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Turnover, Wages, and Adverse Selection

by Charles T. Carlstrom

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Introduction

Worker mobility is necessary for the efficient operation of the labor market, so that the best matches can be found between workers and employers. Employers have only limited information about the abilities of each prospective worker, however. When making hiring decisions, they take the chance of employing a worker who does not have the skills (and thus the productivity) that was originally expected.

Both high- and low-productivity workers seek higher-paying jobs at any given time. The problem facing the employer is how to distinguish between the two. Low-productivity job searchers, of course, try to pass themselves off as high-productivity workers. The employer can discern a worker's true abilities only after the hiring decision has been made, however. Because of this asymmetrical information, workers' ability to change jobs and find the best match may be seriously impaired. Consequently, the labor market may not work efficiently.

This paper suggests that asymmetrical information can result in adverse selection. Adverse selection is a term coined by Akerlof (1970) to explain why the used-car market is dominated by "lemons." Car owners, he argues, often sell their vehicles because of poor performance or unreliability. Potential buyers realize the owner's motivation and pay less for a used car because of the likelihood of purchasing a lemon. The tendency is then reinforced for new-car owners to sell their vehicles only if they are unreliable. Thus, adverse selection can explain why a new automobile sells for considerably less as soon as it is driven off the showroom floor. In the case of the labor market, adverse selection comes about because low-productivity workers may change jobs in order to be confused with high-productivity job-changers.

A model of worker mobility based on adverse selection can help to explain several stylized facts of the labor market, particularly in regard to job turnover and wages. First, as Mincer (1984) shows, frequent job mobility among older workers results in lower wages. Second, while earnings for all workers tend to increase over time, older workers who quit generally experience zero or negative wage growth (Bartel and Borjas [1981]). Adverse selection can also help to explain why workers who have had a history of frequent job moves are more likely to move in the future.

For the same reason that lemons may dominate the used-car market, lower-productivity

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workers tend to be frequent job-changers. These workers will then have lower wages, on average, compared to infrequent job-changers. This can explain why mobility among older workers results in lower wages and why prior mobility can predict future mobility.

These empirical regularities are frequently explained by combining the concept of "firm-specific" human capital with the assumption that workers differ in their propensities to change jobs. Firm-specific human capital is knowledge that increases workers' productivity at their present firm, but that cannot be transferred to other firms. Thus, as a worker's tenure with the same firm increases, his or her firm-specific knowledge grows, pushing up his or her productivity.

Frequent job-movers would invest in less firm-specific human capital, since the knowledge they gain on the job would be forfeited after each job change. The argument is then that frequent job-movers would have lower average wages and flatter age-earnings profiles than infrequent job-changers. Consequently, infrequent job-movers would have a steeper age-earnings profile than would the frequent job-movers.

Arguments based on firm-specific human capital have some problems explaining these observations of the labor market, however. First, no reasons are given for the assumed difference in propensities among workers to change jobs. Second, the firm-specific human capital model cannot explain the relationship between wages and turnover in light of work by Salop and Salop (1976). They show that if a worker's propensity to move is not public information, then the infrequent job-changers would post bonds at firms in order to separate themselves from the frequent job-movers. The implication is that the wage rates for job-movers should be higher than those of job-stayers in the early part of their careers—an observation that is inconsistent with the findings of Bartel and Borjas.

Third, if a substantial number of firms require general rather than firm-specific human capital, then frequent movers would sort themselves into these firms. They thus would have steeper age-earnings profiles because they would bear the full cost of acquiring the general human capital. In firms with primarily firm-specific human capital, the costs would be shared by both the worker and the employer.

The adverse-selection model of labor mobility can help explain these empirical anomalies without relying on firm-specific human capital. Moreover, it provides a basis for examining the welfare implications of "lemons" (low-productivity workers) in the labor market. The model predicts that mobility is hampered because frequent moves can brand a person as a low-productivity worker. However, it is shown that government subsidies to increase mobility would be ineffective.

The model is developed in several steps. The basic assumptions are presented in section I. The first version of the model incorporates contingent wage contracting, which in effect allows firms to sort among workers according to productivity. In this case, it is shown that adverse selection is not a problem, since all workers are paid their expected output.

The remaining versions of the model exclude contingent wage contracts, which introduces the situation in which all workers receive the same wage, ex ante. This pooling of low- and high-productivity workers creates adverse selection, where the low-productivity workers are the frequent job-changers.

