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Outplacement, Training, and Recruitment: A model of adverse selection with general skills and match specific components.*

Heski Bar-Isaac,[†] Ian Jewitt[‡] and Clare Leaver[§]

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Abstract

We analyze a model of adverse selection in labor markets, where workers vary in match-specific as well as general productivity, and firms can shape the information available to rivals. Competition to recruit workers leads to an information structure that resembles outplacement (lots of information to potential employers on bad matches, little on good matches). This involves considerable adverse selection but no inefficiency as a way for workers to effectively pay for efficient training. One consequence, in line with some empirical findings and in contrast to standard tests for adverse selection, is that wages of those who stay in the firm are on average higher than wages of those who leave.

1 Introduction

Following an insight of Pigou (1912) and the seminal contribution of Becker (1962, 1964), it is well understood that general human capital might be under-provided when workers

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[†]University of Toronto, CEPR, and CRESSE; heski.bar-isaac@rotman.utoronto.ca.

[‡]University of Oxford and CEPR; ian.jewitt@nuffield.ox.ac.uk

[§]University of Oxford and CEPR; clare.leaver@bsg.ox.ac.uk

face credit constraints or employers cannot commit to provide it: Employers in competitive labour markets would not pay for training since this is an investment whose payoff will be realized as higher wages. A significant literature (including an excellent overview and contribution is Acemoglu and Pischke, 1999) suggests that when labour markets are imperfect, then firm-sponsored general training might arise. Indeed, an important and widely-discussed source of such labour market imperfection is asymmetric information.[1] In this paper, in effect we consider causality as running in the other direction: Given sufficiently efficient general training opportunities, employers structure jobs to create asymmetric information. In this way workers, can effectively pledge future surplus (in the form of reduced wages) to pay for training.

Viewed in this way, it is also natural to examine how employers might want to create asymmetric information; that is what kind of information structures they would choose, in the language of a recent literature that considers the design and implications of information structures in various games.[2]

Formally, we consider a two period-model of labour market competition where in a first period identical firms compete to attract a trainee in their offers of wages, training, and information structures in competing to attract trainees. Workers vary in their natural level of human capital as is standard in the literature on asymmetric information in labor markets, following Waldman (1984) and Greenwald (1986), but, crucially, we also allow for match-specific values, in the spirit of Jovanovic (1979) and much of the more recent labour literature; that is, we suppose that the kind of workers that a current employer might be particularly keen to retain ia a great match that firm even if she might not be the best for other firms. At the end of the first period, the training firm learns the worker's general ability and match at that firm and information is made publicly available according to the agreed information structure. Then, as in Greenwald (1986) given publicly available information (and anticipating possible adverse selection), rival firms compete in wage offers to the worker before the training firm has the opportunity to match the highest such offer and retain the worker, or not and the worker moves to another firm.

We consider a particular information structure that we call "Full information on Bad Matches" (FIBM) where all information about bad matches is publicly revealed, but no information about good matches is revealed. The heart of this paper is to highlight that such

[1] See also Katz and Ziderman (1990), Chang and Wang (1996) and Acemoglu and Picshke (1998).

[2] A fast-growing literature that is now sufficiently established to include several overviews. A couple of good recent ones are Kamenica (forthcoming) and Bergemann and Morris (2019).

an information structure can be optimal especially where general human capital training is efficient and expensive. Further, this information structure has the noteworthy implication that workers who leave will earn more on average than workers who are retained. As we discuss below, this, in turn has implications for empirical tests of asymmetric information in labor markets.

There are, of course, strong assumptions about commitment and costs that are made to illustrate these possibilities and the nature of these mechanisms. After presenting the model and results, we address many of these.

At this stage it is worth noting that although the FIBM information structure might at first seem abstract and unusual; however, we believe that it corresponds to a common phenomenon—the support that many employers, particularly in training-intensive professional services firms, provide in outplacement. Indeed, a quick perusal of the websites of the leading recruiters of our students highlights that they recognize that many employees might move on from these jobs, and promise considerable support in helping them to do so.[3] That is, these firms promise not only training which might naturally be thought of as augmenting general human capital, but also support if this match turns out to be a bad fit. Moreoever, the notion of support when things do not work out is a little broader than formal outplacement services in case of formal dismissal, and can include a greater willingness to write (or ask for) a reference letter or similar support when it is clear that the worker and firm are not well-suited to each other. To our knowledge, such support and its interaction with training has not been much explored in the economics literature and a contribution of this paper is to do so.[4]

Further, our analysis highlights a natural link between firms decisions about information

[3] As a representative example consider Bain and Co.'s recruitment page https://www.bain.com/careers/ (accessed 22nd April 2019) notes that:

> We want our employees to thrive at Bain, regardless of what their future plans are. Our dedicated career teams (Bain Career Advisory and Bain Executive Network) provide guidance and support at all stages as you plan for your future.
>
> Just two or three years with us will offer you incredible opportunities, both at Bain and beyond—from becoming a Bain partner to starting your own business, stepping into a senior role at a top tech company, joining a private equity firm or making a meaningful social impact at a nonprofit you love.

[4] An important exception is Gilson and Mnookin (1989) who also take motivation from professional services firms—in their case law firms. They consider outplacement support in the case that an up-or-out policy results in the worker going out, which might also be a reasonable interpretation of our framework, but while they consider investments in firm-specific capital they do not allow for heterogeneous match values—a key element in our analysis that leads to rather different mechanisms, focus and results.

structures, such as outplacement activities, and training decisions. These come together in making a position more attractive to a potential employee and as part of a broad human capital management strategy that aims to attract, develop and retain the right talent—the key strategy for human-capital-intensive firms such as professional services and high-tech firms.[5] Bar-Isaac and Levy (2019) shares a similar motivation, in understanding the interaction of all that a firm offers in terms of compensation and opportunities and further allows for worker efforts but considerably simplifies with respect to possible information structures and instead considers a possibility of generating a rival offer.

