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This paper develops a theoretical framework for analyzing contracting imperfections in long-term employment relationships. We focus chiefly on limited enforceability and limited worker liquidity. Inefficient severance of employment relationships, payment of efficiency wages, the relative response of wages and employment to business cycle shocks, and the propagation of these shocks are linked to the nature of contracting imperfections.

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CONTRACT-THEORETIC APPROACHES TO WAGES AND DISPLACEMENT

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ABSTRACT. This paper develops a theoretical framework for analyzing contracting imperfections in long-term employment relationships. We focus chiefly on limited enforceability and limited worker liquidity. Inefficient severance of employment relationships, payment of efficiency wages, the relative responses of wages and employment to business cycle shocks, and the propagation of these shocks are linked to the nature of contracting imperfections.

1. INTRODUCTION

Models of moral hazard in labor relationships have proven to be useful in explaining a variety of important macroeconomic phenomena. The existence of involuntary unemployment has been linked to the need to provide incentives for workers to choose high effort (Shapiro and Stiglitz (1984)). Further, since wage levels are important for workers' incentives, adjustment of wages in response to cyclical shocks may be subject to contractual constraints. This may help to explain the low observed variability of average wages relative to employment levels (Danthine and Donaldson (1990,1995), Strand (1992), MacLeod, Malcomson and Gomme (1994)). More recently, contracting problems have been tied to inefficient severance of employment relationships, giving a mechanism whereby business cycle shocks may be magnified and made more persistent (Ramey and Watson (1997a)).

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This paper focuses on the contract-theoretic underpinnings of wage adjustment and worker displacement in moral hazard models of the labor market. The key assumption throughout is that firms and workers maintain *long-term relationships*, whereby a particular firm and worker transact repeatedly until their relationship is severed. We offer a unified theoretical framework that highlights two types of contracting imperfections in labor relationships. First, relationships may be subject to *limited verifiability*, whereby external enforcement authorities are unable to condition payments on the full set of actions chosen by the contracting partners. For example, the authorities may be unable to ascertain whether severance of the relationship was due to the worker's action or the firm's action. Second, desirable contracts may be infeasible due to *limited liquidity* on the part of the worker, which prevents the worker from making payments to the firm.[1]

We demonstrate that privately inefficient breakdown of relationships may occur in the presence of limited verifiability, i.e. limited verifiability leads contracts to be *fragile*. The key point is that when a negative shock hits, the *joint* returns to cooperation may be insufficient to offset the firm and worker's collective inducements to behave dishonestly, so there is no way to specify transfers between the firm and worker that can preserve the relationship.

Our framework allows for a more precise analysis of the role of wage premia in solving labor contracting problems. We say that a worker obtains an *efficiency wage* when, in contract negotiation, the firm and worker must weigh reducing the worker's compensation against motivating effort. We demonstrate that, in the absence of liquidity constraints, effort incentives are driven solely by verifiability, bargaining power, and the state of the matching market. The worker's compensation in a period can be selected independently of

[1]Our analysis omits some other aspects of labor contracts that have been considered in the literature. First, we assume risk-neutral workers, so wage payments do not play any insurance role, in contrast to "implicit contract" models. Second, renegotiation of wage contracts is allowed, meaning that inefficient severance cannot occur as a consequence of failure to renegotiate. Implicit contract models are surveyed in Romer (1996, ch. 10); see Boldrin and Horvath (1995) for a recent empirical implementation. Suppression of renegotation as a cause of displacement is considered in Hashimoto and Yu (1980) and Hall and Lazear (1984).

these factors, and thus, in a precise sense, efficiency wages play no role in helping to preserve relationships. When the worker is liquidity constrained, however, the incentive constraint may bind at the time of contract negotiation, as a consequence of the worker's inability to make payments to the firm that would implement the unconstrained bargaining outcome. Thus, efficiency wages may emerge as added restrictions on wage adjustment when workers are liquidity constrained.

