Learning in presence of general and match-specific human capital

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Abstract

Research on employer learning has concentrated on contexts where there is uncertainty only on either the general or the match-specific human capital of the worker. This paper develops a model where general and specific human capital coexist, and the uncertainty is on their respective share in total productivity. By definition, only general productivity is transferable to other matches, which makes knowledge about its value crucial, in particular for wage setting. I derive the equilibrium wage offers of the firms, and show that given these offers, the worker's turnover decision is socially efficient (conditional on the informational incompleteness). My model suggests predictions on other dimensions, *viz.* declining worker mobility with experience and rent sharing between employer and worker.

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1 Introduction

Information plays a central part in the labour market. Information imperfections contribute to matching frictions. First, unemployed workers and vacancies coexist at any point in time. Second, workers and firms are often not optimally matched with each other. One interpretation is that productivity is at least partially match specific and there is some uncertainty about this match specific productivity - uncertainty which is, at best, costly to solve.

This paper rests on the assumption that the productivity of a worker in a given match is not entirely specific to this match. In other words, a certain amount of this productivity would be transfered to the new match, should the worker decide (or be led to) change job. I think of this situation as one where productivity has both a general (transferable) and a specific (non-transferable) components. Total productivity on a job is, then, assumed to vary positively with each of those two components.

The relative importance of general productivity and match-specific productivity is likely to vary across sectors of the labour market. If the focus is on careers and mobility between relatively substitutable jobs, e.g. lecturer in economics in different institutions, general productivity will be relevant to the skills that are necessary for this type of job in any university (pedagogy, insight, motivation). Specific productivity will likely be narrower, and include for example peer-effects from department-specific collegues. In this situation it seems that the general component for productivity will amount to most of the productivity in the match[1]. In a way, this 'general' productivity is already specific to this segment of the labour market.

However, one can be interested in mobility across a broader array of occupations. In that case, the transferable part of human capital is expected to amount to a relatively lower share of the total productivity. One can think of many potential sources of variations of productivity across matches. Different workers may react differently to pressure at work; some other worker characteristics, e.g. interpersonal skills, are valued differently across jobs. Worker intrisic motivation is also likely to vary across jobs and affect productivity.

The fundamental assumption I make in this paper is that the general productivity of the worker is unknown *ex ante*, as well as his job specific productivity in any job available to his. Once on a job, whilst the worker's total productivity is perfectly observed by all the agents in the economy, it is not known how this productivity is split between its general and specific components. In other words, there is uncertainty on the share of productivity which can be transfered to the next job, and that which is specific to the current job. This assumption implies that the only way for the economy to obtain information on a worker's general productivity is to observe her experiment enough jobs to extract this information with sufficient clarity.

[1] In other words, and to be consistent with the framework developed later, the variance of the specific component is small compared to that of the general component.

Much of the literature on employer learning on the labour market focuses on information on match specific productivity. Amongst the most prominent papers is Jovanovic (1979). In his paper, the worker and his firm learn continuously about the quality of the current match until the match is broken. Since all human capital is match-specific and the worker lives forever, the value of quitting does not depend on history, and it is shown that the decision to quit depends only on whether the current productivity is above or below a reservation productivity, which itself is a function only of tenure on the current job.

More recent papers featuring uncertainty on job-specific productivity include, for example, Moscarini (2005) and Felli and Harris (1996).

In my model, in contrast with this framework, the turnover history of the worker affects his value of quitting by updating the public information on his general human productivity.

Another branch of the learning literature is interested in learning about general productivity. In a recent working paper, Eeckhout (2006) focuses explicitly on the case where all the human capital is general, that is, the worker is expected to have the same productivity in all jobs. Other papers, such as Farber and Gibbons (1996) or Altonji and Pierret (2001), implicitly study learning about general productivity, in that the worker is endowed with a certain unobserved innate ability, which affects his productivity on all matches. In the case where the worker has better information about his ability than prospective employers, studying uncertainty on general human capital allows for interesting discussions on the value for the worker of signalling his general human capital through education, *à la* Spence (1973). That is the focus of both Farber and Gibbons (1996) and Altonji and Pierret (2001), whereas Eeckhout (2006) concentrates on mobility and competition amongst employers.

