Training, Recruitment, and Outplacement as Endogenous Adverse Selection*

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Abstract

We analyze a model of adverse selection in labour markets. Workers vary in both match-specific and general productivity. Firms can shape the information available to rivals. Competition to recruit workers leads to an information structure that resembles outplacement: Potential employers learn a lot about workers who are bad matches, but little about those who are good matches. This involves considerable adverse selection but no inefficiency. In this way, this kind of information provision acts as a way for workers to effectively pay for efficient training. One consequence is that wages of those who stay in the firm are, on average, higher than wages of those who leave. This is in line with some empirical findings but in contrast to standard tests for adverse selection in labour markets.

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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 face credit constraints or employers cannot commit to provide it. Employers in competitive labour markets do not pay for training since the payoff from this investment is realized as higher wages. A significant literature (including an excellent overview by Acemoglu and Pischke (1999)) suggests that when labour markets are imperfect, 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 efficient enough 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.[2]

Viewed in this way, it is natural to examine how employers might want to create asymmetric information. That is—in the language of a recent literature that considers the design and implications of information structures in various games[3]—what kind of information structures they would choose? Our central result is that an optimal information structure is akin to an outplacement-like strategy. It provides considerable assistance and public information about those for whom the position is not working out, but not for those that the firm is keen to retain. Moreover, this information structure has implications for the distribution of wages and the standard approaches to testing for asymmetric information in labour markets.

Formally, we consider a two-period model of labour market competition. In the first period, identical firms compete to attract a trainee in their offers of wages, training, and information structures. Workers vary in their natural level of human capital, as is standard in the literature on asymmetric information in labour markets,

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

[2] Almazan, de Motta, and Titman (2007) consider location choice (rather than asymmetric information) as a strategic decision to introduce labour market frictions that allow for training.

[3] A fast-growing literature that is now sufficiently established to include several overviews including Kamenica (forthcoming) and Bergemann and Morris (2019).

following Waldman (1984) and Greenwald (1986). Crucially, however, 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 a current employer might be particularly keen to retain a worker who is a great match even if that worker might not be great at other firms. At the end of the first period, the training firm learns the worker's general ability and match for that firm, and information is made publicly available according to the agreed-upon information structure. Then, as in Greenwald (1986), given publicly available information (and anticipating possible adverse selection), rival firms compete with wage offers to the worker before the training firm has the opportunity to match the highest such offer and retain the worker; if the training firm does not do so, then the worker moves to another firm.

We consider a particular information structure that we call "Full information on Bad Matches" (FIBM). Under this structure, all information about bad matches is publicly revealed but no information about good matches is revealed. That is, under FIBM, potential employers learn the match value of the worker at the current firm if the worker is a bad match as well as the worker's general human capital—the expected productivity at a new firm; instead, they learn nothing about a worker who is well-matched (beyond the fact that the worker is currently well-matched). A main objective of this paper is to highlight that such an information structure can be optimal, especially when 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 labour 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 discuss these.

At this stage, it is worth noting that although the FIBM information structure might seem abstract and unusual at first, 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 they promise considerable support in helping them to do so.[4] 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. Moreover, the notion of support when things do not work out is a little broader than that of formal outplacement services in the case of formal dismissal, and can include a greater willingness to write (or ask for) a reference letter or other 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.[5]

Further, our analysis highlights a natural link between firms' decisions about information structures, such as outplacement activities, and training decisions. These come together to make a position more attractive to a potential employee and are a 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

[4]As a representative example, 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.

[5]In the law literature, Gilson and Mnookin (1989), 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. However, 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.

professional services and high-tech firms.[6,7] Indeed, in the absence of costly training, it is optimal for firms to reveal all information about workers—whether well-matched or not.