This paper builds on insight from our earlier paper Bar-Isaac, Jewitt and Leaver (2019). That paper can be understood as providing a much more complete analysis of the second stage of the two-stage game that we analyze in that game (where general human capital, the match-specific component and the information structure are assumed to have a joint Gaussian distribution). We build heavily on the insight, whose applied implications we develop here, is that information structures affect both efficiency—that is, whether a worker stays at a firm which she is well-matched and moves from one where she is ill-matched—and the distribution of surplus through the adverse selection that reduces wages.[6] Crucially, different information structures can affect these separately: It is possible, to move from one information structure to another and to increase both the efficiency of the allocation and average wages (that is, to reduce adverse selection). Moreover, this insight has important implications for labour markets; notably, that there may be positive or negative aggregate selection and that wages of those who leave a firm may be higher or lower on average than those who stay, somewhat in contrast to received wisdom on the impact of adverse selection in labour markets.[7] Bar-Isaac, Jewitt and Leaver (2019) left open the question of which information structures we should expect to observe in practice, and how such information

[5] For example, Maister (1997) writes (p.189) that "the ability to attract, develop, retain and deploy staff will be the single biggest determinant of a professional service firm's success." Similarly, in 2004, the Google IPO prospectus (p.13) states that "Our performance is largely dependent on the talents and efforts of highly skilled individuals. Our future success depends on our continuing ability to identify, hire, develop, motivate and retain highly skilled personnel for all areas of our organization."

[6] In that paper, we discuss the connections of our framework to the literatures on multi-dimensional asymmetric information and adverse selection, and the work on the impact of differing information structures on economic outcomes. We refer the interested reader to the discussion there.

[7] Further, the introduction of match values in a model of asymmetric information in labor markets provides a natural reason for turnover and for a discussion of efficient and inefficient turnover. Instead, Greenwald (1986) and other subsequent literature relies on an exogenous and rather ad-hoc probability of forced turnover. Ferreira and Nikolowa (2018) allow for deterministic firm-specific human capital accumulation and heterogeneous firms (leading to a job ladder) so that there may be inefficient turnover.

structures interact with other strategic choices that firms make to affect recruitment, retention, and development of their workforce. These are precisely the questions that we address here.

In addressing, endogenous information structures with both general human capital and match-specific types, our contribution is distinct from some previous literature on asymmetric information in labour markets. Notably, Waldman (1984), DeVaro and Waldman (2012), Ricart-i-Costa (1988), and Blanes i Vidal (2007) who argue that, since adverse selection in the labor market can affect wages, retention rates, and thereby profits, firms will have incentives to distort (respectively) promotion, task assignment or delegation decisions. Waldman (2017) provides a wide-ranging overview.

In addition, this paper is related to a literature studying information disclosure (see Calzolari and Pavan (2006), Mukherjee (2008), Koch and Peyrache (2005) and Albano and Leaver (2005)). Kim and Marschke (2005) and Lewis and Yao (2006) explore this idea in the context of researchers. Like the current paper, this literature highlights that an employer's information management policy can form part of overall compensation as it influences an employee's future career prospects.[8] Indeed this has been shown to be economically significant empirically in Pallais (2014), which contrasts two different "information structures" (in our language). Many of these papers highlight career concern and moral hazard aspects omitted in our analysis; however, our paper in allowing for variation in both general human capital and match values, allows for consideration of efficient turnover and for richer information structure than many of these works which either force all workers to move firms between the first and second period (Koch and Peyrache, 2005 and Calzolari and Pavan, 2006) or assume that the worker is always more productive in the outside firm by a fixed amount (Mukherjee, 2008). In this respect, and perhaps in contrast to Greenwald (1986) and closer to the spirit of Waldman (1984), our framework addresses why turnover might naturally occur in an environment with adverse selection and why it matters—that is, its implications for efficiency.

[8] Calzolari and Pavan (2006) allow for general disclosure policies, and do not have a labour market application specifically in mind. They do not consider the possibility of retention and assume a monopsonist employer in the second period, leading to somewhat different effects and considerations.

2 Model

Identical firms compete to attract a worker by offering a training position.[9] The training position attracts a worker both through the current wage and the prospect of opportunities in the next employment period whether they be at the training firm or other rival employers. If the worker accepts the training position, two or more rival firms make wage offers to the worker in the following employment period, the training firm can then choose to match the highest such offer and retain the worker or release the worker.

The productivity of the worker during employment depends on the firm to which it is assigned and to its type $\theta \in \Theta$, where the set, Θ of feasible types is finite. It is convenient to think of a type, θ, as a two-dimensional vector (g, m) and $\Theta = G \times M \subset \mathbb{R}^2$. In this notation, g is to be understood as the worker's natural general human capital: a productivity component common across all potential employers, and m is to be understood as the match value at the current firm or that part of the worker's productivity that is specific to the match, and G and M as the sets of possible values for the general and match-specific human capital respectively. We suppose that while matches can be good or bad (so that $\min\{m \in M) < 0 < \max\{m \in M\}$), all workers are productive, that is, $\min\{g \in G\} > 0$). We suppose that there is a common prior, $F(.)$ with frequency $f(.)$ shared, by all market participants and that this has full support that is $f(\theta) > 0$ for all $\theta \in \Theta$. It is convenient to suppose that $E[m] = 0$, and that g and m are independently distributed.