To analyze how contracting imperfections affect market outcomes, we posit that relationships are formed on a matching market, as in Pissarides (1985) and Mortensen and Pissarides (1994). We consider an example in which a limited liquidity specification with efficiency wages but no fragility is contrasted with a limited verifiability specification that is subject to fragility. In response to a permanent shock to the distribution of productivity, the presence of limited liquidity does serve to dampen wage adjustment, relative to a complete-contracting benchmark. However, the dampening is much more pronounced in the limited verifiability case, as the severance of low-productivity relationships greatly reduces the sensitivity of average wages to the shock. Moreover, the effect of the shock on total employment is greatly magnified as a consequence of fragility. Our example illustrates how models that emphasize displacement may be much more potent for explaining wage adjustment and propagation of shocks than models stressing wage effects within a given employment contract.

Our contract-theoretic framework for analyzing employment relationships is related to the work of MacLeod and Malcomson (1989,1993,1998), who also develop a rigorous model for studying employment relationships. MacLeod and Malcomson focus on the timing and enforcement of compensation, using a model in which parties can make both externally-enforced and discretionary transfers. Two contractual forms are emphasized: efficiency wages (which they define as the use of high wages with the threat of severance) and performance pay (defined by the use of discretionary bonuses). They demonstrate how the form of compensation depends on labor market conditions and equilibrium beliefs, interpreting the latter as a "social norm for a fair wage." Our work, on the other hand, addresses (1) a broader range of contracting settings, including different restrictions pertaining to verifiability and liquidity; (2) inefficient severance of relationships following shocks; and (3) issues of propagation in the macroeconomy. We also take a different approach to modeling contract determination, whereby negotiation (and renegotiation) between workers and firms is directly incorporated.[2] On the issue of contractual form, we obtain results different from those of MacLeod and Malcomson.

The basic model of an employment relationship is introduced in Section 2. Section 3 considers enforcement under various contracting environments, which differ in terms of what can be verified to a third party. Section 4 discusses efficiency wages and limited liquidity. Market outcomes derived from a matching setup are studied in Section 5, and Section 6 concludes.

2. Model

2.1. Employment Relationships. Employment relationships consist of one worker and one firm who interact in periods $t = 1, 2, \ldots$ until their relationship is severed. The firm is represented by a *manager*. Both the worker and manager make a private effort choice (high or low) that contributes to production. In addition, these parties negotiate a contract specifying transfers as a function of verifiable information. If both agents exert high effort during production, then the *cooperative* output level z_t is realized. We assume that z_t varies randomly across periods, taking the value z^G in the "good" production state and z^B in the "bad" state, with $z^G > z^B > 0$. For simplicity, z_t is assumed to be realized independently in each period, with ρ denoting the probability that $z_t = z^B$.

The realization of z_t, contracting, and effort choices within a period occur in three phases, as illustrated in Figure 1. In phase 1, the worker and manager observe the realized value of z_t for that period, and then they negotiate a contract that governs current-period interaction. If they reach an agreement, the contract specifies which decisions the agents will make in subsequent phases, as well as a profile of contingent payments. Disagreement leads to

[2] One component of our theory is the view that discretionary transfers are subject to renegotiation.

severance of the relationship, with the worker and manager obtaining outside option values of $b^w + w^w$ and $b^m + w^m$, respectively. The parameters b^j reflect current-period benefits received when the relationship is severed in phase 1 (e.g. the worker may obtain unemployment benefits), while the parameters w^j indicate the discounted values of future benefits, which may include returns from new relationships formed in the future. Severance as a result of disagreement will be referred to as outcome D. Further details of the contract negotiation are discussed below.

The manager makes his effort choice in phase 2. Low effort leads to outcome A, where the manager obtains a current-period private benefit of x^m, while the worker receives no benefit. Worker effort is selected in phase 3; there, low effort leads to outcome B, in which the worker receives a current-period private benefit of x^w and the manager obtains zero. Under either low-effort outcome, output is zero and the relationship is severed at the end of the period. On the other hand, high effort by both agents induces the cooperative outcome C, in which case output is z_t and the relationship continues into the next period. The manager is assumed to appropriate the output.

We assume $x^j > b^j$ for both j, meaning that either agent gains more in the current period from staying in the relationship and putting out low effort than from leaving the relationship in phase 1. Observe however that when an agent chooses low effort, his partner forgoes the opportunity to obtain b^j. We also assume that $x^j < b^w + b^m$, meaning the agents will never agree in phase 1 to induce outcomes A or B. Interpretations for our assumptions are discussed below.

