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WORKERS' TRUST FUNDS AND THE LOGIC OF WAGE PROFILES

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ABSTRACT

This paper defines a concept, a worker's trust fund, which is useful in analyzing optimal age-earnings profiles. The trust fund represents what a worker loses if dismissed from a job for shirking. In considering whether to work or shirk, a worker weighs the potential loss due to forfeiture of the trust fund if caught shirking against the benefits from reduced effort. This concept is used to show that the implicit bonding in upward sloping age-earnings profiles is not a perfect substitute for an explicit upfront performance bond (or employment fee). It is also shown that the second-best optimal earnings profile in the absence of an upfront employment fee pays total compensation in excess of market clearing in a variety of stylized cases.

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I. INTRODUCTION

This paper concerns the logic of age-earnings profiles and worker incentives. Alternative wage profiles yield different incentives in principal-agent models with the employer as principal and the employee as agent. This paper introduces the concept of workers' trust funds (as will be explained presently) and shows the relevance of this concept in analyzing a standard efficiency wage model.

In the most popular efficiency wage model, firms find it profitable to pay wages above market clearing to provide workers with effort incentives.[1] These models have been criticized because contracts in which workers pay employment fees (alternatively called upfront bonds) would eliminate involuntary unemployment (Carmichael, 1985). The threat of forfeiting the bond generates work incentives allowing the total terms of the equilibrium labor contract to adjust to clear the labor market. Such upfront bonds are rarely observed; but, it has been argued that contracts with upward sloping earnings profiles can act as a perfect substitute for contracts with explicit upfront bonds. Thus, the argument continues, the absence of upfront bonds is not a sign of the failure of market clearing.

To test the logic of the preceding argument, we assume that contracts cannot utilize upfront bonds. It will be seen that the second-best contract with an upward sloping wage profile cannot be a perfect substitute for the first-best contract with an upfront bond. Consider the work-shirk decision of a worker facing an upward sloping (but market clearing) compensation profile. This worker can be viewed as having a trust fund of deferred wages and accrued interest which is maintained by the firm. This trust fund will be forfeited

if the worker is caught shirking and dismissed. In a continuous time setting, the value of this trust fund to a risk neutral worker at time T (where time 0 is the start of the contract) is

$$(1) \qquad \int_0^T (w^*(t) - w(t))\, e^{r(T-t)}\, dt$$

where $(w^*(t) - w(t))$ is the difference between the worker's opportunity cost and current wage $w(t)$ at t, and where r is the interest rate. This trust fund is the accumulated value of the worker's deferred wages including accumulated interest.

The worker in deciding whether to work or shirk compares the expected loss if caught shirking to the expected gain from shirking. Suppose that a worker who shirks for a short interval of length dt will be caught and lose his trust fund with probability p dt, and let v dt be the monetary value to the worker of shirking for such an interval. In this case, the worker will work at time T if

$$(2) \qquad p\, dt \left[\int_0^T (w^*(t) - w(t))\, e^{r(T-t)}\, dt \right] \geq v\, dt.$$

In other words, if the expected cost of shirking, the probability of being caught (p dt) times the value of the trust fund forfeited (the term in brackets in (2)), is at least as great as the expected gain from shirking, v dt, he will work. Rearranging terms, one can easily verify that the worker will work only if the value of his trust fund exceeds (or equals) v/p. Note that v/p is a stock, and not a flow. (To induce the worker to work for an instant of length dt, he must incur a loss if caught shirking which exceeds the ratio of the gain

from shirking to the probability of being caught shirking. The gain from shirking for an instant of length dt (v dt) and the probability of being caught shirking (p dt) are both proportional to dt and small. The ratio of these two quantities, which is the size of the loss necessary to induce the worker not to shirk, is an order of magnitude larger than either since the dt's cancel in the ratio.)

The trust fund concept can be used to explain why market clearing contracts that use upfront bonds and those that use only implicit bonds through deferred payments are not perfect substitutes. The risk neutral worker who posts an upfront performance bond of v/p or larger (and who is paid his opportunity cost throughout his job tenure) will never shirk. However, with a market clearing compensation package based on implicit bonding, no matter how low the (nonnegative) wage paid to the worker early in his job tenure, it will take some finite time before the accumulated trust fund has reached the stock level v/p. (There is a bound on how fast this trust fund can accumulate if there can be no <u>net</u> payments from the worker to the firm). And, as a result, with implicit bonds and a market clearing wage package, there is some period of time before the trust fund accumulates sufficiently to induce the worker not to shirk. During that time the worker will shirk rather than work. In other words, if a firm offers an employment package that does not require an upfront bond and is no better than a worker's opportunity costs, a worker will surely shirk at the beginning of his (or her) career: there is no capital loss to the worker from losing the job, but there is a gain due to the smaller effort in shirking.