Firms compete to attract the worker initially by offering a contract, τ, with three elements. First, a training wage $w_\tau^T \in \mathbb{R}_+$. Second, a commitment to training of the form $E_\tau \in \{0, 1\}$ specifying whether or not general human capital training will be provided. Such training comes at a cost c and raise the human capital of any worker by a constant $A \geq 0$ when provided (that is when $E_\tau = 1$ or, equivalently, $1_{E_\tau=1} = 1$) so that the worker's general productivity is $g + A1_{E_\tau=1}$ when her general human-capital type is g.

Finally, the contract includes a commitment to a disclosure policy $\mu_\tau : \Theta \longrightarrow \Delta(T)$ which specifies how much of the training firm's private information is publicly revealed at the end of the training period. As is standard in the literatures on communication and persuasion, following Kamenica and Gentzkow (2011), there are at least as many elements in T as there are in Θ.

[9] The case of heterogeneous firms is obviously of some interest and applied insight. We briefly return to consider it in the discussion at the end of the paper.

In the course of training, the training firm perfectly learns the worker's type and that at the end of the period all other firms observe a common signal T_τ generated according to the disclosure policy μ_τ.[10] Just as in the Bayesian persuasion and the recent related literature on information design, we impose no restrictions on the mapping μ_τ but suppose that the training firm can commit to it, and that, after observing a realization of T_τ, all other firms update their beliefs about the worker's type according to Bayes' rule.

We highlight that in writing $w_\tau^T \in \mathbb{R}_+$, we impose a lower bound (namely zero) on the training wage. This lower bound plays an important role. Specifically, it is the training firm's desire to claw back future rents from a credit constrained worker which motivates its choice of information structure. If training were inefficient or unboundedly negative training wages were possible, then familiar arguments, due to Becker (1962), imply that it would choose the information structures purely on grounds of efficiency and, for example, full disclosure of the type (g, m) might naturally arise.

At the end of the first, training, period, given the information that is revealed (that is the realization of public information T_τ), the rival firms compete in making wage offers of the form $w \in \mathbb{R}_+$. The training firm (on the basis of its private information and specifically the value of the worker if retained at the firm, R_τ) can choose whether or not to match the highest such offer and retain the worker, or instead release the worker.[11]

Timing. The timing of the game can be summarized is as follows:

First/Training Period Each firm, I, simultaneously offers a training contract τ_I=($\mathrm{w}_{\tau_I}^T, \mu_{\tau_I}, E_{\tau_I}$) where $w_{\tau_I}^T \in \mathbb{R}_+$. The worker chooses a training contract from some firm I and training takes place. The worker is paid the training wage $w_{\tau_I}^T$ as specified in τ_I. Training is provided or not, according to E_{τ_I} and the cost of training (if provided) is incurred. Firm I privately observes the realizations g and m and the outside firms all observe the realization of T_{τ_I}.

Second/Employment Period All outside firms $J \neq I$ simultaneously post employment wage contract offers $w_J \in \mathbb{R}_+$ to the worker. Firm I observes the

[10] Supposing that the training firm also has choices to make regarding how much private information to acquire (for example, the nature and intensity of internal evaluation) is clearly an interesting extension. We return to this question in the conclusion.

[11] The second period competition for a worker effectively follows the procedure set out by Greenwald (1986) which has been adopted by much of the subsequent literature, e.g. Gibbons and Katz (1991) and Acemoglu and Pischke (1998). Variants on this wage setting protocol include Pinkston (2009) who studies ascending 'button' auctions and Li (2012) who studies first price auctions.

outside offers and then makes an employment wage counter offer $w_I \in \mathbb{R}_+$. The worker chooses which employment offer to accept. Production takes place, employment wages are paid according to contracts and payoffs are realized. Worker payoffs are the undiscounted sum of wages received, firm payoffs are undiscounted profits, i.e. productivity less wages.

A behavioral strategy for the worker is a pair $a = (a_1, a_2)$ in which a_1 determines which (first-period) training contract to accept and a_2 determines which (second-period) employment contract to accept. a_1 maps from the set of possible training contract offers to a training contract choice. a_2 maps from the set of possible histories of the game to an employment contract choice. Histories consist of a collection of first period contract offers, the form of the first period contract accepted, a realization of public information, and a collection of wage contract offers. A behavioral strategy for the firm is a triple consisting of: a first period contract, a wage offer plan for the event that the worker is not hired in the first period, and a wage offer plan for the event that the worker is hired in the first period.

A Perfect Bayesian Equilibrium (PBE) of the game requires that the worker, and each firm, follows a sequentially optimal strategy for some Bayes consistent belief. In particular, in the second period : for the worker, a_2 selects one of the highest wage employment contracts offered; for the training firm I, its employment wage contract offer maximizes expected second period profit given the strategy of the worker and wage offers of the other firms $J \neq I$; for each non-training firm $J \neq I$, its wage offer at each realization t of T_{τ_I} maximizes its expected profit given its beliefs about the wage offers by other outside firms and the strategy of the training firm I. In the first period: the worker's contract choice maximizes her lifetime expected wages given her beliefs, taken as the simple sum of the training wage and expected employment wage (that is, for simplicity there is no discounting between periods); and each firm's contract offer maximizes its expected profit (again with no discounting between periods).

2.1 A simple illustrative case

To ease exposition and provide intuition, it is convenient to maintain a clear numerical example throughout. We can illustrate many themes by taking $\Theta = \{(5,-3),(5,3),(10,-3),(10,3)\}$ so that the general ability may take the value 5 or 10, and the match value might be 3 or -3. Each combination is equally likely; that is $f(5,-3) = f(5,3) = f(10,-3) = f(10,3) = \frac{1}{4}$.