1.1 Related Literature

This paper builds on insights from our earlier paper Bar-Isaac, Jewitt and Leaver (2020). That paper provides a complete analysis of the second stage of the two-stage game that we analyze here (but under the additional assumption that general human capital, the match-specific component and the information structure have a joint Gaussian distribution). The current paper develops the applied implications of the observation that information structures affect both efficiency—that is, whether a worker stays at a firm with which she is well-matched and moves from one with which she is ill-matched—and the distribution of surplus through the adverse selection that reduces wages.[8] 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, there may be positive or negative aggregate selection, and the wages of those who leave a firm may be higher or lower, on average, than those of the employees who stay. The latter result is somewhat in contrast to received wisdom on the impact

[6]For example, Maister (1997, p. 189) writes 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: "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."

[7]Bar-Isaac and Lévy (2020) share a similar motivation in understanding the interaction of all the elements of the proposition thaat a firm offers in terms of both compensation and future opportunities. They allow for worker efforts (which this paper does not) but considerably simplify with respect to possible information structures and, instead, consider the possibility of generating a rival offer.

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

of adverse selection in labour markets.[9] Bar-Isaac, Jewitt and Leaver (2020) leave open the question of which information structures we should expect to observe in practice, and how such information 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 that in some of previous literature on asymmetric information in labour markets. Notably, Waldman (1984), DeVaro and Waldman (2012), Ricart-i-Costa (1988), and Blanes i Vidal (2007) argue that, since adverse selection in the labour market can affect wages, retention rates, and, thus, 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 a part of overall compensation, as it influences an employee's future career prospects.[10] Indeed, Pallais (2014) shows this to be economically significant by empirically contrasting 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, permits us to consider efficient turnover and richer information structures. Instead,

[9]Further, the introduction of match values in a model of asymmetric information in labour markets provides a natural reason for turnover and for a discussion of efficient and inefficient turnover. Instead, Greenwald (1986) and other subsequent studies rely on an exogenous and rather ad-hoc probability of forced turnover. Ferreira and Nikolowa (2020) allow for deterministic firm-specific human capital accumulation and heterogeneous firms (leading to a job ladder), so that there may be inefficient turnover.

[10]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 they assume a monopsonist employer in the second period, leading to somewhat different effects and considerations.

many of these works either force all workers to move firms between the first and second period (Koch and Peyrache, (2005); 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 in spirit to 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.

2 Model

Identical firms compete to attract a worker by offering a training position.[11] The training position attracts a worker through both the current wage and the prospect of opportunities in the next employment period, whether she remains at the training firm or moves to a rival employer. 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 offer and retain the worker or to release the worker.

The productivity of the worker during employment depends on her type $(g, m) \in G \times M \subset \mathbb{R}^2$, where the set, $G \times M$ of feasible types is finite. In this notation, g is understood as the worker's natural general human capital—a productivity component common across all potential employers—and m is understood as the match value at the training 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.[12] 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

[11]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.

[12]More formally, if there are n potential employers, a type might more appropriately be though of as $G \times M_1 \times M_2 ... \times M_n$; that is, a distinct match at each possible firm. We suppose that the distribution of match values across firms is iid and zero mean. Since only the match at the training firm is relevant we suppress this notation and hope that this does not cause undue confusion.

frequency $f(.)$, shared by all market participants and that this has full support—that is, $f((g,m)) > 0$ for all $(g,m) \in G \times M$. We suppose that $E[m] = 0$ and it is convenient to assume 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 raises 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. Third, the contract includes a commitment to a disclosure policy $\mu_\tau : G \times M \longrightarrow \Delta(T)$, 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 $G \times M$.

In the course of training, the training firm learns the worker's type perfectly and at the end of the period, all other firms observe a common signal T_τ generated according to the disclosure policy μ_τ.[13] 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 (for now) that the training firm can commit to it. 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: it is the training firm's desire to claw back future rents from a credit-constrained worker that motivates the firm's choice of information structure. If training were inefficient or if unboundedly negative training wages were possible, then familiar arguments, due to Becker (1962), would imply that the firm would choose its information structure purely on the basis of efficiency, and, for example, full disclosure of the type (g,m) might naturally arise.

[13] 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.

