Adverse Selection, Short-Term Contracting, and the Underprovision of On-the-Job Training

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Original 1990. Revision with Preface, 2001.

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Preface

Preface? Does an economics article warrant a preface? It does — or, at very least, might — when it's fifteen years old.

The first draft of this article appeared in 1986. The 1980s were a golden era for contract theory: Thanks to the developments during the 1970s in game theory and the economics of information, we had a full palette of new tools, many interesting subjects to tackle, and many clean canvases on which to work.

As theorists began to "paint," it soon became clear that their colors were too powerful: Many subtle — and not so subtle — aspects of reality were obscured. In particular, many real-life problems seemed resolvable, almost trivially, through some contract or another. The rub was that these problems weren't being resolved so trivially in real life. And as clever as contract theorists were, it was a tad arrogant to imagine that they were weekly devising solutions that practitioners had missed in the course of decades or more of business experience.

The topic of this article, provision of general training, exemplifies this point. An obvious solution to ensure adequate provision of training is simply contract on its provision. But by the mid-80s it was obvious the obvious was wrong, not only with respect to training (a point made by Becker, 1975, many years prior), but also more generally. Some terms, like the quality of training, are simply too difficult to incorporate in contracts either because they're too difficult to describe *ex ante* within the terms of the contract or because they're too difficult to *verify ex post* should there be a dispute. The theory of *in*complete contracts (see, *e.g.,* Grossman and Hart, 1986) arose in response.

The problem with incomplete-contract models, particularly those that exploit the distinction between observable and verifiable, is that often there is a way to contract around the apparent source of incompleteness.[1] This insight about "contracting around" is most often associated with Maskin and Tirole (1999), although I like to believe that my own work in this area has also contributed to making this point.[2] The provision of training again exemplifies: Even if a firm and worker can't contract on the quality of the training the firm provides the worker, the parties could contract around this by making the length of employment long enough that the firm recovers its investment in worker training through the worker's enhanced productivity.

[1] In the language of contract theory, if A and B are parties to a contract, what they can both know (see, measure, etc.) is deemed *observable*. What they can provide clear evidence of to a third-party dispute adjudicator (*e.g.,* a judge or jury) is deemed *verifiable*. For example, A and B may wish to enter into a contract under which A produces a good of some specific quality for B in exchange for which B is to pay A some specified amount. The physical exchange and payments are typically considered verifiable; that is, the occurrence of these events can be convincingly demonstrated to a judge. But the quality of the good may be merely observable: A and B know the quality, but a judge may reach a conclusion about quality that differs from theirs (perhaps because assessing quality in this matter requires specialized knowledge that A and B have, but the judge does not).

[2] See, *e.g.,* Hermalin and Katz (1991), Hermalin and Katz (1993*a*), Hermalin and Katz (1993*b*), Edlin and Hermalin (2000), and Edlin and Hermalin (2001).

But, again, theory appears too powerful — general training is typically *under*-provided in the real world. Perhaps, then, there's another reason why contracts aren't as powerful as we might at first imagine. This article was one of a number of independent efforts in the mid-80s that identified one such reason: Asymmetry of information between the parties to the contract at the time they negotiate the contract. For the specific issue of general training, the problem, as this article shows, is that long-term contracts are inherently more valuable to less able workers because these workers "fear" going back on the market after an initial period of employment. In contrast, more able workers "welcome" an opportunity to go back on the market in order to reap the benefits of having proved themselves during that initial period. Hence to induce high-ability workers to sign a long-term contract, the firm must compensate them for this lost opportunity. But because the firm can't identify who's high ability and who's low ability *ex ante*, the firm incurs the cost of overpaying low-ability workers. At some point, this cost becomes too great — the net benefits of training can't outweigh the loss from overcompensating low-ability workers.

In addition to this article, Spier (1992), Diamond (1991), and Aghion and Hermalin (1990) all demonstrated that asymmetry of information could lead to sub-optimal outcomes (from a full or symmetric information benchmark). Spier's article was, in many ways, the most general of these. She offered asymmetry of information as a reason *why* contracts could appear incomplete — that is, appear to lack terms that one might naïvely expect in such a contract. Although her insight is an important one for understanding contract structure, her interpretation that asymmetry of information *leads* to incomplete contracts is not necessarily the most instructive interpretation. Again, consider the provision of general training: It is *not* an *ex ante* asymmetry of information that makes the contract incomplete (*i.e.,* causes it not to be contingent on the quality of training). It is incomplete because "quality" is an inherently difficult to *verify* attribute. Asymmetry of information explains not incompleteness, but sub-optimality: As noted above, asymmetric information makes it undesirable for the parties to write the long-term contracts that have become necessary, due to contractual incompleteness, to support training in equilibrium. Note that a short-term contract is not an incomplete contract — the parties *have* contracted on the parameter of interest (here, length) — it is just a sub-optimal one.[3]

Diamond's article is more closely related to this one. Like me, he was concerned about contract length (in his case, debt maturity). Borrowers with poor-quality projects prefer long-term debt because they prefer not returning to the capital markets once the quality of their projects are revealed. Hence, equilibria can emerge in which debt contracts are short term. Because of transactions costs (*e.g.,* liquidity risk, reappraisal, etc.), short-term contracts could be sub-optimal.