Note that $E(m) = 0$ and $E(g) = E(g|m > 0) = E(g|m < 0) = 7\frac{1}{2}$. We consider various training effects and costs in the course of the paper.

3 Analysis

We proceed by backward induction, first characterizing second period wages for a given information structure. Then consider when full information on bad matches arises in the equilibrium of the full two-period game.

3.1 Second period wages

Unless the disclosure policy reports on g precisely, the training firm will have information that is relevant for potential employers; that is, there will be asymmetric information that is relevant for potential employers in considering the likely productivity of the worker. In turn, this raises the possibility of adverse selection: Potential employers might anticipate that the selection of workers that the training firm does not want to retain have lower productivity than they would expect if estimating the worker's productivity based only on the information disclosed. Such adverse selection, which distorts employment wages is at the heart of our analysis. Consider equilibrium wages given a particular disclosure policy μ_t.

When there is a possibility of turnover, then the wage takes a familiar form, for instance as Equation 13.B.6 of Mas-Colell, Whinston and Green (1995) albeit in a slightly different context and absent public information and non-singular types. There may also be realizations of public information where outside employers cannot make an offer which involves hiring the worker without expecting a loss. In principle, there may be many losing offers consistent with an equilibrium so that the equilibrium wage is not uniquely determined. However, it is natural and commonly-applied selection to suppose that rival employers are cautious and pick out the lowest productivity consistent with the public information.

For example, consider the case outlined in Section 2.1 and suppose that $\mu_\tau(g, m) = (g, m)$; then, if the realization $(10, 3)$ is observed then potential employers would not anticipate hiring the worker at any wage below 13 which is less than their expectation of the worker's productivity at their firm, 10. In this case, we suppose that potential employers simply offer a wage of 10 rather than some wage between 10 and 13, just as in Bertrand competition between firms with heterogeneous costs we typically suppose that the higher

cost firm offers to sell at its own cost and not lower. A, perhaps, more interesting case and one that we will draw on in the discussion below is the case where $\mu_\tau(g, m) = m$. Suppose that $t_\tau = 3$, in this case potential employers know that the worker is better matched at the current firm than she would be expected to be matched at any other firm. Consequently, any offer that the training firm does not match would be too high suggesting that potential employers should bid as low as possible. However, the worker's general productivity can be no lower than 5, which puts a floor on how low competitive potential employers should reasonably bid. Our assumption is that, in this case, they bid at this floor.

Summarizing this discussion, we define the employment wage as follows and obtain the subsequent result immediately.

Definition 1 *The* wage schedule $w_\tau : T_\tau \to \mathbb{R}$ *corresponding to the training contract* τ *is the unique solution to the following wage equation:*

$$w_\tau(t) = \mathbb{E}[g + AE_\tau | T_\tau = t, g + m + AE_\tau < w_\tau(t)] \tag{1}$$

when a solution exists, otherwise $w_\tau(t) = \min\{g | T_\tau = t\} + AE_\tau$.

Proposition 1 *In the second/employment period, given the training contract* τ *adopted in the training period: In equilibrium (under the natural selection criterion described in the text), each rival firm makes the employment wage offer* $w_\tau(t)$ *and the training firms offers the same wage as outside firms if* $g + m + AE_\tau \geq w_\tau(t)$ *but a lower wage if* $g + m + AE_\tau < w_\tau(t)$. *The worker remains at the training firm if its offer matches* $w_\tau(t)$ *and otherwise moves to an outside firm chosen at random.*

Thus, equilibrium market outcomes in the employment period are determined by the wage schedule. It is convenient to introduce notation for the average employment period wage. With some minor abuse of notation, we write $w_\tau = E(w_\tau(t))$.

It is also convenient to introduce notation for the training firm's expected profits in the employment period. We denote the firm's expected second period profit associated with a training contract τ by π_τ. Given the behavior described in Proposition 1, it follows that

$$\pi_\tau = E\left(|g + m + AE_\tau - w_\tau(t)|^+\right), \tag{2}$$

where $|x|^+ = x$ if $x > 0$ and 0 otherwise. Note, that given the definition of the wage schedule in (1), it follows that π_τ depends on the training contract τ only through the

disclosure policy μ_τ and is independent of both the training wage w_τ^T and of whether or not there is training, E_τ. The latter is a consequence of training having a fixed effect; since all potential employers value the training in the same way from the training firm's perspective, any productivity gain associated with (observed) training is offset by a higher associated wage. Indeed, for this reason, and as described above and widely discussed in the literature, there will be no firm-sponsored training. Instead if training is provided, the worker must pay for it in some fashion. In the sequel, we describe how.

First note that since non-training firms are identical and compete, they earn no profits and so the expected second period surplus is equal to $w_\tau + \pi_\tau$.

3.2 The training period

In the training period each firm chooses a training contract τ in order to attract the worker (that is offer the worker expected lifetime earnings at least as high as any other offer) and maximize employment profits as defined in (2) less the training wage and costs of training provided. We can write this problem formally, as maximizing $\pi_\tau - w_\tau^T - cE_\tau$ subject to $w_\tau^T \geq 0$ and $w_\tau + w_\tau^T > \max_{\tau_I}\{w_{\tau_I} + w_{\tau_I}^T\}$.

