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

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Key words: general training, adverse selection, contract length

Abstract

This paper argues that the existence of adverse selection (worker heterogeneity) explains the underprovision of general training by employers. High-ability workers value the option to entertain outside wage offers once their ability becomes known to the market. Thus, offering short-term contracts is a way to screen high-ability types from low-ability types. A firm is not willing to train workers under short-term contracts. Hence, despite the positive returns to training, training may be underprovided in equilibrium. More generally, this paper offers an explanation for the puzzling economic phenomenon of short-term contracts governing long-term buyer-seller relationships.

JEL Classification: 811, 026, 022

ADVERSE SELECTION, SHORT-TERM CONTRACTING, AND THE UNDERPROVISION OF ON-THE-JOB TRAINING¹

I. Introduction

General training is under-provided in the U.S. economy. This is the sentiment of the popular press, as well as the Commission on Workforce Quality and Labor Market Efficiency.^{2,3} 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.⁴ Apparently, then, some firms provide general training in equilibrium, while others do not.

Thus, 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

¹ This work is based on the first chapter of the author's Ph.D. dissertation, which was written with the financial support of the National Science Foundation and the Sloan Foundation. The author gratefully acknowledges the helpful advice of Michael Katz, David I. Levine, Michael Weisbach, Janet Yellen, and his dissertation advisors, Jean Tirole and Franklin M. Fisher.

² For example, see *Business Week*, September 19, 1988.

³ 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.

⁴ 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.

be tempted to under-provide training or provide low-quality training, since in these ways the firm can reduce its training costs.⁵

However, as I show, 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. Thus, to induce high-ability workers to accept a long-term contract, the firm must commit to paying a high level of compensation. However, as 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-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 paper go beyond providing an explanation for the under-provision of general training. The model also provides an explanation for why short-term contracts frequently govern long-term relationships: as

⁵ 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).

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 paper has the following organization. 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 III investigates the case of worker heterogeneity. Section IV discusses the results, suggests extensions and other applications, and relates this paper to other work in the field. Section V contains some concluding remarks.

II. The Model

Basic Assumptions

There are two parties to an employment relationship: a firm and a worker.⁶ The worker has innate ability α . For convenience, I assume α is drawn from the two-element set $\{0, A\}$, where $A > 0$.⁷ 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 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

⁶ 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.

⁷ An earlier version considered the case of a continuum of worker abilities and reached similar results.

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

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.^{8,9}

Also for convenience, I assume that τ can take only one of two values: 0 or t ,

⁸ 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.

⁹ 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.

$t > 0$.¹⁰ I assume the cost to the firm of providing training t is c . In order that the problem be interesting, I assume

$$t < c < 2t. \quad (1)$$

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, since in many situations, firms other than a worker's current employer cannot perfectly observe his productivity.¹¹ 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)).¹² concern that the incumbent employer would only let low-ability workers be bid away makes other firms

¹⁰ Two values is 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.

¹¹ 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".

¹² 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.

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.¹³

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.¹⁴

The assumption that the firm cannot directly observe the worker's ability 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.¹⁵

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 paid in period one and w_2 is the wage paid in period two. A short-term contract is a single wage,

¹³ This point is also made by Katz and Ziderman (1988), 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 10).

¹⁴ To be precise, the model is slightly changed 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.

¹⁵ 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.

w_1 , to be paid in the i th 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. 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, i.e., he can commit not to accept outside wage offers, or he cannot commit, i.e., he remains free to accept outside wage offers. Given the nature of U.S. 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; i.e., 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), this is not an unreasonable assumption to make here, since, 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.¹⁶

Finally, I assume that prior to first-period production the outside firms bid a wage equal to the worker's average ability; i.e., the outside offers the short-term contract, $w_1 = \theta A$.¹⁷

¹⁶ 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.

¹⁷ 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; i.e., 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

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 exists an equilibrium in which the worker signs with the firm and training is provided: the firm offers the long-term contract $(\hat{\alpha}, \hat{\alpha})$. As 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. As 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; i.e., 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 $2\hat{\alpha}$. As the outside would neither offer long-term, nor short-term, contracts that would yield him greater lifetime earnings, the worker signs with the firm in equilibrium.

To summarize:

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).

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 (e.g., $\hat{\alpha}+t$), the firm makes *not* training an expensive proposition: in the second period, the untrained worker will choose to stay with the firm (as his outside wage will be $\hat{\alpha}$); however, as the value of his work is only $\hat{\alpha}$, the firm will suffer a loss of $-t$ in the second period. Thus, to avoid that loss, the firm will provide training.

As in Becker (1975), the worker pays for his training by accepting a wage below his ability (e.g., $\hat{\alpha} - t$). 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.

III. 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

$$E\alpha + t - c - w_1$$

where $E\alpha$ denotes the expected ability of the worker in equilibrium. If it does not train, its profit is $E\alpha - w_1$. As $t < c$, 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 $\theta A + \alpha$, since he will receive θA in the first period and α , the value of his output, in the second period 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 an 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

I assume in this sub-section that the worker cannot commit to a long-term contract; i.e., he is free to accept outside wage offers. There are three different regions of parameter values to be considered:

I. $\min(\theta A, \theta t) \leq 2t - c$

II. $\theta(1-\theta)A \leq 2t - c < \min(\theta A, \theta t)$

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

Depending on the value of t , Region II may not exist.