Example 2 of the model assumes that workers post no bonds, in which case the worker's wage in every period is the firm's estimate of his or her productivity. Next, example 3 allows bonding, which benefits high-productivity workers (the infrequent job-changers) and hurts low-productivity workers (the frequent job-changers). Bonds arise in order for firms to compete for the high-productivity workers. Finally, example 4 is a two-period model with bonding. This example is useful for discussing the welfare implications of the model, which are presented in section II.

I. Job Mobility and Adverse Selection

In the following model of the labor market, workers are assumed to live and work for three periods indexed by 1, 2, and 3. A three-period horizon allows the model to explain why workers who moved frequently in the past are more likely to move in the future. At the end of periods one and two, workers decide whether to continue working at their present job or to change jobs. Workers change jobs if the change raises the expected value of their future wages.

Productivity at a firm consists of a job-matching component, θ, and an individual-specific component, p. The labor contribution to production is represented by the simple linear relation $y = p + \theta$. A worker's base productivity level, p, is assumed to be constant across firms. The matching component, θ, varies across firms, so workers shop around in order to improve their job match. However, since only the workers know their own base productivity, p, firms cannot immediately observe whether a new worker changed jobs because he was a high-productivity worker with a bad job match or because he was

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a low-productivity worker wishing to be confused with a high-productivity job-changer.

The following restrictions are placed on the distributions of p and θ: p is assumed to be distributed on the interval $[p', p'']$ with a cumulative distribution function of $F(p)$ and a density function of $f(p)$; θ is assumed to be distributed on the interval $[-\theta', \theta'']$ with a cumulative distribution function of $G(\theta)$ and a density function of $g(\theta)$ with $E(\theta) = 0$. In addition, it is assumed that θ is independent both across individuals and across different jobs, and that p and θ are independently distributed random variables. Thus, a worker's current job match—or the quality of another worker's match—does not provide the worker with any information regarding his match at another firm. Similarly, a worker's productivity does not indicate which job or task he will be most productive in performing.

Prior to production, neither firms nor workers know what θ will be, although workers know their own productivity type, p. After one period, a worker's output at the firm, y, is assumed to be perfectly observable by both the worker and the firm. Furthermore, it is assumed that a worker's output at a firm is constant over time but cannot be observed by other firms.[1]

For simplicity, it is assumed that firms cannot observe an applicant's past wage rates. This ensures that workers who did not move after the initial period will not move in subsequent periods. The only reason a worker would want to move after the second period would be to find a better job match. He would not move after period two, however, because the incentive to search for a better match declines with age.

Example 1: Mobility and Wages With Contingent Wage Contracts

This section examines the model's properties in an economy with no restrictions on types of wage contracts offered, in order to show that the stylized facts of the labor market cannot be explained without adverse selection. The model predicts that workers will be paid their realized output, y, at the end of each period. This is called a contingent wage contract, because a worker's pay is contingent on his or her realized output in that period.

Since workers are risk-neutral, they are indifferent between accepting a wage equal to their base productivity level, p, or accepting a wage equal to their realized output, y. Contingent wage contracts in effect allow firms to sort among workers according to productivity. If workers are paid based on their output, the model collapses to a simple version of a standard job-matching model, in which workers move only to seek better matches.

Define $W_1(p)$ to be the value of future wage payments at the beginning of the first period for a worker with a base productivity level of p; define $V_2(y)$ to be the value of future wage payments at the beginning of period two for a worker who produced $y = p + \theta_1$ in the first period and decided not to move; and define $\lambda_2(p, \theta_2)$ to be the value of future wage payments for a worker who moved after the first period.

$$(1) \quad W_1(p) = p + \theta_1 + E_1 \max[\lambda_2(p, \theta_2), V_2(y)]$$

where

$$\lambda_2(p,\theta_2) = p + \theta_2 + E_2 \max[p + \theta_3, p + \theta_2]$$

$$V_2(y) = 2(p + \theta_1)$$

and

θ_i = match at ith firm,

E_t = expectation given the information at the end of period t.