Since all training firms are identical, competition amongst them implies that they cannot be earning positive lifetime profits: if in equilibrium all firms chose contracts τ that involved $\pi_\tau - w_\tau^T - cE_\tau > 0$ then one firm could deviate from such an equilibrium by offering a similar contract to whichever was most appealing to the worker but with a higher $w_{\tau'}^T$ attracting the worker and earning strictly positive profits with probability 1.

It follows that competition leads to equilibrium contracts that involve a training wage equal to a training firm's anticipate surplus $w_\tau^T = \pi_\tau - c1_{E_\tau=1}$ and maximizing the worker's expected lifetime earnings:

$$w_\tau + \pi_\tau - c1_{E_\tau=1} \tag{3}$$

subject to the constraint that the training wage is non-negative:

$$\pi_\tau - c1_{E_\tau=1} \geq 0. \tag{4}$$

3.3 The Optimality of Full Information on Bad Matches

Trivially, if training is inefficient or, otherwise, the constraint (4) never binds then firms can maximize (3) simply by maximizing $w_\tau + \pi_\tau$ that is the total employment period surplus.

A natural means of doing so would be by revealing all information— that is equilibrium could involve the information structure $\mu_\tau(g,m) = (g,m)$.

However when training is efficient, so that firms want to provide it, but doing so and revealing full information requires a negative training wage, that is (4) violated, then full information and training cannot be an equilibrium outcome.

We build on the intuition developed in Bar-Isaac, Jewitt and Leaver (2019) to note that there are other information structures that ensure a fully efficient allocation so that total surplus is maximized, while at the same time ensuring higher second period profits for the training firm. Thereby, such an information structure might allow for efficient training to be provided while respecting that wages should be non-negative. Since such an information structure plays a key role in our analysis, as described in the introduction, we give it a name.[12]

Definition 2 *The full information on bad matches (FIBM) information structure has the following form* $\mu^{FIBM}(g,m) = (g,m)$ *if* $m < 0$ *and* $\mu^{FIBM}(g,m) =$ *"*$m \geq 0$*" otherwise.*

First note that this information structure will lead to a fully efficient allocation. Consider the case that the worker turns out to be a bad match, then rival employers would offer $w(g,m) = g$; since $m < 0$ and, so, since $r < g$, the worker is never retained and instead moves to another firm: an efficient outcome in this case. Suppose instead that $m \geq 0$ then the only thing that rival employers learn from publicly available information is that the worker is better matched with the training firm than she would be at theirs. Unsurprisingly, this makes rivals wary of offering a high wage. Adverse selection applies with all its force in this case and so according to the wage schedule, rival employers offer a wage of $w(\text{"}m \geq 0\text{"}) = \min\{g\} + AE_\tau$ and since the worker's productivity (equal to $g + m + AE_\tau$) at the training firm is necessarily higher (since $m \geq 0$), the worker is always retained, as is efficient.[13] To make this observation salient we state it as a result.

Proposition 2 *The FIBM information structure leads to an efficient allocation but can involve non-zero adverse selection.*

[12] There are other information structures which will have equivalent effects; for example, $\mu_\tau(g,m) = g$ if $m < 0$ and $\mu_\tau(g,m) =$"$m \geq 0$" otherwise.

[13] Here we rely on the (natural) choice we made for wages at realizations of the information structure where the worker is always retained.

Bar-Isaac, Jewitt and Leaver (2019) consider a Gaussian distribution for productivity and information and so allow for environments where there is always some probability that the worker is retained. There we show that there is an information structure where the wage is always uniquely determined and outcomes are, essentially, arbitrarily close to this information structure.

Under FIBM the training firm expects a second-period profit equal to

$$\begin{aligned} E\left(|g+m+AE_\tau - w_\tau(t)|^+\right) &= E\left(g+m-\min\{g\}|m\geq 0\right) \\ &= \left[E(g)-\min\{g\}\right]\Pr(m\geq 0)+E\left(|m|^+\right), \end{aligned}$$

where the first equality follows from the definition of w_τ when $\mu_\tau = \mu^{FIBM}$ and the second from the independence of m and g.[14] Trivially, unless g has a degenerate distribution $\left[E(g)-\min\{g\}\right]\Pr(m\geq 0) > 0$ and so the FIBM information structure can allow for outcomes with efficient training, even at parameters where full disclosure would not. The idea here is that the worker pays for the training by agreeing to an information structure that provides the training firm with higher second-period profits, moreover she is able to do so with no loss in allocative efficiency.

Proposition 3 *Suppose that $A > c$ and $\left[E(g)-\min\{g\}\right]\Pr(m\geq 0)+E\left(|m|^+\right) > c$. There is an equilibrium where all firms offer the same contract τ which consists of a training wage $w_\tau = E(g)-\min\{g\}+E\left(|m|^+\right)-c$, training $E_\tau = 1$ and an FIBM information structure $\mu_\tau = \mu^{FIBM}$ but no equilibrium with all firms disclosing all information.*

4 The FIBM information structure and Asymmetric Information in Labour Markets

As Bar-Isaac, Jewitt and Leaver (2019) argue, asymmetric information can have rich labour market implications. In a general setting with multi-dimensional types (that allows for both general productivity and match-specific components) and a broad class of information structures (so that asymmetric information may be more pronounced on some aspects), then "anything goes." There may be positive or negative selection of those workers who leave a firm compared to those who stay, and those who leave a firm might earn more or less than those who stay in the firm.

One approach is to characterize whether there are indeed limits on outcomes: broadly, this is the approach that follows Bergemann, Brooks and Morris (2015) and Bergemann and Morris (2016) and a subsequent literature that addresses what outcomes can be achieved without knowing fine details of the information structure. This is also the approach in

[14] It should be evident that the only role of this independence is to allow to re-write the first expression as the second. In particular, Proposition 2 and, the central intuition, of the paper do not require it.