We have thus seen the flaw in the commonly held belief that market clearing upward sloping wage profiles, in the absence of explicit upfront bonding, can act as an incentive against shirking throughout a worker's career. While such deferred payments can prevent workers from shirking late in their careers, they do not prevent workers from shirking early in their careers.[2] It remains, however, to show that paying a premium above market clearing wages will be a cheaper way to hire effective labor units than paying market clearing wage levels with workers shirking early in their careers. Such a proposition is not true in general. But with a rather wide variety of productivity patterns, the cost of shirking by workers early in their careers with market clearing wage schedules will be greater than the cost of paying wage premia in excess of market clearing which prevent workers from shirking entirely.

The next section constructs a simple model to illustrate why labor markets fail to clear in the absence of employment fees even in markets where firms are trustworthy. In this model, workers have discretion over their own effort and firms have imperfect abilities to monitor shirking. The model is the continuous time analogue of the Becker-Stigler bonding model (Becker and Stigler, 1974) and is closely related to the Shapiro-Stiglitz efficiency wage model (Shapiro and Stiglitz, 1984).[3] Relative to Becker and Stigler, we add one restriction; we do not permit upfront performance bonds (or entrance fees) to be paid by a worker at the beginning of a labor contract. Relative to Shapiro and Stiglitz, we model workers with finite horizons (rather than infinite horizons), and, assume

employers are honest and can commit not to falsely claim malfeasance and dismiss a nonshirking worker.

This paper thus presents a synthesis between bonding models and efficiency wage models. When the models are set up symmetrically, it turns out that the difference between the two models lies in the assumed presence or absence of upfront bonds.[4]

II. BASIC MODEL

A. The Model's Assumptions

The following assumptions fully describe the model.

Time

1. A worker has a work career beginning at time 0 and ending at time n.

2. Time is continuous in the model.

The Work-Shirk Decision and its Consequences

3. At each point of his career, the worker has a decision whether to work or to shirk. The worker makes this decision at each point of time to maximize expected lifetime utility.

4. A worker who shirks will supply 0 units of effective labor to the firm. A worker who works will supply e^* units of effective labor to the firm.[5]

5. e^* is constant throughout the worker's career.

6. The monetary value of shirking to the worker for the short length of time dt is v dt.

The Monitoring Process and Worker Discipline/
Firm Honesty in Dismissal

7. A worker who shirks for the period dt is detected by the firm with probability p dt.

8. A delay cannot occur between observation of shirking and a worker's consequent dismissal.

9. Firms are totally honest in their dismissals. Workers are never dismissed unless caught shirking.

Alternative Opportunities for Workers

10. A worker has outside opportunities which pay a constant wage w^*, for $0 \leq t \leq n$. It is convenient to think of these alternative opportunities as the secondary labor market.

11. Upon leaving the firm at t, the worker can immediately earn $w^*(t)$.

Workers' and Firms' Utilities and Discount Rates

12. Both firms and workers are risk neutral.

13. Both workers and firms have a zero rate of discount.

14. Workers are homogeneous.

Restrictions on Compensation Schedules

15. Workers do not pay firms an explicit bond or fee upon joining the firm. In other words, there are no net payments by workers to firms.

B. Derivation of the Optimal Wage Path

The firm in this model wishes to purchase labor efficiency units at minimum unit cost. We shall show that the cost minimizing wage package involves total payments whose sum is $w^*n + v/p$. The alternative opportunities (which are freely available to a worker) pay a lifetime total of w^*n. Thus, total remuneration from the cost

minimizing package is in excess of the total remuneration in the secondary labor market by v/p.

It is intuitive that the firm will lose nothing by paying all of the worker's remuneration at the worker's retirement date. This way the firm's expenditure on worker remuneration will do the most work in inducing workers not to shirk. At each point in his career, the worker has the inducement not to shirk of the payment at the end of his career which is only received if he is never caught shirking.