$W_1(p)$ consists of the worker's first-period wage (the value of his productivity $p + \theta_1$) and either λ_2 or V_2, depending on whether he switches jobs after the first period. A worker switches jobs if $\lambda_2 > V_2$, but stays at his job if $\lambda_2 \leq V_2$. If a worker does not move after period one, he earns his output, $y = p + \theta_1$, in both periods two and three. A worker who moves after period one will earn $p + \theta_2$ in the second period and then either his output, $p + \theta_2$, if he stays and works at this firm again in period three, or p if he switches jobs once more. A worker who changes jobs after the first period will do so again if his output, $p + \theta_2$, is less than p (his expected wage if he moves). Thus, a worker who changes jobs after the first period does so again if $\theta < 0$. Figure 1 depicts a worker's wage based on whether he moves or stays at his firm after periods one and two.

The reservation output level for a p-productivity worker, $y^r(p)$, is defined to be the wage at which the worker is indifferent between staying and leaving, $V_2(y^r(p)) = E_1 \lambda_2(p, \theta_2) = \lambda_2(p)$. A worker stays at his present job if $p + \theta_1 > y^r(p)$. This definition implies the following

■ 1 This assumption is not crucial because observing a worker's output at a previous firm would give a potential employer a "noisy" signal of a worker's base productivity level.

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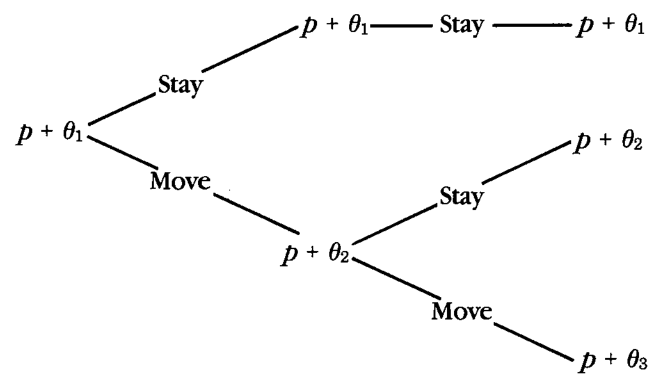
FIGURE 1

Possible Moves and Wages With Contingent Contracts



SOURCE: Author.

expressions for the expected values of W, V, and λ (where E denotes the expectations operator):

$$(2)\quad EW_1(p) = p + G(y^r(p)-p)\lambda_2(p) + (1-G(y^r(p)-p)) \times E(V_2(p+\theta_2 | \theta_2 > y^r(p)-p)$$

$$(3)\quad E\lambda_2(p) = p + G(0)p + (1-G(0))(p + E(\theta_2 | \theta \geq 0))$$

$$(4)\quad EV_2(y) = 2p.$$

The probability that a worker leaves after the first period, $\theta_1 < y^r(p) - p$, is given by $G(y^r(p)-p)$, since G is the cumulative distribution function of θ. Similarly, $G(0)$ is the probability that $\theta_2 < 0$ and is the probability that a worker will move after period two if he moved after the first period. The expected value of future wages for a worker who moved after the first period, $\lambda_2(p)$, is his expected wage in the second period, p, plus the product of his probability of moving again, $G(0)$, and his average wage if he moves again, p, plus the probability that he does not move, $(1-G(0))$, multiplied by his expected wage if he stays, $p + E(\theta_2 | \theta_2 \geq 0)$.

If we further assume that the θs are uniformly distributed over the interval $(-\theta', \theta')$, then the reservation output for a risk-neutral p-productivity worker with no search costs is $y^r(p) = p + \theta'/8$. The probability that a worker moves after period zero would then be $G(y^r(p)-p) = 9/16$, and the probability that a worker moves after period two, given he moved after period one, would be $G(0) = 1/2$. These separation probabilities are constant across workers, implying that adverse selection is not a problem. The reason is that, on average, workers are paid their expected output, p.

The example predicts that job-movers—those with the worst matches—earn lower wages. However, it cannot explain why these same workers have less future wage growth. Similarly, the driving force behind this result is the matching characteristic, which can explain the mobility of younger workers. However, it cannot explain the empirical evidence which suggests that older workers, but not younger workers, are hurt when moving.

Because most wage contracts are not contingent on a worker's future output, the remaining examples in this paper exclude contingent wage contracts. This introduces a pooling equilibrium, where, ex ante, all workers receive the same wage. The result is adverse selection, where the low-productivity workers are the frequent job-changers.