Bar-Isaac, Jewitt and Leaver (2019) who also parameterize the information structure and, further, provide conditions on under which certain relevant outcomes (such as lower wages for those who are retained) arise.

In itself, this is of interest in speaking to a literature following Gibbons and Katz (1991) that tests for adverse selection in labor markets by comparing outcomes for different selections. This literature has sometimes had mixed results. Schönberg (2007) finds evidence of adverse selection for college graduates, while Hu and Taber (2011) find a marked effect for white males, though these authors suggest less asymmetry for other groups; see also Pinkston (2008) and Kahn (2013). Lang and Weinstein (2016) is a recent contribution that suggests to reconcile findings one must move away from the standard model; introducing multi-dimensional types and, so, match-specific types is one means of doing so and can explain some of these results which have been interpreting as inconsistent with asymmetric information is a key driving force.

However, to assess whether wages of workers who are retained are higher or lower the wages of those who leave requires knowledge of parameters of the information structure that may be difficult for outsiders to observe. Indeed, this is the motivation for seeking "robust" outcomes. An alternative approach is to ask whether theory can provide any guidance as to what sort of information structures arise. The contribution of the present paper is squarely around this question.

Our analysis suggests that when information structures are endogenously determined through competition between training firms, then when asymmetric information arises, such asymmetric information imposes adverse selection on those workers who are retained. It does so by providing more information to the outside labor market about the general capabilities of workers who are a poor fit for the current employer than for those workers who are well-matched at the current employer. This has stark implications for wages.

Under the FIBM information structure, all retained workers are retained at a wage of $\min\{g\} + AE_\tau$ while workers who move on to new firms on average earn $E(G) + AE_\tau$. This leads, immediately, to the following result.

Proposition 4 *Under FIBM there is adverse selection but workers who stay at the training firm earn less than workers who move on to new firms.*

In the context of the example outlined in Section 2.1 then $E\left(|m|^+\right) = \frac{3}{2}$ and it is immediate that efficient training up to a cost of $\frac{3}{2}$ can be sustained with full disclosure. Note that $[E(g) - \min\{g\}]\Pr(m \geq 0) = \left[\frac{10+5}{2} - 5\right]\frac{1}{2} = \frac{5}{4}$ and so efficient training up to in

a much higher range of costs—up to $\frac{5}{4} + \frac{3}{2} = 2\frac{3}{4}$—can be sustained with μ^{FIBM}. Turning to wages, with full disclosure, the wage of the worker (whether retained or released) is always equal to g and so, given the independence of g and m, average wages of retained and released are identical and equal to $7\frac{1}{2}$. Instead, while these remain the average wages of released workers under μ^{FIBM}, the wage of retained workers is always equal to 5, which is obviously below the wage of the released workers.

While at first blush appear it may be surprising that released workers earn more than retained workers in the context of the previous literature on asymmetric information in labour markets, it is consistent with the observation that people who move on often earn more than people who stay on at a firm.[15]

5 Discussion

5.1 When FIBM is not enough

The characterization in Proposition 2 above is quite general. We did not have to make assumptions about the relative magnitudes of general productivity and match values or the distribution of types and yet were able to illustrate a number of points outlined in the introduction namely (i) the information structure can be used to transfer second/employment period surplus between training firm and worker and, so, (ii) used as a means for the worker to pay for efficient training, (iii) with an information structure that is more revealing about workers who are a bad match than a good match; with the consequence that (iv) retained workers earn less than workers who are released.

However, we did not provide a complete characterization since there may be parameter constellations where FIBM does not transfer sufficient employment period surplus to "pay" for efficient training. A complete analysis that considers more expensive (but still efficient) training relies on distributional assumptions and a more delicate and case-specific characterization, that we suspect will be limited in its insight.[16] As should be immediate from the discussion thusfar, there is no information structure that leads to a fully efficient

[15] See, for example, Lang and Weinstein (2016) or Bidwell (2011) whose finding that external hires into a large investment bank are on average paid 18 percent more than internal promotions into identical positions is consistent with this result.

[16] Although it is possible that insightful referees will disabuse of this notion, more likely, an over-zealous and tortuous process will eat up additional years of our lives to shift from near certainty to certainty or demonstrate that the problem is intractable without adding additional structure but leading to a harder to read paper.

allocation but allows for higher second period profits for the training firm than those that can be achieved by the FIBM information structure. However, depending on the parameterization, it may be possible to raise the training firm's second period profits and, thereby, allow for the provision of more expensive training albeit at the cost of some efficiency loss in the allocation of the worker to the firm. This efficiency loss from misallocation must be compared to the efficiency of training. Intuitively, one would expect that competition would lead to information structures that minimize this efficiency loss (by leading firms to retain those with only marginally poor matches) and transfer the most surplus to the firm (that is if firms retain poor matches, it should be workers with high general human capital at low wages).

This latter observation can be illustrated through the example of Section 2.1. Suppose that $A > c > 2\frac{1}{4}$ so that training is efficient but cannot be implemented through a contract that imposes FIBM. Consider instead an information structure that only reveals information on a worker with low general productivity who is a bad match; that is $\mu^{Worst}(5,-3) = 5$ and $\mu^{Worst} = \varnothing$ otherwise. Then it can be calculated that $\pi_{worst} = 3\frac{1}{4}$ so that training can be provided at a higher range of training costs; however, it can also be verified that the misallocation induced reduces surplus relative to the efficient allocation by $\frac{3}{4}$ (a high general ability, bad match that reduces surplus by 3 occurs with probability $\frac{1}{4}$).[17] With other parameterizations, there is no way to provide training that is more costly than outlined in Proposition 3.[18]

5.2 Commitment to an information structure

We have supposed that firms can commit to information structures before observing any characteristics of workers This kind of ex-ante commitment to information disclosure is not unusual in theoretical models of information disclosure; Kamenica and Gentzkow (2011) is a recent influential example. Clearly, it requires some discussion in the context of any application. First, we defend it as reasonable, to some extent, in application before questioning its importance for the qualitative insight.