Given that we need only consider compensation schemes in which all payments are made at the end of the worker's career, it is only necessary to discover the optimal total remuneration over the worker's lifetime. The worker must be paid at least w^*n at the end of his career in order to be induced to join the firm. Suppose that the worker is paid $w^*n + x$. What is the optimum value of the premium (x) paid to the worker above the market-clearing wage stream whose lifetime value is w^*n?

Given that the firm is paying the worker $w^*n + x$ at the end, we can view the worker's choice problem in the following way. Suppose a worker has not previously been caught shirking at time t. He may choose to shirk over the interval t to $t + dt$. This policy has the gain $v\,dt$ due to the added utility from shirking. However, if the worker gets caught shirking, his total compensation will be $w^*(n - t)$ from future earnings in the secondary sector rather than the $w^*n + x$ available at his firm for someone never caught shirking. Consequently, if the worker plans to work from time $t + dt$

to n, his potential gain from shirking is $v\,dt$, and his potential loss is

$$p\,dt((w^*n + x) - w^*(n - t)) \tag{3}$$

which simplifies to $p\,dt(w^*t + x)$.[6] At the point T where the worker is just at the margin between working and shirking, we have

$$p\,dt(w^*T + x) = v\,dt. \tag{4}$$

At later times, it will be more costly for the worker to be caught shirking, and therefore the worker will work. And at earlier times it is less costly to be caught shirking and therefore the worker will shirk.

As described above, equation (4) suggests the simple analogy of the trust fund which underlies much of the logic of our argument. We can pretend that the firm sets up a trust fund for its workers. It puts up x in the beginning when the worker is initially hired and later puts money into the trust fund at rate w^*. At each point in time t, the worker must decide whether to shirk, with the ill consequence that he may be caught with probability $p\,dt$ and give up the accumulated trust fund of amount $w^*t + x$. The potential gain from shirking is $v\,dt$. Consequently the worker is just indifferent between working and shirking at time T_x for which

$$p\,dt\,[w^*T_x + x] = v\,dt. \tag{5}$$

What is the optimal value of x given that T_x obeys (5)? Equation (5) yields the value of T_x for each x,

$$T_x = \max((v/p - x)/w^*, 0). \tag{6}$$

The firm's problem is to choose x to minimize unit labor costs which are given by

$$\frac{w^*n + x}{(n - T_x)e^*} = \frac{w^*n + x}{(n - [(\frac{v}{p} - x)/w^*])e^*} \tag{7}$$

over the range $0 \leq x \leq v/p$. It is easily shown that expression (7) is minimized over this range if $x = v/p$, since the derivative of (7) with respect to x is negative for all x in the range $0 \leq x \leq v/p$.

As a result, the optimal (cost minimizing) wage package will pay a premium $x = v/p$. This implies $T_x = 0$. There is never any shirking under the optimal compensation profile and the firm makes total career payments of v/p in excess of the market.

An explanation for this solution proceeds as follows. For a worker <u>ever</u> to work, at the last instant worked he or she must receive a surplus of at least v/p. This v/p constitutes a fixed cost to the firm. At all previous moments worked, the worker must also have a surplus of at least v/p, so that the firm pays a minimum to the worker of $w^*t_w + v/p$ for working a length of time t_w. By paying $w^*n + v/p$ at the end of the worker's career, the firm spreads the fixed cost v/p over the maximum working time (the worker's whole career n) and therefore unit labor cost is minimized.[7]

It has been seen that in the case without discounting that a firm which minimizes its unit labor costs in the presence of a shirking problem and without the ability to collect upfront employment fees from workers will pay a career wage that exceeds the alternative career earnings available to workers in the secondary sector by v/p. Upward sloping wage profiles cannot fully substitute for explicit employment fees in such a model. Only after the trust fund has an accumulated value v/p will the worker stop shirking. And if "bonding" occurs by workers' initial receipt of wages below the secondary sector level, it takes too long for the worker to stop shirking if total lifetime wages paid out are at the market clearing level. It is better instead for the firm to pay an efficiency wage premium of v/p in excess of market clearing at the end of the worker's career and prevent shirking altogether.

Remark:

The model above has only one type of job for workers in the primary sector. If jobs differ according to the ease of monitoring, a firm's optimal strategy is to assign younger workers (recent hires) to more easily monitored jobs. Indeed, if there are enough productive jobs with costless monitoring, the equilibrium contract will be market clearing with workers placed in jobs with no shirking potential early in their careers and moved to more responsible jobs once their trust funds have built up sufficiently.[8]

III. EXTENSIONS OF THE RUDIMENTARY MODEL

A longer paper (Akerlof and Katz (1987)) explores in some detail each of seven extensions of the rudimentary model of the previous

section. The logic of each of these extensions conforms to the analysis of the previous section. Here we will only give a brief summary of these extensions.