One reason that asymmetric information can lead to sub-optimal contracts is that pooling equilibria, which can, in some instances, be welfare superior to

[3]See Hermalin and Katz (1993*b*) or Tirole (1999) for a more detailed discussion of what "incompleteness" means in contract theory.

separating equilibria, are often considered unstable (see, *e.g.,* Cho and Kreps, 1987). Better types can have an incentive to unravel pooling equilibria by making separating deviations. If, however, some contract terms are *mandatory* (*e.g.,* a prohibition on waiving one's right to declare bankruptcy when negotiating a loan), then these separating deviations can be impossible, thus preserving the more efficient pooling equilibrium. This is the primary point of Aghion and Hermalin, although we also make the "meta" point that *ex ante* asymmetries of information can lead to sub-optimal contracts — at least in a world with*out* constraints on contracting.[4]

Having put this article in historical context, one might ask what's the point of publishing it now.[5] Despite being, to some extent, yesterday's news, it does make some interesting points relevant to labor markets not made by other papers (although, Cantor, 1990, and Hosios and Peters, 1993, make some related points and also consider issues of contract length in the labor-market context). It also demonstrates how asymmetric information can lead to contractual inefficiency in a screening model. Although this is not wholly surprising given results from signaling models (*e.g.,* Aghion and Hermalin, 1990 and Spier, 1992), it is also true that some inefficiencies that occur with signaling disappear when the model is recast as a screening model (see, *e.g.,* Hermalin and Katz, 1993*b*, for a discussion and an example).[6] Finally, this article has received its share of citations over the years, so possibly people could have an interest in finding it and, thus, it could be useful to have the article in a more accessible place than my file drawer.[7]

[4]Hermalin and Katz (1993*b*) demonstrate that asymmetry of information is the *only* possible efficiency justification for imposing mandatory constraints on contracts in situations where bilateral contracts do *not* affect third parties (see Aghion and Bolton, 1987 for an important example in which a bilateral contract *does* impose an externality on a third party and, hence, where constraints on freedom of contract could be warranted).

[5]Less graciously, one could ask why it wasn't published in the late 80s or early 90s. The article was rejected by one top-tier journal in the second round after what seemed like a promising solicitation to resubmit. Another top-tier journal rejected it because it was insufficiently applied. A third rejected it because it was insufficiently general. By 1990, I was too busy with other projects to fiddle with this article yet again — and, in any case, much of its thunder had been lost to related work such as Spier (1992), Diamond (1991), and Aghion and Hermalin (1990) among others.

[6]Basically, one source of inefficiency in a signaling model is that the behavior of one type, call this type G, of the informed player "imposes" a negative externality on another type, call it B. That is, because the informed player plays one way when she's the G type, she is adversely affected when she is, instead, the B type. She might, consequently, wish to commit — prior to learning her type — to behave differently if she's a G type so that if she proves to be a B type she'll be less adversely affected. Typically, such commitment is impossible and so, from an *ex ante* perspective, there's an inefficiency. But in the case of a *screening* model, the uninformed player can sometimes internalize that externality in a way the informed player cannot, thereby eliminating the inefficiency (see Hermalin and Katz, 1993*b*, for details).

[7]Among the articles that have cited this article (in one version or another) are Aghion and Bolton (1987), Anderlini and Felli (1994), Bolton and Scharfstein (1990), Cantor (1990), Hosios and Peters (1993), Maskin and Tirole (1999), Spier (1992), Tirole (1988), and Tirole (1999).

This Version in Comparison to Previous Versions

Over the four years I struggled to place this article in a top journal, it went through a number of transformations. The version that appeared in my dissertation (Hermalin, 1988) was more general in many aspects, in particular with respect to the modelling of competition among potential employers. Competition with screening is, however, complicated to model because of the danger of running into Rothschild and Stiglitz (1976) non-existence of equilibria problems. Consequently, the dissertation version contained some less than elegant "kludges" to insure existence of equilibrium. One way to avoid Rothschild and Stiglitz non-existence is to turn the problem into a signaling problem — and a version of this article that recast the problem as a signaling problem demonstrated non-optimal equilibria similar to those derived here (that version was closer, in game-theoretic terms, to the models in Aghion and Hermalin, 1990, and Spier, 1992). Of course, in the context of firms and workers, a signaling model — which entails the informed workers proposing employment contracts to uninformed firms — is considerably less realistic than a screening model — uninformed firms proposing employment contracts to informed workers. Consequently, this version revives the original casting of the problem in terms of screening.

This version is nearly identical to the last version, which was a 1990 UC Berkeley Department of Economics working paper (paper #90–139). Some citations have been updated. The writing has been tweaked here and there. But the analysis is identical.

Acknowledgements

This article is based on the first chapter of my dissertation (Hermalin, 1988), which was written with the financial support of the National Science Foundation and the Sloan Foundation. I remain grateful to my dissertation advisors, Jean Tirole and Franklin M. Fisher, both for their advice on this article and for everything else they did for me then and have done for me over the years. Earlier versions were improved as a consequence of the helpful advice of Michael L. Katz, David I. Levine, Michael Weisbach, and Janet Yellen. Also over the years, a number of people have encouraged me to dust this article off and submit it again — still apparently seeing in it something of interest. Among them were Jean Tirole, Bengt Holmstrom, and — most recently — Aaron Edlin. At last, I've decided to listen to them.

1 Introduction

General training is under-provided in the US economy. This is the sentiment of the popular press, as well as the Commission on Workforce Quality and Labor Market Efficiency.[8,9] On the other hand, there is certainly some provision of general training; according to the Commission, $30 billion is spent by firms annually on training.[10] Apparently, then, some firms provide general training in equilibrium, while others do not.

Consequently, a model of the provision of general training must explain cases in which general training is under-provided, as well as cases in which it is provided. The model I present here meets those criteria. It does so by departing from the classic Becker (1975) model in two ways. First, as in the Becker model, it allows workers to "purchase" training by initially accepting a wage below their marginal product. The difference is that this model recognizes that if the workers purchase training from the firm, then an agency problem is created: The firm becomes the workers' agent with respect to training. Therefore, unless provided with incentives, the firm will be tempted to under-provide training or provide low-quality training, since in these ways the firm can reduce its training costs.[11]

As I show, however, this agency problem alone does not explain the under-provision of training. Consequently, the second point of departure is that I assume that there is worker heterogeneity (adverse selection). With worker *homogeneity*, the solution to the agency problem involves the firm offering long-term contracts to its workers. With worker heterogeneity, it may become costly for the firm to make such offers. High-ability workers value the option to entertain outside wage offers once their ability becomes known to the market. Hence, to induce high-ability workers to accept a long-term contract, the firm must commit to paying a high level of compensation. However, because the firm cannot distinguish high-ability workers from low-ability workers, the firm could end up overpaying its workers on average. If the cost of overpaying exceeds the returns to training, then training will not occur in equilibrium.