[17] Of course, this may be more misallocation than needed. As long as $(A-c)$ is larger than the cost of misallocation then when $3\frac{1}{4} > c > 2\frac{3}{4}$ the equilibrium will feature an outcome where the worker goes to a training firm that offers a training wage $w_\tau^{Tr} = 0$, training $E_\tau = 1$, and an information structure equivalent to one of the form $\mu_\tau(5,-3) = (5,-3)$, $\mu_\tau(10,-3) = (10,-3)$ with probability α and $\mu_\tau(10,-3) = \varnothing$ with probability $1-\alpha$ and $\mu_\tau(5,3) = \mu_\tau(10,3) = \varnothing$, where α is chosen so that $\pi_\tau = c$.

[18] For example, adapt the example Section 2.1 to suppose the m is equally likely to take the values 6 and -6 (rather than 3 and -3) while maintaining than g is equally likely to take the value 5 or -5.

In practice, different information structures do arise, in many instances, as a result of designed firm procedures that are largely fixed across different trainees. For example, firms vary in their human resources practice and the nature and amount of information they collect on employees (for example, in the intensity and frequency with which employees are reviewed, and in the assessment criteria). The information available to rival firms similarly varies; for example, in the software industry, the information about programmers that outsiders observe can differ dramatically depending on whether the project is open source or closed source (as discussed for example in Lerner and Tirole, 2005; Spiegel, 2009, and Blatter and Niedermayer, 2008), and firms credibly commit (either contractually, or often through reputational concerns) as to how much time a programmer can spend on open source. Similarly, firms can direct the extent to which a consultant or lawyer has direct access and contact with clients, they can publicize that the kind of work that the worker is engaged, for example, by allowing public websites or blogs, or they can even institute explicit rules and restrictions on social interactions (Liebeskind, 1997). These tend to be organizational rules or standard terms in contracts rather than tailored to individual employees. More broadly, choices over production technologies (such as whether to require team or solo production) and the design of organization (including layers of hierarchy and promotion criteria, as discussed by Waldman, 1984) will affect the information structure and, specifically, the information available to potential rival employers. Further, in many industries, firms advise employees and presumably provide more detailed references when things do not work out. Indeed, there is an industry to help in such outplacement activities. Here, we abstract from considering direct costs in such choices of which kind and how much information to collect and make public, and while in reality commitment may be partial and imperfect, we simplified the analysis and highlight mechanisms by making the somewhat extreme assumption of perfect commitment.

Another standard response to the commitment assumption is to wave hands furiously (or generate reams of algebra) and rely on a firm's reputation as a means to ensure appropriate commitment.[19] While, we are not averse to such an argument (and, historically, have not been averse to generating such impenetrable algebra), it is also worth noting that we believe that the central intuitions may not depend crucially on a firm's ability to commit to an information structure.

[19] In the spirit of Stephen Morris' letter to members of the Econometric Society on September 5th 2019 on limiting paper length, and since we do not anticipate that the additional insight would outweigh the notational and algebraic pain, we have spared the reader.

In the case of the running example, while FIBM is not a sustainable information structure without commitment, an information structure that revealed information only about the worst possible type (a bad match of low general ability) is sustainable without commitment: In case of the worst productivity at the firm $(5, -3)$, a training firm loses nothing by revealing this outcome. Moreover, if this is what outside employers anticipate then if the training firm discloses nothing otherwise, the wage it would pay its worker is 5: as low a wage as is feasible given that the worker's general productivity never falls below 5. Note that this "Worst" information structure has the feature that retained workers earn no more than workers who move on and adverse selection operates, so that for many workers wages are below their general productivity. More generally, one might expect that since bad matches are less productive for the training firm, the training firm is more willing to reveal information about them leading to qualitatively similar results.

It might also be the case that firms cannot commit easily to information structures but might be able to commit to other aspects of organizational design. One such celebrated aspect of organizational design is the up-or-out contract and a hierarchy that (approximately) fixes promotion rates; this is familiar, not only in the academic tenure system (where promotion rates are generally flexible) but also in partnership tracks in law firms and similar professional firms.[20] Suppose that a firm is committed to retain only half of the workers it trains, then evidently in the example of Section 2.1 then FIBM can be sustained as the training firm would seek to retain the well-matched workers—of type $(10, 3)$ and $(5, 3)$—and so may reveal little further information about them. Instead, the firm would release the poorly matched workers who are less productive and there is no loss in revealing all information about them.

5.3 Commitment to training

In our analysis we have assumed that training provision is contracted on—that is, the firm can commit to provide training. This is a strong assumption not only for application but also in the context of a literature in labour theory that has sought to understood how such training could be provided in the absence of such commitment. The more recent literature has relaxed full commitment to training and focussed on dynamic considerations: Morrison and Wilhelm (2004), and the related analysis of Bar-Isaac (2007), have highlighted the role

[20] The ability of up-or-out contracts to effectively commit employers to future wages is familiar from Kahn and Huberman (1988) and Waldman (1990).

of the partnership firm in creating a commitment for a mentor's effort, and Garicano and Rayo (2017) consider the provision of training over time. An earlier literature, one we build on here, is focused on shorter-run considerations. Acemoglu and Pischke (1999b), in particular, and as mentioned above have highlighted the role of labour market frictions in compressing the structure of wages. We build on this insight below.