Adverse selection can explain why older workers are seemingly worse off after they move. Although a job-matching model is not realistic when considering the mobility of older workers, the assumption is maintained in order to ensure that some workers always change jobs. The matching component is not necessary for the following examples.[2] The next example examines the implications of the model excluding both contingent wage contracts and bonds, so that a worker's wage in every period is his expected output in that period.

Example 2: Mobility and Wages Without Contingent Wage Contracts and Bonds

The examples given in tables 1–4 assume that there are two types of workers, who can have three possible outputs at a firm. Half of the workers are high-productivity with $p = 2$; the rest are low-productivity with $p = 1$. The job-matching component is assumed to take on three values (–1, 0, or 1), each of which occurs with a one-third probability.

This example considers an equilibrium where no bonds are posted, that is, where a worker's wage in every period is the firm's estimate of his or her productivity. This implies that there will be a pooling equilibrium and that all workers will receive the same wage in the first period. With these assumptions, the solution given in tables 1 and 2 can be verified.

■ 2 See Greenwald (1986).

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TABLE 1

Mobility and Wages for a Low-Productivity Worker Without Bonding

	Period 1	Period 2	Period 3
Output at which a low-productivity worker is indifferent between moving and staying	$y^r(1) = 1.4$	$w_3 = 6/5$	—
Fraction of workers who move at end of period	2/3	2/3	—
Wages for a low-productivity worker who never moves	3/2	$y = 2$	$y = 2$
Wages for a low-productivity worker who moves only after period one	3/2	$w_2 = 4/3$	$y = 2$
Wages for a low-productivity worker who moves after both periods one and two	3/2	$w_2 = 4/3$	$w_3 = 6/5$

NOTE: w_2 = the second-period wage for workers who changed jobs after period one; w_3 = the third-period wage for workers who changed jobs after periods one and two.
SOURCE: Author.

The transition probabilities and wages given in tables 1 and 2 can be shown to solve the preceding problem. First assume that the separation rates in the tables are correct. They can then be used to verify the wages, w_2 and w_3. Given that the wages are consistent with the separation rates, it is then necessary to show that these wages imply the separation rates posited.

For example, if the reservation output for a high-productivity worker is 1.7, then he will leave his original firm if $y < 1.7$ or equivalently if $y_1 = 1$, which occurs one-third of the time. High-productivity workers who stay will earn their output, which is either $y = 2$ or $y = 3$. If a high-productivity worker moved after period one, he would move again if $y_2 < w_3 = 6/5$. This occurs one-third of the time, or when $y_2 = 1$.

Similarly, low-productivity workers will move two-thirds of the time given their reservation outputs. With these transition probabilities, we can calculate the wages of job-movers. Then, λ_2 and $V(y)$ can be calculated with these wages to verify that the reservation output for a low-productivity worker, $y^r(1)$, is 1.4, while the reservation output for a high-productivity worker, $y^r(2)$, is 1.7.

Notice that the low-productivity workers move twice as often as the high-productivity workers: two-thirds (one-third) of the low- (high-) productivity workers move after period one, while two-thirds (one-third) of those who moved previously move again after period two. This is a result of adverse selection.

Example 3: Mobility and Wages Without Contingent Contracts, Bonding Allowed

Because of the difference in mobility between high- and low-productivity workers, example 2 cannot be an equilibrium once bonding is allowed. Firms could earn positive profits by trying to compete for the high-productivity workers, since firms make money by employing these workers and lose money by employing low-productivity workers.

Because high-productivity workers move only half as often as low-productivity workers, firms try to attract the high-productivity workers by requiring incoming workers to post bonds that are paid according to their future mobility. Those who change jobs forfeit their bonds, while the job-stayers split the proceeds of the bonds.

Bonding implies that workers no longer earn their expected productivity every period: instead, they are paid less than their expected productivity in the first period of an employment contract, and make up for this loss in later periods. The amount of the bond is the difference between a worker's expected productivity and his wage during the first period of an employment contract. In later periods, a worker is paid more than his marginal productivity, the bonus being the difference between his wage and his expected productivity.

Bonding benefits the high-productivity workers—those who move infrequently—and hurts the low-productivity workers—the frequent job-movers. Because bonds offset some of the income gained by the low-productivity workers as a result of adverse selection, they redistribute income from the low-productivity workers to the high-productivity workers. Competition for high-productivity workers ensures that workers post bonds, although in equilibrium, bonding may not be sufficient to separate workers according to their respective productivities.