The costs of overpaying will tend to exceed the returns to training when there is a great amount of worker heterogeneity or when the returns to training are small relative to the degree of dispersion in worker ability. The general predictions of the model are, thus, that equilibrium will be described by long-

[8] For example, see *Business Week*, September 19, 1988.

[9] The Commission on Workforce Quality and Labor Market Efficiency was established in July 1988 under the aegis of the Department of Labor. It issued its report, *Investing in People: A Strategy to Address American's Workforce Crisis*, in September 1989.

[10] This figure, presumably, includes expenditures on both specific and general training. Thus, this figure may overstate the amount spent on general training. However, this figure only reflects formal training costs, so the costs of informal training are not included. Thus, this figure may understate the amount spent on general training.

[11] Historically, this problem was recognized in the design of apprenticeship contracts in England. A group of apprentices even sued their master claiming inadequate training. See Elbaum (1989).

term contracts and training when there is little worker heterogeneity or when the returns to training are large relative to the dispersion in worker ability; when these conditions are reversed, then equilibrium will be described by short-term contracts and no training.

The theoretical contributions of this article go beyond providing as explanation for the under-provision of general training.[12] The model also provides an explanation for why short-term contracts frequently govern long-term relationships: Because low-ability types value the protection provided by long-term contracts, offering short-term contracts could be part of a strategy aimed at identifying high-ability types (*i.e.,* screening out low-ability types). This general insight applies to many situations, including franchising, patent licensing, and other long-term buyer-seller relationships.

The next section presents the model and considers the case of worker homogeneity. The model has been kept deliberately simple, in order to focus attention on the agency and adverse selection problems. Section 3 investigates the case of worker heterogeneity. Section 4 discusses the results, suggests extensions and other applications, and relates this article to other work. in the field. Section 5 contains some concluding remarks.

2 The Model

Basic Assumptions

There are two parties to an employment relationship: a firm and a worker.[13] The worker has innate ability α. For convenience, I assume α is drawn from the two-element set $\{0, A\}$, where $A > 0$.[14] Setting the low-ability level equal to 0 is without loss of generality and, as the reader will see, serves to simplify a number of expressions. Due to this assumption, A is also a measure of the dispersion of worker ability. Let θ denote the probability that the worker is high ability. Note that θA is, then, equal to average worker ability. The worker knows his ability.

The firm offers an employment contract to the worker. At the same time other firms (the "outside") are also seeking to hire workers, and the worker could go to work for them. From the contracts offered by the firm and the outside, the worker chooses the one which will lead to the greatest lifetime income. The worker may then receive training. First-period production follows. At the end of the first period, the worker may receive outside wage offers. His current employer can match these offers if it wishes; if it does, the worker remains with

[12] Or at least did when the article was originally written — see discussion in the Preface.

[13] This formulation of the model differs from the formulation in an earlier version, Hermalin (1988). I am grateful to Michael Katz for suggesting this change in formulation, which allows me to reach essentially the same conclusions in a much more straightforward manner. (This is, however, the 1990 formulation.)

[14] An earlier version considered the case of a continuum of worker abilities and reached similar results.

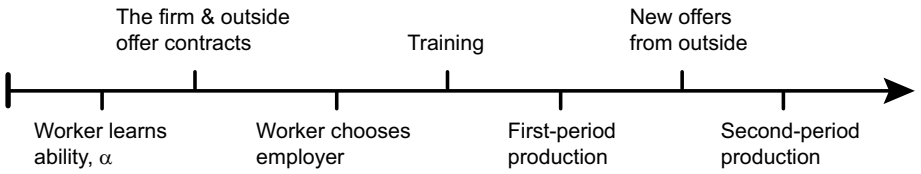

Figure 1: Timeline

his current employer, otherwise the worker changes employer. Second-period production then occurs. Schematically the timing is shown in Figure 1.

The value of the worker's output in each period is $\alpha + \tau$, where τ is the amount or quality of training the worker initially received. Furthermore, the training is general — if the worker receives training τ from the firm in the first period, but works on the outside in the second period, the value to the outside firm of his second-period output is $\alpha+\tau$ as well. For convenience, I assume only the firm is capable of providing training.[15,16]

Also for convenience, I assume that τ can take only one of two values: 0 or t, $t > 0$.[17] I assume the cost to the firm of providing training t is c. In order that the problem be interesting, I assume

$$t < c < 2t\,. \tag{1}$$

Expression (1) captures the idea that it is unprofitable to train a worker who leaves after one period, or, equivalently, has his wage bid up after one period. However, over two periods, there is a positive return to training.

Information and Contract Assumptions

I assume that no employer can observe the worker's ability directly. I do, however, assume that at least one firm, in addition to the worker's current employer, perfectly observes the value of the worker's first-period output. This is admittedly a strong assumption: In many situations, firms other than a worker's

[15] An earlier version considered more strategic labor-market competition among firms, all of whom were capable of providing training with similar results. However, as the lengthy analysis of that competition does not aid in the understanding of the central issues of adverse selection and contract length, I have chosen not to include it here.

[16] There are many examples of industries where only a subset of the firms provide training. Anecdotal evidence suggests this is true in accounting, where the large firms train workers who may leave for small firms or self-employment, and in insurance, where insurance firms train workers who may be hired away by insurance agencies.