In some cases, assuming that all human capital is transferable seems to be a better approximation of reality than the assumption that it is entirely match-specific (eg, example of academics); however, there is reason to believe that the more general case that is explored in my paper, where I allow for the coexistence of general and match-specific productivity, may be closest to reality[2].

It can be argued, in models of bayesian learning about worker productivity, that the accumulation of information about the quality of a match may be interpreted as accumulation of human capital. See, for example, Felli and Harris (2004). There are, therefore, two competing effects through which human capital is accumulated during a match. The first, probably most intuitive way, is through learning-by-doing. This effect implies an increasing productivity on the job (informational effects put aside). The second effect is the informational effect mentioned above, that is, the worker and the employer learn about the quality of the match while it lasts. These two effects are not exclusive, although most analyses tend to focus on either one. An interesting exception is Nagypál (2006), which endeavours to distinguish and measure the two effects. Nagypál builds and estimates a model where (specific) learning-by-doing and learning about match quality coexist. Her estimates suggest that the relative

[2]In the current version of the paper, this feature comes at the cost of strong assumptions on other respects, e.g. only three periods, and workers themselves do not know their general human capital.

strength of these two effects varies with tenure. Learning-by-doing may be present during the first few months of employment, but the dominating, longer-lasting effect seems to be learning about match quality. Moreover, Nagypal's estimates imply that learning about match quality leads to an increase in output of roughly 30% over a ten years horizon. This is a selection effect: matches that are revealed to be unproductive are broken earlier, and only the most productive remain.

My assumption that the total productivity of a worker on a match is immediately observable by all agents might seem to be very strong, as it implies an infinite speed of learning about match quality. However, as my model is a three-period model, I believe that it is reasonable to interpret each period as long enough for this assumption to be justified. If the first period is to be interpreted as the entry of the young worker on the labour market, and the third period as immediately followed by retirement, then each period can actually be seen as summarizing more than ten years, which is more tenure than enough to learn perfectly about match quality[3]. According to Lange (2007), after three years, the employer's initial expectation errors about match-quality has declined already by 50%. My contribution, though, is to raise the point that perfect knowledge about the worker's productivity on a match does not say anything about how much of this productivity is transferable to other potential matches.

In this paper, I explore the implications of learning on both general and specific human capital. I first assume that the worker is always paid exactly her productivity. The worker turnover decision in this case is efficient, as it optimizes his expected productivity, and thus his incentives are aligned with those of a social planner with the same (limited) information set. I derive the turnover decision of the worker in this context, and show that he will be slightly more prone to change job after the first period if his initial information on general productivity is imprecise.

I then assume that the firms (all assumed to observe the job history of the worker) make simultaneous wage offers at each period. Although his rewards are modified, the worker's turnover behaviour is unaltered compared to the previous case. Competition between potential new employers guarantees that the outside wage paid to the worker if he moves equals his expected productivity, and the current employer can try to extract a rent from the worker's match specific productivity, as long as it can afford to pay at least the outside wage.

2 The model

2.1 The baseline three-period model

I consider one worker facing an infinity of job vacancies, issued by separate firms competing on the market for labour, indexed by $i \in \{1, ..., +\infty\}$. The ex ante characteristics of job vacancies are iden-

[3]For the same reason (and for simplicity), I assume that learning-by-doing is negligible and do not include it in my model. This is consistent with Nagypál's results.

tical. The worker is endowed with a general productivity, summarized by a quantity denoted as g, and match-specific productivities corresponding to each of the job vacancies, denoted as s_i. These quantities are unobserved, but all agents (worker and firms) have the same beliefs about them. There is no information asymmetry.