1. Positive Discount Rates. In the previous model the discount rate is zero. Adding a positive discount rate does not alter the previous result regarding the desirability of wage premia. The analysis with positive discount rates is exactly analogous to the analysis with zero discount rates.

2. Growing Worker Productivity. In the rudimentary model workers have constant productivity. If workers have low productivity in the early part of their careers then it does not much matter to firms if they shirk in that part of their careers. As a consequence, if worker productivity is growing sufficiently fast over workers' careers, firms' best strategy will let workers shirk in the early part of their careers while their trust funds are building up, and it will not be optimal to pay a wage premium.

3. Endogenous Productivity Gains. The argument of the preceding paragraph relating productivity gains and wage premia assumes, however, that working workers and shirking workers are alike in their productivity gains. According to a more natural assumption workers only have increasing productivity insofar as they are not shirking. In this case it is particularly important to avoid shirking early in workers' careers, and it can be shown that wage premia are again the second-best optimal policy.

4. Positive Output by Shirking Workers. In the rudimentary model shirking workers produced zero output. Kevin M. Murphy has suggested a change in our model which permits workers to accumulate an implicit bond in the form of output even if explicit upfront bonds are prohibited. The modification is to suppose that shirking workers supply e_o efficiency units where e_o is strictly positive (rather than zero as assumed in our basic model). If the work horizon (n) is sufficiently long, in the profit maximizing contract firms will pay workers a zero wage until retirement and a payment of nw^* at retirement. A worker will shirk producing effort e_o until the value of his or her trust fund reaches v/p. Thereafter the worker will work producing effort e^*. I_n this case, the firm will minimize labor costs by allowing workers to shirk early in their careers and dissipating all worker rents with a market clearing compensation package. Such solutions with workers receiving market clearing compensation packages and shirking early in their careers are sensitive to our extreme assumption that workers are willing to accept zero wages at the beginning of their careers provided lifetime remuneration is sufficient. If workers must be paid at each instant a wage higher than the shirking productivity level e_o, a trust fund of v/p can never be accumulated by shirking workers. Furthermore, since many forms of shirking may cause large damages to firms (e.g., the examples discussed in Mars (1982)), the assumption that shirking workers produce e_o less than or equal to zero may not be unrealistic. Other reasons for efficiency wages such as the effect of higher wages

in facilitating recruiting and reducing turnover are added reasons why firms will not dissipate all ex-ante rents in this fashion.

5. Higher Discount Rates for Workers Than Firms. In the rudimentary model workers and firms have the same discount rate. If workers have a higher discount rate than firms, the second best optimal policy will not pay workers at the end of the contract, but rather pay a steady stream of wages over their working career with a lump sum payment at the end.[9] This strengthens the argument in favor of wage premia at retirement, because the trust fund builds up more slowly when wages are being paid out. Consequently, in the absence of wage premia paid to workers at retirement workers' relative myopia makes the period of shirking longer. Thus higher discount rates for workers than firms increase the unit cost of effective labor when no wage premia are paid and as a result, make it relatively more advantageous to pay wage premia.

6. Endogenous Monitoring. The rudimentary model assumed that the probability of catching a worker shirking in the interval t to $t + dt$ was fixed at $p\,dt$. It is surprisingly easy to extend the model to the case where the probability of catching the working shirking is proportional to the monitoring cost. An optimal time dependent path for p can then be derived. Workers late in their careers, who have more to lose, will be monitored less closely. Again wage premia will be paid.

7. Stigma and Moving Costs. If workers' employment histories can be observed by potential employers, workers fired for shirking

may be stigmatized and have a more difficult time gaining reemployment or be offered reduced wages. They may also incur moving costs. If the cost of stigma (or moving costs) is denoted s, the worker will begin working when the value of his trust fund exceeds v/p - s. If s exceeds v/p, market clearing wages will be paid. If s is less than v/p, the presence of this stigma (or moving costs) will not affect the decision whether to pay wages in excess of market clearing or to let workers shirk until their trust funds are sufficiently large to induce working.