As we have noted above, in our model, training has an identical effect on all workers and augments their ability by the same fixed component. Consequently, rival wage offers fully compensate for this augmentation of training. If instead, training has different implications for different types of workers then the extent to which rivals will compensate a worker for their augmented skills will depend on their belief about the worker's natural type.

This is easy to understand in the context of the example of Section 2.1. Suppose that training had no effect on low human capital types, but instead raised the productivity of the high human capital types. That is, the augmentation of human capital only arises in case the natural general human capital of the worker is equal to 10. With no commitment to training, there will be no training under full disclosure even if training is efficient (which in this case would require that $A > 2c$, where the 2 arises since training is only effective half the time). Instead under FIBM, if the training firm chooses to train then it anticipates retaining all well-matched workers (whether of high- or low-general human capital) at a wage equal to 5 (the general productivity of the low type level). Since all types are equally likely, there is a $\frac{1}{4}$ probability that the worker is well-matched and of high general human capital, and so as long as $A > 4c$ then even without commitment to training, training is provided under FIBM though it is never provided under full disclosure, and a worker can anticipate that a firm offering FIBM would provide training. Since FIBM maintains the efficiency of the allocation and provides training in this case, there is no way for a rival training firm to profitably offer a more attractive package to the worker.

5.4 Other aspects

In the analysis we assume that the training firm knows the worker's general productivity and match value perfectly. If it is costless to learn about the worker's type then the analysis of Bar-Isaac, Jewitt and Leaver (2014) suggests that this assumption is without loss of generality: Although it may not be the case for a fixed information structure, when a firm can vary the disclosure policy at the same time as it acquires information then it can increase efficiency with no impact on adverse selection. Consequently, there is nothing to

lose but potentially something to gain from gathering all available information. Of course, in practice, internal review systems do come with costs. To the extent that it is easier to commit to gathering particular kinds of information than to disclosing them then the discussion in Section 5.2 above suggests that firms might choose to focus their internal review systems to evaluate and stress the worker's fit with the firm rather than on the more transferable skills.

Perhaps the greatest weakness in the analysis above is the treatment of workers who are not active agents in the analysis. Workers are assumed to have no information about their own abilities initially. Further they take no actions that affect their productivity; that is, there is no moral hazard. There are two aspects of moral hazard that may be relevant. A familiar one is actions that raise the worker's output either in the current period or as investments in general human capital. Information structures can act to provide incentives for workers to exert effort as is familiar from the literature on career concerns following Holmstrom (1999) and Dewatripont, Jewitt, and Tirole (1999). Such concerns are likely to lead to information structures that balance providing incentives to the worker and transferring surplus to induce the training firm to invest in training, as in Bar-Isaac and Levy (2019). More specific to our analysis, note that with an information structure such as FIBM, since bad matches expect higher earnings than good matches, a worker might prefer to be viewed as a bad match. Over a long training period (for example, a partnership track that may last a decade or more), it may not be easy for a worker to dissimulate their type. Further, trying to reduce the training firm's perception of only the match value but not the general ability may be difficult. Indeed, the willingness to engage in such behavior might vary (Frankel and Kartik, forthcoming and references therein) and, frankly, might be viewed as a negative general human capital trait.

More broadly, in an ongoing relationship, a worker may resent being "punished" for being a good fit. Wage determination might not simply reflect the outside option, and the importance of maintaining goodwill may mitigate and interact with the forces that we have outlined here, leading to outcomes that are not as extreme as the ones that we have characterized.

There are other natural questions and extensions that one could consider. In the analysis above, training is a discrete binary decision and related solely to general productivity. There is, of course, a rich tradition that considers much more nuanced training decisions and decisions around match-specific as well as general human training.[21] Our hope, in-

[21] On this latter aspect note that to the extent that firm-specific training creates additional surplus

stead, has been to provide a simple and clear setting to illustrate forces. Moreover, by allowing firms to choose any information structure, we are likely allowing for more flexibility than is possible in practice. The extent to which firms have discretion over the information available to rival employers or can affect it is likely to vary by industry.[22]

Finally, in our analysis we have assumed that all firms are identical. In practice and anecdotally in professional services, some firms might provide more opportunities to augment general human capital (offering "a better training") and, so, be relatively more attractive. This observation will not be lost on professors at business schools or others who monitor graduate recruitment (what used to be known as the "milk round" in the U.K.). There are some firms which are particularly desirable as starting points for a career and part of their offering is not only training but, as suggested in Footnote 1, access to help in securing a career beyond the firm. This is easy to interpret in the context of the analysis above.[23]

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that through competition would, otherwise, lead to higher training wages, it can relax the non-negativity constraint. Thereby, opportunities for firm-specific training might be complementary to the provision of general training. Stevens (2012) Kessler and Lulfesmann (2006) and Balmaceda (2007) also highlight strategic complementarity between firm-specific and general training though through different mechanisms. All these approaches rely in some way on imperfect labour market.

Our analysis suggests that there may be additional interactions through the implications for the distribution of match values.

[22] In work that is related in spirit, Burguet, Caminal and Matutes (1999) argue that in certain industries, specifically professional sports, characterised by extreme visibility of performance, incentives are created for restrictive labour practices such as transfer fees.

[23] Indeed, earlier expositions of the ideas in this paper, notably Bar-Isaac, Jewitt and Leaver (2014) presented this as the leading application.

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