Ex ante, g is believed to follow a normal distribution with mean m_g and variance σ_g^2. Similarly, for all i, s_i is normally distributed with mean 0 and variance σ_s^2. g and all the s_i are believed to be independent from each other.

The prior belief on g can be interpreted as deriving from all the signals available about g before the worker enters his first job - ie, signals resulting from the education of the worker.

At the beginning of each period, the worker is free to chose to work in any of the jobs, but cannot go back to a job he left in the past. Since all the jobs are equivalent *ex ante*, this means that in fact, his choice is between staying on the current match, or changing job. The production x_i of the period is perfectly observed, and is known to satisfy $x_i = g + s_i$. That is, total productivity is the sum of general productivity and match specific productivity.

I assume, for now, that the wage paid to the worker is equal to his total productivity. This is not a realistic assumption, since a profit-maximizing firm will try to retain at least part of the rent, especially if the match-specific (non transferable) component is believed to be high. I will depart from this benchmark later, when I allow for strategic wage-setting.

Studying the turnover behaviour of a worker being paid his full productivity is a way to find the efficient turnover, maximizing social surplus, of a more general model where the rent is somehow shared between the firm and the worker. The worker, in this benchmark, internalizes all the effect of his turnover. He gets paid his expected total productivity at the beginning of each period [4].

Upon changing job, a new s_i is drawn, and x_i, its sum with g, is perfectly observed. This allows the worker and the firms to update their belief on s_i, and, more crucially maybe, on g.

The worker's objective is to maximize his intertemporal utility, which is assumed to be the sum of his discounted wages. The interest rate is denoted as r.

The worker lives only for three periods. He can change jobs after the first and second periods.

I henceforth use subscripts to denote the period. For all t in $\{1, 2, 3\}$, the worker's productivity (perfectly observed) is denoted as x_t and the two components of his productivity are believed to be

[4] Assuming, as I do, that all agents are risk neutral, this last assumption is actually equivalent to the alternative where the worker is paid at the end of the period, once production has been observed - or even to an intermediate possibility (which I do not develop) where productivity within a match is learnt progressively during each period, and wages follow the evolution of beliefs on total productivity. However for this last context to be consistent with the other assumptions about learning between periods, it still needs to be the case that total productivity is perfectly known by the time one period ends.

normally distributed with means μ_t^g and μ_t^s and variances ${s_t}^2$[5].

Theorem 2.1 *If the economy's belief on g is normally distributed with mean μ_t^g and variance ${s_t}^2$ and the worker starts job j where his productivity is revealed to be x, then the economy's updated belief on g is normally distributed with mean $\frac{\mu_t^g \sigma_s^2 + x {s_t}^2}{\sigma_s^2 + {s_t}^2}$ and variance $\frac{\sigma_s^2 {s_t}^2}{\sigma_s^2 + {s_t}^2}$.*

This theorem, applied as many times as necessary, gives us the distribution of the economy's belief once past matches are observed and accounted for. A corollary is:

Corollary 2.2 *The economy's belief on g after n matches have been experienced is normally distributed with variance $S(n) = \frac{\sigma_s^2 \sigma_g^2}{\sigma_s^2 + n\sigma_g^2}$.*

2.1.1 Behaviour in the second period

The worker gets payoff x_2 in the second period and decides whether to change job or not for his third period. He will change job if his expected payoff from doing so is greater than x_2, which he can get for sure by not breaking the current match. That is, the worker moves if $\mu_2^g > x_2$, or $0 > \mu_2^s$. An expression for μ_2^s is $\frac{(x_2 - \mu_1^g)\sigma_s^2}{\sigma_s^2 + {s_1}^2}$.