Beginning with Region I:

Proposition 2: *If the parameter values lie in Region I; i.e., 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 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 the firm can hope for: because of offers from the outside, the worker is able to capture the expected value of his ability. Thus the firm has no incentive to deviate by proposing another contract. Finally, as neither type can do better going on the

outside, both types of worker are playing a best response by signing with the firm. ■

The reader may feel that it is unrealistic to assume the firm can commit to overpaying workers it does not train. To the extent that feeling is correct, then that is an argument against firms providing general training: from Result 1, 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. All things being equal, it is unclear why firms could not use these methods of commitment in the way required by the Becker-like solution.¹⁸

In terms of empirical implications, Proposition 2 says that one should expect to see training in fields such as accounting, where the returns to knowing accounting must be 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.¹⁹

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

¹⁸ Elbaum (1989) reports that some firms in the U.S. committed to paying bonuses to employees at the end of their training program.

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

short-term contracts.

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

Proposition 3: *If the parameter values lie in Region II; i.e., 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

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

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

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

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). Thus, 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 $\theta A + A - (2t-c)/\theta$. Since $A > (2t-c)/\theta$, 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 $w_1 = \theta A$): as 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, and, from the lemma and the preceding analysis, $w_2 \geq W$ if the worker is to consider the firm committed to training; since 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 $\theta A + A$ (since otherwise the firm could not attract the high-ability worker). Hence, the largest possible expected profit with training is

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

As that 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 . Thus the largest possible profit with training is

$$2t - c - \theta A,$$

which is negative outside of Region I.

■

Turning, at last, to Region III:

Proposition 4: *If the parameter values lie in Region III; i.e., there is great uncertainty over the worker's ability or the amount of dispersion in 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 then 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. Except for Region II, the same is true for the low-ability type.

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., committed 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 profit is

$$2t - c - \theta A$$

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; i.e., 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.

IV. Discussion and Extensions

Theoretical Contribution of this Paper

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.²⁰

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

²⁰ Alternatively, the informed party may use contract length as a signal of its ability.

uses for the product). Due to the asymmetric information about α , it is possible that the licensor 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 paper. To some extent it is the logical extension of the idea, found in bargaining under asymmetric information, that offers (e.g., price bids) *signal* private information (see Wilson (1987) or the various essays in Roth (1985)). 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 (1989), 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 important features of this paper that distinguish it from previous work. First, here it is the *uninformed* party who makes contract offers; thus, this paper shows how asymmetric information distorts contracts in *screening* models. Second, this paper addresses the important question of contract length.²¹ Third, this paper offers insights about human capital acquisition.

The idea that *ex ante* asymmetric information is what limits contract length

²¹ 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, related, work done by this author.

distinguishes this paper from other studies of contract length (Dye (1985) and Harris and Holmstrom (1987)). In those papers, the parties sign short-term contracts because as time passes there is symmetric learning by both parties to the contract about some state. 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. Thus 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 paper, 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; i.e., even though first-period production reveals 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, i.e.,

$$u(CE(\alpha)) = \mathbb{E}\left(u(w)|\alpha\right),$$

where $\mathbb{E}(\cdot|\alpha)$ indicates expectation over the spot-market wage given the worker's ability. 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

$$\theta A < CE(A). \quad (3)$$

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 (3) holds, as it would 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.²²

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.²³

V. Conclusion

This paper 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

²² The exact form of the equilibrium depends on the properties of the utility functions, how labor market competition is modeled, and the relative bargaining powers of the worker and the firm. Also, depending on how labor market competition is modeled, no equilibrium might exist for the reasons identified by Rothschild and Stiglitz (1976).

²³ The effect of worker heterogeneity on turnover costs has been explored, in a different framework, by Salop and Salop (1976).

to explain the cases where training does not occur, but also to explain the cases where it does occur. In doing so, the paper 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 over-paying low-ability workers. As that is costly for the firms, they may ultimately prefer not to offer long-term contracts.

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 paper 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

Suppose not, then $w_2 \leq t$ 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 profits if it trains are

$$\theta A + t - c - w_1 \quad (\text{A.1})$$

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

$$\theta A - w_1 + \min(\theta A, \theta w_2) - w_2 \quad (\text{A.2})$$

[The "min" term arises because either $A < w_2$, 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 profits are $2\theta A - w_1 - w_2$, while in the second case, expected profits are $\theta A - w_1 - (1-\theta)w_2$.] Comparing (A.1) with (A.2), the firm will train if and only if

$$t - c + w_2 \geq \min(\theta A, \theta w_2) \quad (\text{A.3})$$

If $A \leq w_2$, then (A.3) becomes $t - c + w_2 \geq \theta A$, but that cannot be since the parameters lie outside of Region I and $w_2 < t$. If $A > w_2$, then (A.3) can be rewritten as

$$t - c + (1-\theta)w_2 \geq 0 \quad (\text{A.4})$$

Maximizing the lefthand side of (A.4) over the domain $0 < w_2 < \min(t, A)$, yields

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

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

■

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