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 by 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 offer and retain the worker, or, instead, release the worker.[14]

Timing. The timing of the game can be summarized and formally described as follows:

First/Training Period Each firm, I, simultaneously offers a training contract of the form τ_I=($\mathrm{w}^T_{\tau_I}, \mu_{\tau_I}, E_{\tau_I}$), where $w^T_{\tau_I} \in \mathbb{R}_+$. The worker chooses a training contract from some firm I and training takes place. The worker is paid the training wage $w^T_{\tau_I}$ 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 outside offers and then makes an employment wage counteroffer $w_I \in \mathbb{R}_+$. 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, while firm payoffs are undiscounted profits—i.e., productivity less wages.

Our solution concept is Perfect Bayesian Equilibrium (PBE) where the worker's contract choice maximizes her lifetime expected wages given her beliefs, taken as

[14]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, including 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.

the simple sum of the training wage and expected employment wage (for simplicity, there is no discounting between periods); and each firm's contract offer maximizes its expected profit (again with no discounting between periods) and in the second period the wage offer of each non-training firm $J \neq I$, 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.

2.1 A simple illustrative case

To ease exposition and provide intuition, it is convenient to maintain a simple 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 (that is, values for A) and associated costs, c, in the course of the paper.

3 Analysis

We proceed by backward induction, first characterizing second-period wages for a given information structure and then considering 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 to potential employers—specifically, there will be asymmetric information that potential employers could use in assessing the likely productivity of the worker. In turn, this raises the possibility of adverse selection. Potential employers might anticipate that the 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 disclosed information. 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, the wage takes a familiar form, albeit in a slightly different context and absent public information and non-singular types.[15] Namely, the wage is the conditional expectation of the general human capital (including any training) that conditions on both the publicly available information, and on the current employer's decision not to retain the worker. It is only in the case of this last possibility that a new employer may end up with the worker. Further, it is this conditioning event that makes the current employer's information relevant and raises the possibility of adverse selection.

There may also be realizations of public information where outside employers cannot make an offer that 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 a 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 **??** and suppose that $\mu_\tau(g, m) = (g, m)$; then, if the realization $(10, 3)$ is observed, potential employers would not anticipate hiring the worker at any wage below 13; however, this 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. Perhaps a more interesting case, and one that we will draw on in the discussion below, is the case in which $\mu_\tau(g, m) = m$. Suppose that $t_\tau = 3$; in this case, potential employers know that the worker is better matched at the current firm than she is expected to be matched at any other firm. Consequently, any offer

[15] For example, a textbook version of adverse selection appears in Mas-Colell, Whinston and Green (1995) whose leading example is a labor market application where their wage equation appears as Equation 13.B.6.

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.

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 firm 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 **??**, 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 (**??**), 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 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. Below, 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, offers the worker expected lifetime earnings at least as high as any other offer) and maximize employment profits as defined in (**??**), less the training wage and the costs of the provided training. 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 choose contracts τ that involve $\pi_\tau - w_\tau^T - cE_\tau > 0$ then one firm could deviate from such an equilibrium by offering a similar contract to whichever one was the 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 anticipated 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 constraint (**??**) never binds, then firms can maximize (**??**) simply by maximizing $w_\tau + \pi_\tau$, which is the total employment period surplus. A natural means of doing is to reveal all information— that is, equilibrium can 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, (**??**) is violated—then full information and training cannot be an equilibrium outcome.

However, 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. Thus, such an information structure might allow for efficient training to be provided while respecting that wages should be non-negative. As described in the introduction, since such an information structure plays a key role in our analysis, we give it a name.[16]

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 in which the worker turns out to be a bad match. Rival employers will 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 with 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 $w($"$m \geq 0$"$) = \min\{g\} + AE_\tau$; 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.[17] To

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

[17] Here, we rely on the (natural) choice we made for wages at realizations of the information

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.*

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.[18] Trivially, $\left[E(g)-\min\{g\}\right]\Pr(m\geq 0) > 0$ unless g has a degenerate distribution. Thus, 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 of 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 in which 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.*

structure where the worker is always retained. Bar-Isaac, Jewitt and Leaver (2020) consider a Gaussian distribution for productivity and information and so allow for environments in which there is always some probability that the worker is retained. There, we show that there is an information structure in which the wage is always uniquely determined, and outcomes are, essentially, arbitrarily close to this information structure.