The present discounted value of the payoff in the second period is therefore a function of x_2 which we shall denote as $\Pi_2(x_2)$:

$$\begin{aligned}
\Pi_2(x_2) &= x_2 + \frac{1}{1+r} Max\left(x_2, \frac{\mu_1^g \sigma_s^2 + x_2 {s_1}^2}{\sigma_s^2 + {s_1}^2}\right) \\
&= x_2\left(1 + \frac{1}{1+r}\right) + \frac{1}{1+r} Max\left(0, \frac{(\mu_1^g - x_2)\sigma_s^2}{\sigma_s^2 + {s_1}^2}\right)
\end{aligned}$$

2.1.2 Behaviour in the first period

In the first period, the worker gets payoff x_1 and decides whether to change job or not. This decision depends on how his expected discounted payoffs compare in both cases. If he does not change job, he receives payoff $(1 + \frac{1}{1+r} + \frac{1}{(1+r)^2}) x_1$[6]. If he changes job, he receives payoff $x_1 + \frac{1}{1+r} E_1(\Pi_2(x_2))$, where E_1 denotes expected value given the information available (i.e. beliefs held) at the end of period 1.

[5]Since $x_t = \mu_t^g + \mu_t^s$ and x_t is observed, it needs indeed be the case that μ_t^g and μ_1^s are believed to have the same variance.

[6]It is easy to show that if the worker does not move today, he will not move tomorrow either. This is because the expected reward for moving is larger after period 1 than after period 2. Indeed, in the case of mobility after period 2, the expected return from moving is simply the difference between the current productivity and the expected productivity on the new match. On the contrary, in the case of mobility after period 1, if the new match is a good match, it can be enjoyed for two periods; if it is a bad match, it is possible to move again in period three. That is, the possibility of moving again after period 2 makes moving after period 1 more appealing.

Theorem 2.3 *The worker decides to change job in the first period if and only if*

$$\mu_1^s \leq \frac{1}{2+r}\frac{1}{\sqrt{2\pi}}\frac{\sigma_s^2}{\sqrt{\sigma_s^2+{s_1}^2}} \tag{1}$$

or equivalently

$$x_1 - m_g \leq \frac{1}{2+r}\frac{1}{\sqrt{2\pi}}\frac{\sigma_s^2+\sigma_g^2}{\sqrt{\sigma_s^2+{s_1}^2}} \tag{2}$$

Proof Given that $E_1(x_2) = \mu_1^g$ and that $\mu_1^g - x_2$ is believed to be normally distributed with mean 0 and variance ${s_1}^2 + \sigma_s^2$, it can be proved that $E_1\left(\Pi_2(x_2)\right) = \left(1+\frac{1}{1+r}\right)\mu_1^g + \frac{1}{1+r}\frac{1}{\sqrt{2\pi}}\frac{\sigma_s^2}{\sqrt{\sigma_s^2+{s_1}^2}}$. Therefore, the worker's expected payoff if he moves is believed to be $x_1 + \frac{1}{1+r}\left(\left(1+\frac{1}{1+r}\right)\mu_1^g + \frac{1}{1+r}\frac{1}{\sqrt{2\pi}}\frac{\sigma_s^2}{\sqrt{\sigma_s^2+{s_1}^2}}\right)$.

Comparing this expected return with the return of staying with the current employer straightforwardly yields the theorem. $\square$

The right-hand side in 2 can be shown to be always increasing in σ_g^2. Its variations with respect to σ_s^2 are non-monotonous. It decreases until $\sigma_s^2 \leq (\sqrt{3}-1)\sigma_g^2$, and increases ever after.

In other words, *ceteris paribus* (in particular, for a given x_1 higher than m_g[7]), we learn three things about the worker's mobility *given his first draw* x_1. (1) The worker tends to move more the higher the initial uncertainty on his general productivity is. (2) If the draws of match-specific productivity are very precise, then reducing this precision tends to make the worker move less. This second effect is more pronounced when there is high initial uncertainty on general productivity. And (3), if the draws of match-specific productivity are rather imprecise, then reducing this precision tends to make the worker move more.