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TABLE 2

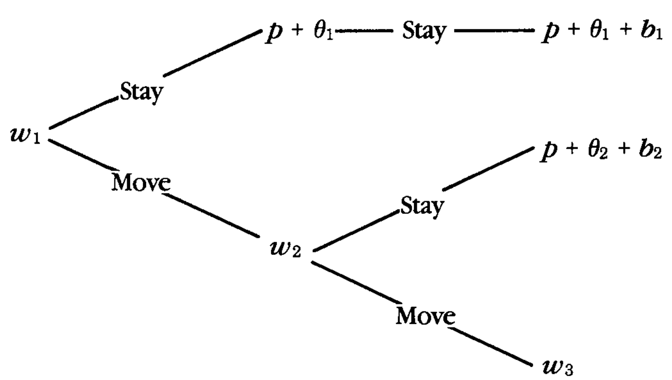
Mobility and Wages for a High-Productivity Worker Without Bonding

	Period 1	Period 2	Period 3
Output at which a high-productivity worker is indifferent between moving and staying	$y^r(1) = 1.7$	$w_3 = 6/5$	—
Fraction of workers who move at end of period	1/3	1/3	—
Wages for a high-productivity worker who never moves	3/2	$y = 2$ or 3	$y = 2$ or 3
Wages for a high-productivity worker who moves only after period one	3/2	$w_2 = 4/3$	$y = 2$ or 3
Wages for a high-productivity worker who moves after both periods one and two	3/2	$w_2 = 4/3$	$w_3 = 6/5$

NOTE: w_2 = the second-period wage for workers who changed jobs after period one; w_3 = the third-period wage for workers who changed jobs after periods one and two.
SOURCE: Author.

FIGURE 2

Possible Moves and Wages Without Contingent Contracts



SOURCE: Author.

Define b_1 to be the bonus paid to workers who did not change jobs after period one, and . define b_2 to be the bonus paid to workers who switched jobs after period one and stayed after period two. Figure 2 depicts a worker's wage based on whether he moves or stays at his firm after periods one and two. Given the structure of bonding as described above, tables 3 and 4 illustrate the solution for this example.[3]

Tables 3 and 4 are an equilibrium for this example, since a potential firm could never successfully compete for either a low-productivity or a high-productivity worker. The low-productivity workers are still being confused with the high-productivity workers and thus do better than they would if they admitted that they were low-productivity workers and were paid their expected output, 1, every time they moved and did not post any bonds.

It can also be shown that if the amount of the bond posted by workers changed, the high-productivity workers would be made worse off.[4] This is because the bonuses, b_1 and b_2, are the largest possible so that the high-productivity workers still move. (That is, b_1 and b_2 are chosen such that a high-productivity worker who produces an output of 1 would be indifferent between moving and staying.) If b_1 were increased, high-productivity workers would never move, even if they have a bad match, $\theta = -1$. If b_2 were increased, high-productivity workers would never move after period two and would be made worse off.

This example illustrates that adverse selection is present in the model, since two-thirds (one-third) of the low- (high-) productivity workers

■ **3** Since two-thirds (one-third) of the (low-) high-productivity workers move after period zero and again after period one, the expected productivity of a worker who changes jobs after the first period is [(2/3 x 1/2 x 1) + (1/3 x 1/2 x 2)] / [(2/3 x 1/2) + (1/3 x 1/2)] = 4/3; the expected productivity of a worker who changes jobs after both periods is [(2/3 x 2/3 x 1/2 x 1) + (1/3 x 1/3 x 1/2 x 2)] / [(2/3 x 2/3 x 1/2) + (1/3 x 1/3 x 1/2)] = 6/5; and the expected productivity of a worker in the initial period is simply [(1/2 x 1) + (1/2 x 2)] = 3/2. The wages reported in the text can be obtained as follows. In the first period, the probability that a worker stays at his present job is 1/2, therefore $w_1 = 3/2 - (1/2)_1 b_2 = 10/9$; similarly, the conditional probability that a worker changes jobs after the second period given that he changed jobs after the first period is 4/9, therefore $w_2 = 4/3 - (4/9)\,_o b_2 = 56/45$; and the wage for a worker who changes jobs twice is his expected productivity, $w_3 = 7/6$.