IV. CONCLUSION

A method has been proposed to analyze dynamic wage paths in the second-best optimal case where for some reason or other workers cannot or will not post upfront performance bonds or pay employment fees to gain jobs. Surprisingly, in a wide variety of cases these second-best contracts without performance bonds involve wage premia above the market clearing level of wages.

Bonding models, such as in Becker and Stigler (1974), make the unrealistic prediction that firms utilize employment fees or upfront bonds to clear the labor market. Efficiency wage models with untrustworthy firms and infinitely lived workers, such as in Shapiro and Stiglitz (1984) and Bulow and Summers (1986), yield the counterfactual prediction that firms cannot utilize deferred compensation mechanisms. On the other hand, the model analyzed in this paper matches the observation that firms do not make workers post upfront bonds but do utilize pensions and other deferred payment schemes.

Finally, we emphasize the justification for our assumption of the absence of upfront bonds and employment fees. We have made this assumption to explore the importance of upfront bonds for market clearing when worker moral hazard problems are present. This paper has demonstrated the importance of this assumption: in the absence of upfront bonds, simple models of work incentives may not yield market clearing. Why? Because with market clearing compensation profiles workers will shirk until the time when the value of their trust fund equals v/p. With many plausible career productivity patterns, firms will find it less costly to prevent shirking throughout a worker's career by paying a premium v/p above the market clearing level than to suffer the lower output generated by workers shirking early in their job tenures.

FOOTNOTES

1. Models of this type have recently been examined by Bowles (1985), Bulow and Summers (1986), Calvo (1985), Eaton and White (1983), Shapiro and Stiglitz (1984), Stoft (1982) and others. Yellen (1984) and Katz (1986) provide surveys of alternative efficiency wage models. Mars (1982) presents numerous examples of the importance of worker discretion and the limited ability of firms to monitor worker behavior.

2. Market clearing packages without upfront fees may provide sufficient incentive to prevent workers from shirking throughout their careers if there are substantial costs associated with the stigma of being fired for shirking or if there are substantial costs to moving between jobs. The conditions under which stigma or moving costs eliminate the need for wage premia are discussed in section III.

3. See Akerlof and Katz (1987) for a detailed comparison between the model developed in this paper and the bonding model of Lazear (1981).

4. Examination of contracts without upfront bonds may be particularly relevant since practical considerations may limit the use of such devices. Bulow and Summers (1986), Dickens, Katz, Lang and Summers (1987), and Shapiro and Stiglitz (1984) provide detailed discussions of reasons why firms may be limited in their ability to get workers to post performance bonds.

5. We assume that firms' production functions are of the form $f(e^* n)$ where n is the number of laborers who are supplying effort e^*. A worker who supplies 0 labor has no effect on output. It is said that a worker who shirks supplies 0 units of effective labor while a worker who works supplies e^* units of effective labor.

6. If the firm could hide its knowledge of having detected a worker shirking and wait till n before dismissing a worker for a shirking offense committed at t, the worker's potential loss from shirking at t is instead $p\,dt\,(w^* n + x)$ since a worker dismissed at n will attain no outside earnings. In this case, the firm's optimal strategy is to hide its knowledge of having caught a worker shirking and wait till just prior to the worker's retirement date to fire the worker. If the worker knows that he or she has been caught shirking this strategy has no use. At that point, the worker will seek other employment. Also, the delayed informing of the worker that he or she has been caught shirking and in danger of disciplinary action may leave a firm open to an unjust dismissal suit in some U.S. states and would not be permissible under the dismissal rules in many European countries.

7. Hutchens (1986) shows in a shirking model in which workers are assumed to be able to post upfront bonds that the specter of firm

cheating on delayed payments introduces a form of fixed costs into the employment relationship. Since a firm entails these fixed costs each time it hires a new worker, firms prefer to hire young workers with long potential tenures. Hutchens argues that firms with reputations for honesty do not face these fixed costs and should be indifferent between hiring young and old workers. In contrast, our model shows that even honest firms face the fixed costs of generating enough surplus to provide work incentives if upfront bonds are not possible.

8. Furthermore, if primary sector firms are paying above market clearing wages because of monitoring difficulties, there is an incentive for primary sector firms to merge with secondary sector firms. In this case, workers would be positioned in the secondary sector jobs that have little potential for shirking early in their careers and optimal deferred payment schemes could potentially be market clearing. The importance of job specific human capital accumulation may limit the usefulness of such measures.

9. The generalized version of different discount rates has been analyzed by Kuhn (1986).

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