[17] Two values are sufficient to illustrate the agency problem; hence allowing more values, or even a continuum of values, adds little. The assumption of two values essentially abstracts from the choice of an optimal level of training when the firm decides to provide training.

current employer cannot perfectly observe his productivity.[18] However, altering this assumption to give the incumbent employer an informational advantage can create a "winner's curse" problem (see Greenwald, 1986, or Lazear, 1986):[19] Concern that the incumbent employer would only let low-ability workers be bid away makes other firms less aggressive in bidding for workers. In turn, less aggressive bidding reduces worker mobility. In the extreme, when worker mobility is eliminated, the main problem with general training, namely that trained workers will be bid away, is also eliminated.[20]

In some fields, such as law and accounting, one of the worker's outside options is self-employment. Thus, an alternative to the assumption that an outside firm observes the value of the worker's output is the assumption that the worker has the option of self-employment. Obviously, the winner's curse problem does not arise under this alternative assumption.[21]

The assumption that the firm cannot directly observe the worker's ability initially has two additional implications. First, the firm does not know the worker's ability at the time it hires him (*i.e.,* an adverse selection problem exists). Second, the firm does not know the worker's ability when deciding whether to train him. Only the first implication is crucial to the model; the second can be relaxed without changing the general predictions of the model.[22]

There are two types of contracts, long-term contracts and short-term contracts. A long-term contract is a pair of wages (w_1, w_2) where w_1 is the wage

[18] An obvious exception is academia, where the value of a professor's scholarly output is known throughout his field. Another exception is insurance, where agents sometimes offer employment to the trained underwriters with whom they interact or where "headhunters" attempt to lure underwriters from one firm to another. More generally, outside firms might be expected to know a worker's productivity whenever that worker "works in public."

[19] No winner's curse problem will arise if the outside's observation of the value of the worker's output is not too imperfect. For example, suppose the outside observed $x \equiv \alpha + \tau + \nu$, where ν is a random noise term drawn from the interval $[-n, n]$. If the amount of noise is small relative to the amount of dispersion in worker ability (*e.g.,* $n < A/2$), then, in a pure-strategy equilibrium, imperfect observability will not matter — from x and their knowledge of equilibrium, the outside can infer $\alpha+\tau$. As the reader can verify, the equilibria of Propositions 1–4 would still hold under this formulation with only minor modifications.

[20] This point is also made by Katz and Ziderman (1990), who argue that general training is provided because there is asymmetric information between the current employer and the outside. Although this argument may explain the provision of training in some settings, it does not work as explanation in settings, such as insurance, where "public" workers receive training (see footnote 17).

[21] To be precise, the model is slightly charged if self-employment is taken to be the worker's outside option. The reason is that the lifetime earnings of a worker who initially self-employs is 2α, whereas in the model presented here, the lifetime earnings of a worker who is initially employed on the outside is $\theta A + \alpha$. The general predictions of the model, however, are not changed. In particular, it can be shown that if $2t - c < 2(1-\theta)\theta A$, then no equilibrium exists in which long-term contracts are offered; and hence no equilibrium exists in which training occurs.

[22] In particular, it can be shown that if $2t - c < \min\{\theta A, (1-\theta)^2 A\}$, then there is no equilibrium with long-term contracts and, hence, no equilibrium with training even when the firm knows the worker's ability prior to providing training.

paid in period one and w_2 is the wage paid in period two. A short-term contract is a single wage, w_i, to be paid in the ith period. I assume that the firm can fully commit to a long-term contract, in that it can commit not to break the contract unilaterally or to escape it by firing the worker.[23] The firm can, however, "renegotiate" a long-term contract after one period in order to match a higher wage offer. I will consider two possibilities for commitment by the worker: Either the worker can commit to a long-term contract; that is, he can commit not to accept outside wage offers. Or he cannot commit; that is, he remains free to accept outside wage offers. Given the nature of US law, the latter possibility is the more realistic, though the former is useful for illustrating certain ideas. All parties can commit to a short-term contract.

It should be recognized that I am ruling out the possibility of the parties' contracting directly on either training or the value of the worker's work; that is, contracts are *incomplete* with respect to τ and $\alpha + \tau$. This is important, because in this model the parties have an incentive to write contracts contingent on training or the value of the worker's output. Although incomplete contracts can be difficult to justify theoretically (see Hart, 1987, for a discussion),[24] this is not an unreasonable assumption to make here: With complete contracts, there would be no under-provision of training; the observation that there is under-provision means that, for some reason, contracts must be incomplete.[25]

Finally, I assume that prior to first-period production the outside firms bid a wage equal to the worker's average ability; that is, the outside offers the short-term contract, $w_1 = \theta A$.[26]

Training with Worker Homogeneity

As a benchmark, consider the situation in which α can take only one value, $\hat{\alpha}$. Suppose first that the worker can commit to a long-term contract. There

[23] One may object that it is unrealistic to assume the firm can commit to not fire, particularly when that would result in the firm overpaying in the second period. To the extent that objection is correct, then that is an argument against firms providing general training: From Result 1 below, the inability to make long-term commitments implies no training will be provided. Note this holds true with or without worker heterogeneity; thus without any long-term commitments, the agency problem created when the worker seeks to purchase training from the firm is insurmountable (at least given the assumed information structure). On the other hand, such long-term commitments may not be unrealistic. Through pensions, seniority rules, and promotion schedules, firms frequently commit to future levels of compensation.

[24] Hart (1995) is a more detailed and up-to-date reference. As noted in the Preface, the discussion here precedes a number of developments in the incomplete contracts literature.

[25] Possible reasons include the costs and difficulties inherent in recording and verifying (hard) evidence on training or the value of the worker's output, the costs and difficulties inherent in writing and negotiating complete contingent contracts, and legal restrictions that limit the enforceability of certain contracts.