■ **4** Under the assumptions of this model, bonds cannot be made contingent on a worker's realized output. Bonds are allowed to be made contingent only on a worker's decision either to move or to stay at the firm. The more general case, when the bond can depend on y, has proven intractable. Intuition suggests that including this more general case would make it more likely that a separating equilibrium will exist, but if there is enough variability in the job-matching component, θ, then there will be groups of workers in which a pooling equilibrium will still result. The remainder of the paper maintains the assumption that the return on bonds cannot depend on y.

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TABLE 3

Mobility and Wages for a Low-Productivity Worker With Bonding

	Period 1	Period 2	Period 3
Output at which a low-productivity worker is indifferent between moving and staying	$y^r(1) = 1.0$	$w_3 - b_2 = 1.0$	—
Fraction of workers who move at end of period	2/3	2/3	—
Wages for a low-productivity worker who never moves	3/2 - 7/18 = 10/9	$y = 2$	$y = 2 + 7/9$
Wages for a low-productivity worker who moves only after period one	3/2 - 7/18 = 10/9	$w_2 =$ 56/45	$y = 2 + 1/5$
Wages for a low-productivity worker who moves after both periods one and two	3/2 - 7/18 =10/9	$w_2 =$ 56/45	$w_3 =$ 6/5

NOTE: w_2 = the second-period wage for workers who changed jobs after period one; w_3 = the third-period wage for workers who changed jobs after periods one and two.
SOURCE: Author.

move after period one, and two-thirds (one-third) of these workers move again after the second period. Wages for both job-movers and job-stayers increase over the life cycle, although at a slower rate for job-movers.

Notice also that the increase in wages for movers is not monotonic over time: it reaches a maximum in period one and drops off slightly in the last period. Workers who move twice continue to earn more in the last period of their working life than they did in the first period; however, their wages decrease with their last job move. This is consistent with the findings of Bartel and Borjas (1981), who determine that for older men a quit can have either a zero or a negative effect on wage growth.

The example also explains why prior mobility is an indicator of future mobility. The probability that a worker changes jobs in the first period is one-half, while the conditional probability that a worker changes jobs in the second period, given that he changed jobs in the first period, is five-ninths. In contrast, workers who did not move after the initial period will choose never to change jobs. The presence of movers and stayers results because low-productivity workers move more often than high-productivity workers.

The next example illustrates this result by a two-period example. The cost of using a two-period model is that the model can no longer explain why prior mobility is a good indicator of future mobility. The example helps illustrate how these results apply when workers have a continuum of different productivity types.

Example 4: Mobility and Wages in a Two-Period Example With Bonding

The following example is a two-period version of the model presented in example 3. Using the notation defined above, b is the bonus paid in the second period to job-stayers, while w_1 is the first-period wage for all workers and w_2 is the second-period wage for job-changers. In this example, p is allowed to vary continuously with the distribution function, $f(p)$. Thus, each worker has a different productivity level. In addition, we define Λ to be the fraction of workers who change jobs after the first period. Remembering that a worker will change jobs only if $\theta < w_2 - p - b$, Λ is determined as follows:

$$(5) \quad \Lambda = \int G(w_2 - p - b) f(p) dp.$$

The intuition behind this equation is simple. $G(w_2 - p - b)$ is the fraction of the p-productivity workers who change jobs after the first period. This fraction is then multiplied by $f(p)$, the proportion of all workers who have a productivity of p. Summing this product over all productivity types gives the average mobility rate of workers.

The second-period wage for job-movers is determined similarly:

$$(6) \quad w_2 = \int p G(w_2 - p - b) f(p) dp / \Lambda.$$

The intuition behind this equation is similar to that given above. $G(w_2 - p - b) f(p)/\Lambda$ is the fraction of job-movers who have a productivity of p. Multiplying by p and summing over all workers gives the average productivity, or the average output, of a job-changer.