[18]It should be evident that the only role of this independence is to allow us to rewrite the first expression as the second. In particular, Proposition **??** and, the central intuition, of the paper do not require it.

4 The FIBM information structure and asymmetric information in labour markets

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), Bar-Isaac, Jewitt and Leaver (2020) has been criticized as suggesting "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), as well as a subsequent literature that addresses what outcomes can be achieved in different games without knowing fine details of the information structure. This is also the approach in Bar-Isaac, Jewitt and Leaver (2020), who also parameterize the information structure and, further, provide conditions under which certain relevant outcomes (such as lower wages for those who are retained) arise.

In itself, this speaks to a literature following Gibbons and Katz (1991), which tests for adverse selection in labour 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), Kahn (2013) and Friedrich (2019). In a recent contribution, Lang and Weinstein (2016) suggest that to reconcile findings, one must move away from the standard model; introducing multi-dimensional and, specifically, match-specific types is one means of doing so and can explain some of these results, which have been interpreted as inconsistent with asymmetric information as a key driving force.

However, assessing whether wages of workers who are retained are higher or

lower than the wages of those who leave requires knowledge of the parameters of the information structure that may be difficult for researchers 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 lies squarely on this question.

Our analysis suggests that when information structures are endogenously determined through competition between training firms, if asymmetric information arises then such asymmetric information imposes adverse selection on those workers who are retained. It does so by providing the outside labour market with more information about the general capabilities of workers who are a poor fit for the current employer than about those workers who are well-matched withthe current employer. In particular, it stresses that well-matched workers are, indeed, well-matched. 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 earn, on average, $E(G) + AE_\tau$. 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 **??**, 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 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, thus, given the independence of g and m, the 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 released workers.

At first blush, it may seem surprising that released workers earn more than retained workers in the context of the previous literature on asymmetric information

in labour markets. However, it is consistent with the following observations: (i) firms might be concerned with keeping down the wages of its own workers, but less concerned about the wages of workers that it is less interested in retaining, and (ii) people who move on often earn more than people who stay on at a firm.[19]

5 Discussion

5.1 When FIBM is not enough

The characterization in Proposition **??** 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 we were able to illustrate a number of points outlined in the introduction: (i) the information structure can be used to transfer second-period surplus between the training firm and the worker and, so, (ii) the information structure can be used as a means for the worker to pay for efficient training; (iii) it is optimal to do so with an information structure that is more revealing about workers who are a bad match than about workers who are 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, which for expositional clarity we do not provide. As should be immediate from the discussion thus far, there is no information structure that leads to a fully efficient allocation but also allows for higher second-period profits for the training firm than those that can be achieved with the FIBM information structure. However, depending on the parameterization, it may

[19]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.

be possible to increase 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, they should be workers with high general human capital at low wages).

This latter observation can be illustrated through the example in Section **??**. 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, a "worst" information structure that reveals information only 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 $\frac{1}{4}$).[20] With other parameterizations, there is no way to provide training that is more costly than that outlined in Proposition **??**.[21]

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

[20] Of course, this may be more misallocation than needed. As long as $(A - c)$ is larger than the cost of misallocation, 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 $\pi_\tau = c$.

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

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 the labour market application before questioning its importance for qualitative insight.

In practice, different information structures do arise, in many instances as a result of firm procedures that are largely fixed across different trainees and that arise out of explicit firm decisions. For example, firms vary in their human resources practices 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- 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) to the amount of time a programmer can spend on open source. Similarly, firms can limit the extent to which a consultant or lawyer has direct access and contact with clients; they can publicize the kind of work that the worker is engaged in, 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 terms tailored to individual employees. More broadly, choices over production technologies (such as whether to require team or solo production) and the design of the 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 the direct costs in such choices when deciding which kind and how much information to collect and make public, and while, in reality, commitment may be partial and imperfect, we simplify 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. 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.