[26] To be precise. I am assuming the outside is only semi-strategic. This assumption could be relaxed, if one (reasonably) assumes the outside is large relative to the firm; that is, if the firm can hire only an insignificant fraction of the total labor market. Given this assumption, it can be shown that the equilibrium short-term contract offer of a strategic outside is arbitrarily close to θA (or equal to θA if the firm's fraction of the market is taken to have zero measure).

exists an equilibrium in which the worker signs with the firm and training is provided: The firm offers the long-term contract $(\hat{\alpha}, \hat{\alpha})$. Because outside firms would never offer long-term contracts more generous than $(\hat{\alpha}, \hat{\alpha})$, or short-term contracts more generous than $w_1 = \hat{\alpha}$, it can be assumed the worker signs with the firm. Because the worker is committed to stay both periods, the firm's profit if it trains is $2t - c$, which is greater than 0, its profit if it does not train.

Now suppose the worker cannot commit to a long-term contract. In the second period, competition between the firm and the outside for the worker means that the worker will capture the full value of his output through his second-period wage; that is, he will be paid $\hat{\alpha}$ if he did not receive training and he will be paid $\hat{\alpha} + t$ if he did receive training. Nonetheless, a modified version of the "Becker solution" yields an equilibrium in which the worker signs with the firm and training is provided: Suppose the firm offers $(\hat{\alpha} - t, \hat{\alpha} + t)$. If the worker signs with the firm and training is provided, then the firm's profit will be 2t - c. If the firm does not train the worker, its profit will be 0. Thus, if the firm signs the worker, it will provide training. Hence, if the worker signs with the firm, his lifetime earnings will be $2\hat{\alpha}$. Given that the outside would never offer long-term or short-term contracts that would yield him greater lifetime earnings, the worker signs with the firm in equilibrium.

To summarize:

Proposition 1 *Given worker homogeneity, there exist equilibria in which the worker signs with the firm and receives training, regardless of whether, or not, the worker can commit to a long-term contract. The firm captures all the surplus created by training.*

It is important to understand why the firm is willing to provide training even when the worker's wage will be bid up. By committing to a high second-period wage (*i.e.,* $\hat{\alpha}+t$), the firm ensures that the worker will never be bid away (regardless of training). Consequently, the firm is guaranteed two periods of the worker's time, which makes training a valuable proposition.

As in Becker (1975), the worker pays for his training by accepting a first-period wage below his ability (market). Note that this "Becker-like" solution works here because the worker and the firm sign a long-term contract: the firm bonds itself to train through the promise of a high second-period wage. As the worker is assured of training, he is willing to pay for it by accepting a first-period wage below his ability.

3 Worker Heterogeneity

In this section, I consider the case where there is worker heterogeneity and, thus, adverse selection. To begin, consider three general results. These results provide intuition for what follows, as well as lay the groundwork for the formal analysis.

First, given a short-term contract, the firm's profit if it trains is

$$\mathbb{E}\{\alpha\} + t - c - w_1\,,$$

where $\mathbb{E}\{\alpha\}$ denotes the expected ability of the worker in equilibrium. If it does not train, its profit is $\mathbb{E}\{\alpha\} - w_1$. Because $t < c$, one has:

Result 1 *Under a short-term contract, the firm never trains the worker.*

If the worker signs with an outside firm initially, his lifetime earnings will be $\theta A + \alpha$, because he will receive θA in the first period and α, the value of his output, in the second period (the latter as a consequence of competition in the second-period labor market). Thus,

Result 2 *In equilibrium, the lifetime earnings of an α-type worker must be at least $\theta A + \alpha$ if he signs with the firm.*

Finally, consider any long-term contract (w_1, w_2). If the worker is committed to the contract, then his lifetime earnings are $w_1 + w_2$ regardless of his type. If the worker is not committed, then his lifetime earnings are $w_1 + \max\{w_2, \alpha + \tau\}$. From this it is clear:

Result 3 *Under any long-term contract, (w_1, w_2), the lifetime earnings of a low-ability worker, y_0, cannot be less than $y_A - A$, where y_A is the lifetime earnings of a high-ability worker under that contract.*

Result 3 formalizes the intuition given in the introduction, namely that long-term contracts tend to be a relatively better deal for low-ability workers than for high-ability workers.

An important extension of Results 2 and 3 is that if the firm offers a long-term contract and the high-ability worker signs that contract, then the low-ability worker must also be willing to sign that contract. To see this, recall that a high-ability worker will accept a long-term contract only if $y_A \geq \theta A + A$. By Result 3, $y_A \geq \theta A + A$ implies $y_0 \geq \theta A$, which, by Result 2, is the condition for the low-ability worker to want to sign that long-term contract.

The Worker Cannot Commit to a Long-Term Contract

Assume that the worker cannot commit to a long-term contract; that is, he is free to accept outside wage offers. There are three different regions of parameter values to be considered:

Region I: $\min\{\theta A, \theta t\} \leq 2t - c$;

Region II: $\theta(1-\theta)A \leq 2t - c < \min\{\theta A, \theta t\}$; or

Region III: $2t - c < \theta(1-\theta)A$.

Depending on the value of t, the second region may not exist.

Beginning with Region I:

Proposition 2 *If the parameter values lie in Region I; that is, there is a high probability that the worker is low-ability or the amount of dispersion in worker ability is small relative to the net returns on training, then there exists an equilibrium in which the firm hires both types of worker and provides training. The contract offered by the firm in equilibrium is the long-term contract* $(\theta A - t, t)$*. Neither, type of worker captures any of the surplus created by training.*

Proof: The contract proposed by the firm is similar to the Becker-like solution employed in Proposition 1: the first-period wage, $\theta A - t$, is below average ability and, in this way, the worker pays for his training. The promised second-period wage is set sufficiently high to make the firm's promise of training credible: Given that the parameters lie in Region I, the firm's profit is greater if it trains than if it does not train. If the firm trains, then its expected profit is $2t - c$; that is, the firm captures the net returns from training. From Results 1–3, that is the best for which the firm can hope — because of offers from the outside, the worker is able to capture the expected value of his ability. Hence, the firm has no incentive to deviate by proposing another contract. Finally, as neither type can do better going on the outside initially, both types of worker are playing a best response by signing with the firm at the beginning of the first period. ■

In terms of empirical implications, Proposition 2 says that one should expect to see training in fields where the returns to training are large relative to the amount of dispersion in worker ability. Perhaps more interestingly, Proposition 2 predicts that firms that hire the lowest-ability workers in the labor force will provide training in equilibrium.[27]

In terms of the worker's payoffs, the contract offered by the firm in the equilibrium of Proposition 2 is similar to a short-term contract in the sense that, for both types of worker, the second-period wage equals the worker's value (*i.e.,* the high-ability worker receives $A + t$ and the low-ability worker receives t). As the next lemma shows, this is a consequence of being in Region I; outside Region I training can only occur under long-term contracts that do not resemble a sequence of short-term contracts.