The following example assumes that the matching component, θ, and the individual productivity component, p, are both uniformly distributed: $\theta \sim [-\theta', \theta']$ and $p \sim [p', p'']$. Fol-

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TABLE 4

Mobility and Wages for a High-Productivity Worker With Bonding

	Period 1	Period 2	Period 3
Output at which a high-productivity worker is indifferent between moving and staying	$y^r(1) = 1.7$	$w_3 - b_2 = 1.0$	—
Fraction of workers who move at end of period	1/3	1/3	—
Wages for a high-productivity worker who never moves	3/2 - 7/18 = 10/9	y = 2 or 3	y = 2 + 7/9 or 3 + 7/9
Wages for a high-productivity worker who moves only after period one	3/2 - 7/18 = 10/9	w_2 = 56/45	y = 2 + 1/5 or 3 + 1/5
Wages for a high-productivity worker who moves after both periods one and two	3/2 - 7/18 = 10/9	w_2 = 56/45	w_3 = 6/5

NOTE: w_2 = the second-period wage for workers who changed jobs after period one; w_3 = the third-period wage for workers who changed jobs after periods one and two.
SOURCE: Author.

lowing example 3, a candidate equilibrium for this example is a pooling equilibrium (where all workers are treated identically ex ante), which maximizes the returns to the highest-productivity worker. Competition for the high-productivity workers, whom firms earn profits by employing, ensures that a pooling equilibrium is obtained by choosing a wage-bonus package (w_1, b) to maximize the expected return of the highest-productivity worker.

$$(7)\quad \max_{w_1, b} \{w_1 + E\max[p'' + \theta + b,\ w_2]\}$$

such that

$$(1)\ w_1 + (1-\Lambda)b \leq E(p)$$

$$(2)\ \Lambda = \int G(w_2 - p - b)f(p)dp$$

$$(3)\ w_2 = \int pG(w_2 - p - b)f(p)dp/\Lambda.$$

Carlstrom (1989) shows that the problem satisfies

$$b = w_2 - p'$$

If we further assume that p is uniformly distributed between 1 and 2, the corresponding prices and quantities are

$$\Lambda = 1/2 - 1/4\theta',$$
$$b = (3\theta'-2)/(6\theta'-3),$$
$$w_1 = 3/2 - (1-\Lambda)b,$$
$$w_2 = (9\theta'-5)/(6\theta'-3),$$
$$G(w_2 - p - b) = 1/2 - (p-1)/2\theta', \text{ and}$$
$$\Lambda = 1/2 - 1/4\theta'.$$

The above equations indicate that the more disperse θ is (with respect to p), the less important adverse selection is. Increasing θ' raises the wage rate of job-changers and workers' mobility. The reason is straightforward: increasing the variance of θ diminishes the impact of adverse selection, since it increases the incentives for all workers to change jobs. When more workers change jobs, the probability that job-changers are "lemons" is reduced.

Carlstrom also shows that an equilibrium for this example exists if there is enough adverse selection in the labor market, that is, if $\theta' \geq 1$. If we restrict $\theta' = 1$, the corresponding prices and quantities are

$$\Lambda = 1/4,$$
$$b = 1/3,$$
$$w_1 = 5/4,$$
$$w_2 = 4/3, \text{ and}$$
$$G(w_2 - p - b) = 1 - p/2.$$

Notice that the example is consistent with the stylized facts; workers experience a wage increase when they change jobs, yet they earn less over time than job-stayers who earn their output, y, plus their bonus, one-third.

The following section uses this example to discuss questions of optimality.

II. Welfare Implications

Example 4 illustrates another aspect of the model: in equilibrium there is less job mobility than occurs in a world with perfect information. This is not true for all workers, however. High-productivity workers move less often than they would in a world without adverse selection, while low-productivity workers may or may not move less often. There are two reasons for this effect, both of which are due to adverse selection. The

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first is identical to that in Akerlof's "lemon" model: adverse selection reduces the future wages for workers when they move and thus reduces the incentive to move. The second effect is due to the posting of bonds in equilibrium, which further reduces the incentives for mobility.

The results of this section are shown with a two-period model, assuming that θ is uniformly distributed. For most of the results, these assumptions can be relaxed. Without bonds, the probability that a worker with a productivity, p, will change jobs is $G(w_2 - p)$; the average probability that a worker changes jobs is $E\{G(w_2 - p)\} = G(w_2 - E(p)) < G(0)$, where $G(0)$ is the probability that a worker would change jobs in a model without adverse selection. The posting of bonds accentuates this effect. In example 4, the unconditional probability that a worker moved was one-fourth, with the lowest-productivity worker moving half of the time, and the highest-productivity worker never moving.