In the case of the running example, while FIBM is not a sustainable information structure without commitment, an information structure that reveals 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 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 common, 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.[22] Suppose that a firm is committed to retain only half of the workers it trains; then, evidently, in the example in Section **??**, 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 additional information about them. Instead, the firm would release the poorly matched workers who are

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

less productive, and there would be no loss from revealing all the information about them.

5.3 Commitment to training

In our analysis, we have assumed that firms contract on training provision—that is, firms can commit to provide training. This is a strong assumption, not only in application, but also in the context of a literature in labour theory that seeks to understand how training could be provided in the absence of such commitment. The more recent literature relaxes full commitment to training and focuses on dynamic considerations: Morrison and Wilhelm (2004) and the related analysis of Bar-Isaac (2007) highlight the role 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, highlight the role of labour market frictions in compressing the structure of wages. We build on this insight below.

As we note 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 or stochastic and privately-observed effects, then the extent to which rivals will compensate a worker for her augmented skills will depend on publicly available information.

This is easy to understand in the context of the example in Section **??**. Suppose that training had no effect on low-human-capital types, and, instead, raised the productivity of high-human-capital types. That is, the augmentation of human capital arises only when 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 effective only half of 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 at 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 $A > 4c$, 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 will 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.

As an alternative example suppose that the worker is known to be of low quality and that training has a stochastic and privately-observed effect. Specifically, say that the worker is known to be equally likely to be a $(5, 3)$ or $(5, -3)$ type but now suppose that general training has a stochastic effect and is equally likely to have no effect or raise the general human capital to 10. Under full disclosure but with no commitment to training, the firm will not train the worker; however, under FIBM the firm will be able to retain a good match—whether of high or low human capital—at a wage of 5 and so expects to earn an additional 5 with probability 1/4 (the probability that training is effective and the worker is a good match) if it provides training.

It is worth noting that, in this subsection, there has been no mention of the non-negativity of the first-period training wage. With no commitment to training, even when the non-negativity constraint does not bind, there is a role for information structures that create adverse selection in the second period. This is because when there is no commitment to training, the training firm must anticipate a sufficient second-period return to induce such training. Indeed, a lack of commitment to training (with much of it informal), coupled with fairly high training wages and approaches to outplacement that resemble FIBM, might capture features of the professional services industry in a more compelling way than would the baseline model with commitment to training.

5.4 Other aspects

In our 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 in an earlier working paper version of this project (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 that it acquires information, 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, the discussion in Section **??** above suggests that firms might choose to focus their internal review systems on evaluating and stressing the worker's fit with the firm rather than on the more transferable skills.

Perhaps the greatest weakness in the above analysis 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 Lévy (2020). More specific to our analysis, note that with an information structure such as FIBM, since bad matches expect higher earnings than good matches expect, 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 her type. In addition, trying to reduce the training firm's perception of only the

match value and 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. Moreover, while a training and one working period is clearly analytically convenient, many periods of work suggest a worker may want to start afresh if offered a wage well below their productivity, or perhaps set up on their own and establish a new firm—options that would increase with higher human capital regardless of information disclosure but that may involve some costs, and, so, are unlikely to fully overwhelm the effects we describe.

There are other natural questions and extensions that one could consider. In the above analysis, 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 regarding both specific and general human training.[23] Rather, our hope is to provide a simple and clear setting in which 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.[24]

Finally, in our analysis we have assumed that all firms are identical. In practice

[23]On this latter aspect, note that, to the extent that firm-specific training creates additional surplus that, through competition, would, otherwise lead to higher training wages, it can relax the non-negativity constraint. Therefore, 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 an imperfect labour market. Our analysis suggests that there may be additional interactions through the implications for the distribution of match values.

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

and anecdotally in professional services, some firms might provide more opportunities to augment general human capital (offering "better training") and, thus, be relatively more attractive. Some firms are particularly desirable as starting points for a career, and part of their offering is not only training but, as suggested in Footnote 4, access to help in securing a career beyond the firm. This is easy to interpret in the context of our analysis.[25]

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