A few comments may be in order regarding each of these effects. (1) is simply a consequence of the fact that if there is high initial uncertainty on general productivity, then the first match has a large influence on the way the economy's belief is updated. Remember that we restrict ourselves to the case where x_1 is larger than m_g, which means that the belief on general productivity is updated upwards. At the limit, when σ_g^2 goes to infinity, the new belief approaches x_1, and then the worker will want to move no matter how x_1 compares to m_g. (2) works through a similar mechanism. If $x_1 \geq m_g$, and σ_g^2 is quite high compared to the initial σ_s^2, then when σ_s^2 increases, the updated belief on general productivity (μ_1^g) shifts away from x_1 and towards m_g, and thus decreases. Then the current match is perceived as a better match than before the σ_s^2 increase, and the worker's willingness to move decreases. This is a rather small effect, but it can dominate over (3) in certain situations. The intuition behind (3) is the following: if $x_1 \geq m_g$, and σ_g^2 is relatively low compared to the initial σ_s^2, then when σ_s^2 increases, the most important effect is that the distribution of future draws becomes more variable. This means that exceptionally high draws become more common. (So do exceptionally low draws, of

[7]If $x_1 < m_g$ the worker unambiguously moves.

course, but at this point the worker knows that there will be one more opportunity to move in the future - so a low draw will only be imposed on the worker for one period, whereas a high draw will be enjoyed twice.) Therefore when σ_s^2 increases, the worker's incentives to move go up.

The previous discussion was all conditional on the first draw x_1. It is quite straightforward to show that prior to this first draw, the probability of the worker moving after the first period is $\Phi\left(\frac{1}{2+r}\frac{1}{\sqrt{2\pi}}\frac{\sigma_s^2+\sigma_g^2}{\sigma_s\sqrt{\sigma_s^2+2\sigma_g^2}}\right)$, which is everywhere decreasing in σ_s^2 and increasing in σ_g^2. That is, the worker's unconditional probability of moving increases when his initial information on general human capital becomes more imprecise, or when the signals he receives on each new job become more precise - ie, when the speed of learning increases. Effect (2) now dominates over (3) everywhere.

Let us now condition the probability of moving on the general human capital of the worker g (e.g. to study mobility of high human capital workers, keeping in mind that they do not know that their general human capital is indeed high). We then obtain a probability of moving after the end of the first period equal to $\Phi\left(\frac{1}{2+r}\frac{1}{\sqrt{2\pi}}\frac{\left(\sigma_s^2+\sigma_g^2\right)^{\frac{3}{2}}}{\sigma_s^2\sqrt{\sigma_s^2+2\sigma_g^2}}-\frac{g-m_g}{\sigma_s}\right)$. This probability is increasing in σ_g^2 and varies ambiguously with σ_s^2. Besides, it is obviously decreasing in g: workers with high human capital will tend to attribute part of their good productivity in their first job to the match specific component of their productivity, thus over-estimating the quality of their current match and under-estimating the returns to mobility. This prediction does not seem to fit the data very well[8]. I believe that this can be solved by introducing asymmetric information (which I have not done in this paper, as signalling considerations arise which complicate the tractability considerably). Assuming indeed that the worker is aware of his high human capital, while the firms are not, could increase the incentives to move for high general human capital workers, whilst reducing that of low general human capital workers.

2.2 Equilibrium wages

In this subsection, I allow for firms to make wage offers to the worker at the beginning of each period. This contrasts with the previous version of the model, where wages were assumed to equal expected total productivity instead of being set strategically by firms. Firms now compete with each other to attract the worker. I will derive the equilibrium wage offers for the last two periods[9].

[8]Although it is hard to pick up and may call for a careful empirical study, there does not appear to be an important effect of ability on mobility of workers in the data.