Since mobility is lower in this example than in a model with complete information, it is natural to ask whether a government could increase welfare by subsidizing mobility. An example of such a government subsidy is unemployment insurance. However, since there is no unemployment in the model, unemployment insurance cannot be analyzed. Instead, this paper models unemployment insurance, which decreases the costs of moving, as a subsidy to the wage of job-movers. It therefore asks whether a government can achieve a Pareto improvement by subsidizing the wages of job-movers. Because a government does not have superior information about a worker's productivity, the answer is no.

Subsidizing mobility would not benefit the highest-productivity workers, so taxing them to pay for this subsidy would make them worse off. However, a stronger welfare result can be proven in this model. That is, a government cannot tax first-period wage income to subsidize the wages of job-changers in order to increase aggregate welfare.[5] In fact, it is shown that if a government subsidized the wages of job-movers, there would be no effect on the equilibrium allocations. With a subsidy of s, the equilibrium prices and allocations from the second example are

(8) $b = w_2 - p'$,

(9) $\Lambda = \int G(p' - p)f(p)dp$,

(10) $w_2 = \int pG(p' - p)f(p)dp / \Lambda$, and

(11) $w_1 = E(p) - (1 - \Lambda)b$
$= E(p) - (1 - \Lambda)(w_2 - p')$.

To verify that subsidizing w_2 by s and taxing first-period income by Λs has no real effect, consider the above equations. Assuming the wage paid to job-movers by firms, w_2, did not change, then from (8) the equilibrium amount of the bonus would increase by s (or bonds would increase by $(1 - \Lambda)s$). In other words, the amount of the bonus paid to the job-stayers would change one-for-one with the subsidy on w_2, leaving mobility the same and thus implying (and verifying the assumption) that the wage paid to job-movers, w_2, remains the same. Therefore, second-period income would increase by s for both movers and stayers, and first-period income would decrease by s. The following are the new equilibrium allocations:

(8′) $b' = w_2 + s - p'$,

(9′) $\Lambda = \int G(w_2 - p - b)f(p)dp$
$= \int G(p' - p)f(p)dp$,

(10′) $w_2 = \int pG(w_2 - p - b)f(p)dp / \Lambda$
$= \int pG(p' - p)f(p)dp / \Lambda$, and

(11′) $w_1 = E(p) - (1 - \Lambda)b'$
$= E(p) - (1 - \Lambda)b - s$.

Quick inspection of equations (8)–(11) and (8')–(11') shows that subsidizing mobility affects neither mobility, (Λ), nor total wages over time. Mobility stays the same, while wages in the first period for all workers decrease by the subsidy, and net wages in the second period increase by the subsidy. The intuition behind this result is straightforward. Subsidizing mobility benefits the frequent job-movers—the low-productivity workers. In a pooling equilibrium, however, the returns to the highest-productivity workers are maximized. The amount of the bond that would be posted in equilibrium would change one-for-one with the amount of the taxes to eliminate the effects of the government's action.

■ **5** This is in contrast to the welfare implications of Akerlof's model, where a government could subsidize the trading of cars and increase aggregate welfare in the sense that owners of the low-quality cars would gain more than owners of the high-quality cars would lose.

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III. Conclusion

Adverse selection is thought to be prevalent in many markets. This paper argues that adverse selection may also be important in the labor market. It can explain why wages tend to increase as workers get older, except for frequent job-movers, whose wages may actually decrease in later years. It also can explain why older workers who move frequently have lower average wages than do infrequent job-changers. Job-movers earn low wages because frequent mobility brands them as low-productivity workers. This effect then decreases the incentives for workers to change jobs.

Thus, adverse selection may seriously impair the ability of workers to change jobs and can interfere with the efficient operation of the labor market. Because of this market failure, it is natural to ask whether a government action to subsidize mobility can reduce the severity of adverse selection and improve the functioning of the labor market. However, it is shown that such a government action will have no real consequences. The reason is that bonds arise in the model in order for firms to compete for the high-productivity workers. Subsidizing mobility hurts the infrequent job-movers (the high-productivity workers), leading firms to increase the amount of bonds required by incoming workers. This increase in bonding offsets the subsidy given to job-movers, leaving the government action ineffective.

The paper also suggests that adverse selection will not be a problem for job-changers if they are paid a piece rate or with a contingent wage contract. Recent actions by firms to pay their workers bonuses and stock options may ease the impact of adverse selection. Future work is needed to address whether these types of contracts are arising as a result of adverse selection and whether these contracts may lead to a more fluid and efficient labor market.

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