Lemma 1 *If the parameter values lie outside of Region I and if the firm trains both types of worker in equilibrium, then the firm must offer a contract in which the second-period wage,* w_2*, is greater than the value of training,* t*.*

Proof: See Appendix.

As will become evident, the important implication of this Lemma is that if training is provided, then the low-ability type must receive a rent. If that rent is modest, then training will still be provided (Proposition 3). However, if that rent becomes extreme, then no training will be provided (Proposition 4). Whether the rent is modest or extreme depends on whether the parameters lie

[27] There is anecdotal evidence that some firms that hire unskilled workers provide remedial education and other general training (*Business Week*, September 19, 1988).

in Region II or Region III. When the parameters lie in Region II, the following proposition holds:

Proposition 3 *If the parameter values tie in Region II; that is, there is a high probability that the worker is high-ability or the amount of dispersion in worker ability is modest relative to the net returns on training, then there exists an equilibrium in which the firm hires both types of worker and provides training. The contract offered by the firm in equilibrium is the long-term contract* $(\theta A - t, W)$*, where*

$$W = A + t - \frac{2t - c}{\theta}\,.$$

Only the low-ability worker captures any of the surplus created by training.

Proof: First, the firm will wish to provide training under this contract. Its expected profit if it trains is

$$\theta A + t - c - (\theta A - t) + (1 - \theta)(t - W)\,,$$

because, in the second-period, the high-ability worker will have his wage bid up. Simplifying that expression, the firm's expected profit from training is

$$\frac{2t - c}{\theta} - A(1 - \theta)\,. \tag{2}$$

If it does not train, its expected profit is

$$\theta A - (\theta A - t) + \min\{\theta A, \theta W\} - W\,.$$

However, as $\theta t > 2t - c$, it follows that $A < W$ (*i.e.,* the firm is committed to overpay both types if it does not train). So, simplifying, the firm's expected profit if it does not train is

$$\frac{2t - c}{\theta} - A(1 - \theta)\,.$$

Hence, the firm is just willing to provide training.

Given that the firm will train, both types are willing to sign with the firm — the high-ability worker receives lifetime earnings of $\theta A + A$ and the low-ability worker receives lifetime earnings of $\theta A + A - (2t - c)/\theta$. Because $A > (2t - c)/\theta$, the low-ability worker is capturing some of the returns from training. To complete the proof, I need only check that the firm could not do better by offering a different contract. In light of previous analysis, there are four possibilities to consider: 1) the firm offers a contract that does not induce training, 2) the firm offers a contract that induces training but allows the high-ability worker's wage to be bid up in the second period, 3) the firm offers a contract that induces training and allows no type's wage to be bid up, and 4) the firm attempts to hire and train only the low-ability worker.

Possibility 1: In Region II, expression (2) is positive and the firm, thus, does better than if it offered a contract under which it did not train (*e.g.,* the short-term contract $w_1 = \theta A$). Because the worker captures the expected value of his ability, the largest expected profit the firm can earn without training is zero.

Possibility 2: From Result 2, $w_1 \geq \theta A - t$ if the firm is to attract the high-ability worker. From the Lemma and the preceding analysis, $w_2 \geq W$ if the worker is to consider the firm committed to training. Because lower wages mean higher profits, $(\theta A - t, W)$ must be best.

Possibility 3: If neither type has his wage bid up, then lifetime compensation under the long-term contract offered by the firm must be at least $\theta A + A$ (because otherwise the firm could not attract the high-ability worker). Hence, the largest possible expected profit with training is

$$2\theta A + 2t - c - (\theta A + A) = 2t - c - (1 - \theta)A\,.$$

Because that amount is smaller than (2), the firm has no incentive to offer a long-term contract in which neither type has his wage bid up.

Possibility 4: Finally, if the firm hires only the low-ability worker, it must guarantee him lifetime earnings of θA. The largest possible profit with training is, thus, $2t - c - \theta A$, which is negative outside of Region I.

■

Turning, at last, to Region III:

Proposition 4 *If the parameter values lie in Region III; that is, there is great uncertainty over the worker's ability or the amount of dispersion to worker ability is large relative to the net returns on training, then there exists an equilibrium in which the firm hires both types of worker, but does not provide training. The contract offered by the firm in this equilibrium is the short-term contract* $w_1 = \theta A$.

Proof: The proof is nearly identical to the proof of Proposition 3. The only difference is that now (2) is a negative amount. Hence, the short-term contract $w_1 = \theta A$ is the best contract to offer. ■

When the net returns to training are small relative to the parameters of worker heterogeneity (*i.e.,* $2t - c < \theta(1 - \theta)A$), then those returns are too small to make training profitable. In order for training to occur, the firm must offer a long-term contract that commits it to train. But, in Region III, the cost of that commitment is so great, as to make it greater than the returns to training.

If the economy consists of firms and industries falling into all three regions, then one will see provision of general training by some firms, or in some industries, but not in others. In particular, one should expect to see general training

in firms or industries with an approximately homogeneous labor force or where the returns to training are large relative to the amount of dispersion in worker ability. Thus, this model explains both the provision and the under-provision of general training.