[9]In the first period, all firms make the same wage offer, which happens to have a rather ugly algebraic formulation. I will not comment it, as it is not crucial to the discussion. For the curious reader, the said expression is

$$w=m_g+\frac{1}{1+r}\left[(2+r)\frac{\sigma_s^2}{\sqrt{\sigma_s^2+\sigma_g^2}}\phi\left(\frac{1}{2+r}\frac{1}{\sqrt{2\pi}}\frac{\sigma_s^2+\sigma_g^2}{\sigma_s\sqrt{\sigma_s^2+2\sigma_g^2}}\right)-\frac{1}{\sqrt{2\pi}}\frac{\sigma_s^2\sqrt{\sigma_s^2+\sigma_g^2}}{\sqrt{\sigma_s^2+2\sigma_g^2}}\left(1-\Phi\left(\frac{1}{2+r}\frac{1}{\sqrt{2\pi}}\frac{\sigma_s^2+\sigma_g^2}{\sigma_s\sqrt{\sigma_s^2+2\sigma_g^2}}\right)\right)\right]$$

I shall refer to the firm at which the worker is currently working as the *current* firm, and to the firms at which he could be working after breaking the current match as the *other* firms.

2.2.1 Third period

Between the second and third periods, the other firms will, in equilibrium, offer to the worker a wage of μ_2^g (his expected productivity). If they offer more, they expect to make losses, and if they offer less each of them would have an incentive to deviate and offer slightly more, thus securing that if the worker moves, then he will move to that firm.

The current firm will match that offer if and only if $x_2 > \mu_2^g$. In that case, I assume that the worker will choose to stay with that firm (imagine that the firm pays a very small ϵ on top of μ_2^g to make sure the worker stays). Otherwise it will offer x_2[10].

Then the worker moves at the beginning of the third period if and only if $x_2 < \mu_2^g$.

2.2.2 Second period

Theorem 2.4 *Between the first and second periods,*

- *If* $(x_1 - \mu_1^g) < \frac{1}{2+r}\frac{1}{\sqrt{2\pi}}\frac{\sigma_s^2}{\sqrt{\sigma_s^2+{s_1}^2}}$, *then the worker moves. The current firm offers* x_1[11]. *The other firms offer* $\mu_1^g + \frac{1}{1+r}\left(\frac{1}{\sqrt{2\pi}}\frac{\sigma_s^2}{\sqrt{\sigma_s^2+{s_1}^2}}\right)$.
- *If* $(x_1 - \mu_1^g) \geq \frac{1}{2+r}\frac{1}{\sqrt{2\pi}}\frac{\sigma_s^2}{\sqrt{\sigma_s^2+{s_1}^2}}$ *then the worker stays. All firms offer*[12] $\mu_1^g + \frac{1}{1+r}\left(\frac{1}{\sqrt{2\pi}}\frac{\sigma_s^2}{\sqrt{\sigma_s^2+{s_1}^2}}\right)$.

Proof Let us denote as $V_c(x_1)$ and $V_o(x_1)$, respectively, the wages offered in (an) equilibrium by the current firm and the other firms. Then to ensure positive expected profit of the current firm, we need $V_c(x_1) \leq x_1 + \frac{1}{1+r}\mathbb{1}_{x_1 \geq \mu_1^g}(x_1 - \mu_1^g)$. Likewise, we need, for the other firms, $V_o(x_1) \leq \mu_1^g + \frac{1}{1+r}\frac{1}{\sqrt{2\pi}}\frac{\sigma_s^2}{\sqrt{\sigma_s^2+{s_1}^2}}$, and because of competition between firms the inequality needs to be an equality for all firms in equilibrium[13].

If the worker stays, he will receive $V_c(x_1) + \frac{1}{1+r}\mu_1^g$. If he moves, he expects to receive $V_o(x_1) + \frac{1}{1+r}E_1(\mu_2^g) = \mu_1^g + \frac{1}{1+r}\left[\mu_1^g + \left(\frac{1}{\sqrt{2\pi}}\frac{\sigma_s^2}{\sqrt{\sigma_s^2+{s_1}^2}}\right)\right]$. He will therefore move if and only if $V_c(x_1) < \mu_1^g + \frac{1}{1+r}\left(\frac{1}{\sqrt{2\pi}}\frac{\sigma_s^2}{\sqrt{\sigma_s^2+{s_1}^2}}\right)$.

