement, and changed their investment plans accordingly. Evidence presented in Hamermesh (1987a), however, suggests this does not occur.

[17]One might claim that all I am saying here is that, when workers are displaced, they are more likely to lose their industry and occupation specific human capital. Although this is part of what is happening in the above scenario, it is not the whole thing. That is, even ignoring industry and occupation specific human capital, the above discussion suggests that more human capital is specific when the standpoint is that of a plant closure than when the standpoint is that of a layoff.

[18]This could occur, for example, if a worker's human capital consisted partly of knowledge concerning his employer's production methods, and a rival firm wanted to acquire information concerning those methods.

[19]To be precise, if we restrict the set of workers to a single value for μ_{ij}, then we will have zero workers. Hence, one should think of the following discussion as pertaining to an interval for μ_{ij}, and what happens in the limit as this interval approaches a point.

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