To summarize, when the net returns to training are large relative to the other parameters, training occurs in equilibrium. When those returns are small, training does not occur. Although the high-ability type never captures any of the surplus created by training, in some instances the low-ability type does capture some of the surplus. In terms of the firm's expected profit, Region I is the best — the firm attains the maximum possible expected profit — while Region III is the worst — the firm attains an expected profit of zero. Finally, the firm always offers a contract in which the high-ability type's wage is bid up.

The Worker Can Commit to a Long-Term Contract

Now, suppose the worker can commit to a long-term contract. Surprisingly, even though contracts can now be written in which the worker commits, the firm will not offer contracts in which the worker is asked to commit himself. Thus, commitment by the worker is not the answer to the problems identified in the previous sub-section.

Proposition 5 *In equilibrium, the firm never offers a long-term contract in which the worker is committed to stay (i.e., commits not to accept outside wage offers in the second period).*

Proof: From previous analysis, if the firm requires commitment, then the firm must offer lifetime compensation equal to $\theta A + A$ if it seeks to attract both types of worker; or θA if it seeks to attract only the low-ability worker (from Results 2 and 3, it is impossible for the firm to attract only the high-ability worker). If the firm seeks to attract both types, then its maximum expected profit is

$$2\theta A + 2t - c - (\theta A + A) = 2t - c - (1 - \theta A)\,.$$

From the analysis of the previous sub-section, for each region of parameter values, that is a smaller expected profit than generated by the equilibrium contract for that region. If the firm seeks to attract only the low-ability worker, then its maximum expected profit is $(1 - \theta)(2t - c - \theta A)$. Again, the equilibrium contracts identified in the previous sub-section yield greater profits. ■

The result that commitment by the worker does not mitigate the problem of under-provision of general training may strike the reader as odd. Yet this result arises for the same reason the firm wanted to allow the high-ability worker to have his wage bid up in the previous sub-section: Given the high-ability worker's "preference" for short-term contracts, the firm must adequately compensate him for committing to a long-term contract; that is, the firm must provide compensation at least equal to $\theta A + A$. However, because the firm cannot distinguish high ability from low ability, the firm would have to pay this high

level of compensation to the low-ability worker as well. That, however, is too costly. A less expensive way to compensate the high-ability worker for accepting a long-term contract is to exploit the screening potential of not requiring the worker to commit: The freedom to have one's wage bid up is more valuable to the high-ability worker than to the low-ability worker, thus granting the worker this freedom becomes a way to compensate the high-ability worker without having also to compensate the low-ability worker.

4 Discussion and Extensions

Theoretical Contribution

As discussed in the introduction, the idea that an informed party's preference for contract length can be used to screen different types of informed parties is a fairly general one and applicable to a variety of situations: Whenever two parties are asymmetrically informed, then they may be reluctant to enter into a long-term relationship. Specifically, when the informed party's private information is revealed over time, the informed party will be sensitive to contract length. If the informed party loses when the uninformed party (or the market) acts on the information it learns, then the informed party will prefer long-term contracts, as long-term contracts can prevent the uninformed party from acting on what it learns (or they can insulate the informed party from the market). Conversely, if the informed party benefits when the uninformed party (or the market) learns its information, then the informed party will prefer short-term contracts. If both types of informed party exist *ex ante*(*i.e.,* some win and some lose when their information is revealed), then the uninformed party may use (or attempt to use) contract length as a means of screening the two types.[28]

Clearly, this explanation for short-term contracts is not limited to the problem of general training. It also applies, for instance, to licensing agreements: Suppose a licensor knows the intrinsic value of its patent, α, while the licensee does not. Interpret the variable τ as investments which enhance the value of the patent (*e.g.,* development of accessories, popularizing the product, or inventing new uses for the product). Due to the asymmetric information about α, it is possible that the licensee will sign only a short-term license and make no investments in the patent. Another example is franchising, where asymmetric information about the franchisee or franchiser leads to short-term contracts, but under short-term contracts neither the franchisee or franchiser may have incentives to invest in the franchise for fear that their investment will be appropriated by the other party. In principle, this problem of asymmetric information leading to inefficiently short contracts can plague any long-term buyer-seller relationship.

The idea that the terms of a contract can convey private information is not unique to this article. To some extent it is the logical extension of the idea that

[28] Alternatively, the informed party may use contract length as a signal of its ability.

offers (*e.g.,* price bids) signal private information (see Wilson, 1987). This idea is also found in Aghion and Bolton (1987), who consider an incumbent monopolist who signals information through the terms of an exclusive dealing contract; in Spier (1992), who argues that asking for complete contracts can signal information; and in Aghion and Hermalin (1990), who argue that laws restricting the terms of private contracts, particularly provisions for limited liability and restrictions on damages for breach of contract, are necessary to prevent inefficient signalling. There are three features of this article that distinguish it from previous work. First, here it is the *uninformed* party who makes contract offers; thus, this article shows how asymmetric information distorts contracts in screening models. Second, this article addresses the important question of contract length.[29] Third, this article offers insights about human capital acquisition.

The idea that *ex ante* asymmetric information is what limits contract length distinguishes this article from other studies of contract length (Dye, 1985, and Harris and Holmstrom, 1987). In those articles, the parties sign short-term contracts because, as time passes, there is symmetric learning by both parties to the contract about some state.[30] In order to use new information, the parties limit the length of their contracts. In the present analysis, only one side learns over time, as the other side is fully informed at the outset. What determines contract length here is that the two types of informed player differ as to whether they want new information used — the good type (high-ability) does, while the bad type (low-ability) does not. Hence, contract length is determined by the uninformed player's attempt to exploit those differing preferences to screen the two types.

Worker Heterogeneity and Contract Length

In this article, long-term contracts are desirable because training will only occur under a long-term contract. Thus, to the extent the resulting adverse selection leads to short-term contracts, the presence of worker heterogeneity leads to an inefficient outcome (recall the net returns to training, $2t - c$, are positive by assumption).