[10] Actually this is only one out of a continuum of possible equilibria. If $x_2 < \mu_2^g$, the current firm offering any wage strictly below μ_2^g is an equilibrium. Likewise, if $x_2 > \mu_2^g$, all that is needed for there to be an equilibrium is that at least one of the other firms offers μ_2^g - but actually the other firms are indifferent between any wage offer below μ_2^g.

[11] For example. Anything below the other firms' offer would give another, equivalent equilibrium.

[12] Or at least the current firm does. The other firms can make lower offers and yet sustain the equilibrium, as long as at least one offers exactly that wage.

[13] At least when the offer of the current firm is lower, i.e. when the worker moves.

Given this behaviour of the worker, the optimal wage for the current firm to set is $\mu_1^g + \frac{1}{1+r}\left(\frac{1}{\sqrt{2\pi}}\frac{\sigma_s^2}{\sqrt{\sigma_s^2+{s_1}^2}}\right)$, but this wage will guarantee positive profits only if it is lower than $x_1 + \frac{1}{1+r}\mathbb{1}_{x_1 \geq \mu_1^g}(x_1 - \mu_1^g)$, which is only possible if $x_1 > \mu_1^g$. Therefore the condition for the worker to stay is indeed $(x_1 - \mu_1^g) \geq \frac{1}{2+r}\left(\frac{1}{\sqrt{2\pi}}\frac{\sigma_s^2}{\sqrt{\sigma_s^2+{s_1}^2}}\right)$. □

2.2.3 Efficiency

The analysis above indicates that the turnover decisions of the worker hang on the same conditions in the case of firm setting their wages as on that of the wages being set equal to the productivity. That is to say, the mobility of the worker is efficient even in the case where firms set their wages.

Efficiency of turnover between the second and third periods is intuitive. The other firms make offers equal to the worker's expected productivity on the new match, and the current firm only matches this offer if the worker's total productivity on the current job is higher than those outside offers: therefore the worker will move if and only if moving increases his expected output in third period.

Efficiency between the first and second period can be explained as follows. Due to competition between other firms, the wage paid to the worker if he leaves his current job is equal to his expected productivity on the new job, plus the expected potential rent that can be extracted in period 3. His current employer can only match offers up to his productivity on the current job, plus the rent it will extract in period 3. Therefore, the incentives faced by the worker are exactly the same as before[14].

Note that this result is sensitive to the assumption that the worker is risk neutral. If I were to make instead the assumption that the worker is risk averse, then he would tend to move less when he is paid his exact productivity at the end of each period than if the (risk neutral) firms can pay him his expected productivity at the beginning of each period. But then his turnover would still be efficient in the case of wage-setting firms. It is in the case of wage set equal to the productivity that turnover would be inefficiently low.

In environments of imperfect but symmetric information like ours, it is not unusual to observe such efficient turnover behaviour when the firms set wages. In Felli and Harris (1996) and Jovanovic (1979), it is indeed the case that the worker's turnover decisions maximize social surplus given the information available in the economy. One paper that differs is Felli and Harris (2004). By introducing firm-specific training as a choice variable of the firms, the authors introduce inefficiencies in their model, which in all variations of their baseline model translate into inefficiently low turnover.

[14]There is only a difference in timing, with wages paid in period 2 anticipating productivity in period 3.

2.2.4 Rent sharing, general and specific productivity

The worker invariably gets all of what is believed to be the return from his general productivity. He also receives a positive bonus corresponding to the rent the firm expects to be able to extract from match specific productivity in subsequent periods. This result is similar to those in Eeckhout (2006)[15].

However, the particular realization of match specific productivity is a risk supported entirely by the firm. It may take a high value that no other firm can expect to enjoy, and that the current firm can enjoy for several periods; or a low value which will lead to the immediate break of the match. As a consequence of competition, firms expect to make zero profits.

Let us have a look at how the return from a high general productivity is shared between the firms and the worker. By looking at the wage equations, it becomes clear that high general productivity workers only get a rent from their high ability through the economy's belief of it. That is, initially all workers are paid the same wage (first period), after which high productivity workers, in general, will be believed to be more able (in the sense of general productivity) and will get added returns from it. The opposite is true for workers with low general productivity, who can thus enjoy benefits from having their productivity over-estimated by the economy. The latter effect is stronger when σ_g^2 is low and σ_s^2 is high (that is, when updating is slow). However, since the workers don't have more information than the firms, they cannot adapt their turnover behaviour to this. If they did have more information, we might expect (ceteris paribus, i.e. for a given level of total productivity) high productivity workers to move more to signal their type and get the rent from it, and low productivity workers to move less to hide their type and continue enjoying a rent they don't actually deserve[16].

3 Discussion and conclusion

In this section, I will critically assess the model described in this paper, and discuss directions for further research.

My model, albeit still preliminary, nevertheless carries some insights, most notably on the subjects of worker mobility and rent sharing.

On job mobility, I find declining rates of mobility with the life cycle, which is a well documented stylized fact. This is mostly driven by the variations on job-specific productivity across jobs: workers keep moving until they find a match that they think is good enough for them.

On rent sharing, I find that the belief that the economy has on a worker's general productivity has an important impact on how much rent its employer can extract. A worker with high general

[15] However our assumptions differ in many dimensions. Eeckhout assumes that employers have asymmetric information about the worker's general human capital, with the current employer having access to a better signal; moreover, the wage setting rule is a second price auction. Yet Eeckhout finds, like me, that employers bid up to the expected (general) productivity, plus all rents that can be extracted in the future.

[16] But this behaviour would, in turn, be informative to firms.

productivity will only enjoy returns from it if all the firms are aware of this high productivity. This shows how much knowledge about general human capital matters in wage determination, and suggests that workers would be willing to strategically signal or hide their true general human capital if they had private information about it.

It seems reasonable to expect that, in reality, workers have a more or less clear idea of their general human capital, through experiences that are unobservable by the firms (e.g. grades obtained in high school, amount of efforts needed to obtain a degree, etc.). Assuming this sort of asymmetric information would likely alter many of the predictions of my model,. For example, it would likely no longer be the case that high general productivity workers move less than less able workers. It may actually be the other way round, if mobility can be used as a signal for high general human capital[17]. I believe that introducing asymmetric information would make the worker's turnover decisions inefficient (relative to his knowledge), precisely because of these signalling issues. High productivity worker's mobility may be inefficiently high, and that of low productivity workers inefficiently low.

Asymmetric information could also allow for endogenous education choices. For example, it may be assumed that education is less costly for high general human capital workers, who could therefore use it as another signalling device. The details of this, of course, are for further research to determine. The current model will provide a useful benchmark for future versions of this work, as it illustrates the extreme situation where information is always perfectly symmetric.

I hope that my model illustrates the need for a theory of employer learning that takes into account the duality of uncertainty on the worker's productivity. Models that concentrate only on learning on general productivity often fail to feature realistic job mobility and residual wage dispersion; and models that concentrate on learning on match-specific productivity cannot feature signalling on worker general ability.

[17]But this will probably only be possible if the worker's information on his own general human capital is perfect or very precise: otherwise, the signalling effect will compete with the effect of the worker's uncertainty. The former pushes mobility up (the worker wants to signal that his general human capital is likely to be higher than the firms think), but the latter pushes it down (if the worker observes a high productivity, he will be tempted to interpret it partly as job-specific, and thus be reluctant to move).

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