The desire to have general training is only one of many reasons for long-term employment contracts. Another, identified by the implicit contracts literature (Baily, 1974, Azariadis, 1975, and Holmstrom, 1983), is the surplus created by insuring risk-averse workers against fluctuations in the spot-market wage. To see how adverse selection might undermine such insurance, consider the following simple model: Let α now be the *expected* spot-market wage for an α-type worker in the second period. Note that, even though first-period production reveals

[29] For extreme parameter values in Aghion and Bolton (1987), there is a separating equilibrium in which one type of monopolist offers a short-term contract and the other type offers a long-term contract. See Aghion and Bolton for a discussion of the relationship between their work and earlier versions of this article.

[30] Similar learning also explains why the *ability* to renegotiate a contract can be beneficial in some settings (see Hermalin and Katz, 1991, and Edlin and Hermalin, 2001).

the worker's type, there is fluctuation in the wage for workers of each type. Assume the worker is risk averse with per-period utility $u(w)$, and let $CE(\alpha)$ be the certainty equivalent for the random second-period wage for an α-type worker. Assume the firm is risk neutral. As is well known, under *symmetric information*, the worker would sign a long-term contract guaranteeing him a wage between $CE(\alpha)$ and α (the actual wage would depend on the relative bargaining powers of the worker and the firm). With *asymmetric* information, there is no equilibrium in which both types sign a long-term contract if

$$\theta A < CE(A)\,. \tag{3}$$

The reason for this is that the firm would never agree to a wage greater than θA and the high-ability worker would never agree to a wage less than $CE(A)$. Consequently, if expression (3) holds (as it would, *e.g.,* if the worker is not too risk averse or if there are relatively few high-ability workers), then the only equilibria would be pooling equilibria in which both types signed short-term contracts (no insurance is provided), or separating equilibria, in which only the low-ability worker signs a long-term contract.[31]

A third reason for long-term contracts is to restrict turnover in order to minimize hiring costs, insure workforce stability, and prevent employees taking clients or secrets.[32]

5 Conclusion

This article has offered an explanation for the under-provision of general training by employers. It did so employing a model that was flexible enough not only to explain the cases where training does not occur, but also to explain the cases where it does occur. In doing so, the article also offered an explanation for the prevalence of short-term contracts in employment relationships. The key to this explanation was the recognition that workers are heterogeneous with respect to ability and, thus, an adverse selection problem exists.

Worker heterogeneity creates different preferences over contract length. Able workers prefer contracts without long-term commitments, as they want to be free to accept higher outside wage offers when their ability is recognized. Consequently, to induce able workers to accept long-term contracts, firms must offer a high-level of compensation. However, firms cannot distinguish able workers from less able workers. Thus firms will, with positive probability, end up overpaying low-ability workers. This inability is costly for the firms, so they may ultimately prefer not to offer long-term contracts.

[31] The exact form of the equilibrium depends on the properties of the utility functions, how labor market competition is modelled, and the relative bargaining powers of the worker and the firm. Also, depending on how labor market competition is modelled, no equilibrium might exist for the reasons identified by Rothschild and Stiglitz (1976).

[32] The effect of worker heterogeneity on turnover costs has been explored, in a different framework by Salop and Salop (1976).

Unfortunately, without a long-term contract, firms will not be willing to provide training. Thus, as a consequence of worker heterogeneity, it is possible that no training will be provided. Whether training is provided depends on whether the costs incurred by long-term contracts are greater than the returns to training. The cost of long-term contracts increases with greater dispersion in worker ability and with greater uncertainty over worker ability; hence, if the amount of dispersion in ability is small or there is little uncertainty, then there is training in equilibrium. If those parameters are large, then there is no training in equilibrium.

This article also argued that this is a general insight: Asymmetric information creates a bias toward short-term contracts. Clearly, this has implications for a wide range of contracting problems, some of which were discussed. As noted, this insight is, in turn, part of an even broader proposition: When there is asymmetric information, the terms of a contract may be required to do "double duty"; not only are they used to set the terms of trade, but they are also used to convey information. As it is only the former duty, and not the latter duty, that determines efficiency, it becomes clear that with asymmetric information, one can no longer presume that private contracting will yield efficient outcomes.

Appendix

Proof of Lemma 1: Suppose not, that is $w_2 \leq t$ and the firm trains. Consequently, in the second-period, both types will have their wages bid up to equal their value. Thus, the firm's expected profit if it trains is

$$\theta A + t - c - w_1 \,. \tag{4}$$

Suppose first that $w_2 > 0$. If it deviates by not training, then its expected profit is

$$\theta A - w_1 + \min\{\theta A, \theta w_2\} - w_2 \,.^{33} \tag{5}$$

Comparing (4) with (5), the firm will train if and only if

$$t - c + w_2 \geq \min\{\theta A, \theta w_2\} \,. \tag{6}$$

If $A \leq w_2$, then (6) becomes $t - c + w_2 \geq \theta A$, but that cannot be given that the parameters lie outside of Region I and $w_2 < t$. If $A > w_2$, then (6) can be rewritten as

$$t - c + (1 - \theta) w_2 \geq 0 \,. \tag{7}$$

Maximizing the left-hand side of (7) over the domain $0 < w_2 < \min\{t, A\}$, yields

$$t - c + (1 - \theta) \min\{t, A\} \geq 0 \,.$$

[33] The "min" term arises because either $A \leq w_2$, in which case the firm overpays both types in the second period, or $A > w_2$, in which case the firm only overpays the low-ability type. In the first case, expected profit is $2\theta A - w_1 - w_2$, while in the second case, expected profit is $\theta A - w_1 - (1 - \theta) w_2$.

However, that condition cannot hold outside of Region I, thus (7) cannot hold either. Thus the firm will not train if $0 < w_2 \leq t$. If $w_2 \leq 0$, then expected profit if the firm does not train is $\theta A - w_1$, which, from (1), exceeds (4), thus the firm will not train if $w_2 \leq 0$. ■

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