We now compute the value of the relationship under various possible outcomes. First, it may be that high effort is chosen under both z^G and z^B in every period, in which case the relationship never breaks up. In this "robust" solution, the discounted future value of the relationship is given by:

$$g^R = \frac{\beta((1-\rho)z^G + \rho z^B)}{1-\beta},$$

where β is the agents' common discount factor. Second, high effort may be selected when z^G is realized, but the agents might agree to sever the relationship under z^B. In this "fragile" solution, in each period the relationship breaks up with probability ρ. The discounted future value of the relationship in this case satisfies

$$g^F = \beta[(1-\rho)(z^G + g^F) + \rho(b+w)],$$

where $b = b^w + b^m$ and $w = w^w + w^m$. Solving for g^F yields

$$g^F = \frac{\beta(1-\rho)z^G + \rho\beta(b+w)}{1-(1-\rho)\beta}.$$

Finally, the agents may agree to sever the relationship under both z^G and z^B, so that the relationship breaks up in period 1, having value $b + w$.

We impose a final assumption:

$$b + w < z^B + g^R < x + w < z^G + g^F, \tag{1}$$

where $x = x^w + x^m$. The first inequality in (1) implies that the agents prefer the robust outcome under either production state, so that the robust outcome is efficient. The remaining two inequalities will determine the conditions under which the agents can find a contract that supports the robust and fragile solutions, as discussed below.

2.2. Contracting. At the start of each period, the worker and manager negotiate a short-term contract that specifies payments from the manager to the worker conditional on the productivity level z^k, $k = G, B$, and on the outcome of productive interaction (A,B or C). The set of feasible contracts is generally constrained by the limits of the external enforcement institution. Payments might also be subject to liquidity constraints. Let s_C^k denote the payment made to the worker in the event that outcome C is realized, under productivity level z^k, $k = G, B$. Since the manager directly appropriates z^k when outcome C is reached, his current-period payoff in this case is $z^k - s_C^k$, while the worker obtains s_C^k. Transfers conditioned on outcomes A and B will be written s_A and s_B, respectively; these transfers will not need to depend on k. In addition, the agents may agree on up-front transfers s_0^k, made at the time of contracting in phase 1. We adopt the convention that negative values of s_C^k, s_A, s_B and s_0^k denote transfers from the worker to the manager.

The worker and manager also formulate a joint plan for how they will behave in the future, which yields an expected continuation value g. For example, if the agents intend to implement a robust solution, then $g = g^R$. We look for a specification of behavior, consisting of explicit contracts and individual actions over time, that satisfies four conditions. First, agents' expectations about g accurately reflect the value of continuing the relationship. Second, in each period, agents make their effort choices in a utility-maximizing manner, given g and the values of transfers agreed to under the contract. Third, short-term contract negotiation is resolved according to the Nash bargaining solution. Here the agents recognize that they are implicitly bargaining over the total value of the relationship, which is the sum of current-period returns and the continuation value g (assuming the agents are able to maintain the relationship into the next period). The worker's and manager's bargaining weights are, respectively, π^w and π^m, and the disagreement point is outcome D. The parameters π^w and π^m are nonnegative and satisfy $\pi^w + \pi^m = 1$. Fourth, the best equilibrium satisfying the first three conditions is selected by the firm and worker.[3] In light of assumption (1), the firm and worker will chose the robust solution if it can be supported. Next in line is the fragile solution, followed by immediate severance.

2.3. Interpretation. *Effort choices and unemployment benefits.* Our model of employment relationships allows for effort choices by both workers and managerial personnel who supervise workers. These choices can be interpreted in a number of ways. The most familiar interpretation involves personal exertion, and here we augment the usual shirking model by specifying that, in addition to worker effort, managerial effort is also important for production. Further, low effort may also entail activities that are directly harmful to production,

[3]The first three properties define a *negotiation equilibrium*, which is simply a specification of behavior consistent with private incentives and the Nash bargaining solution. The fourth property implies that, at the meta-level of negotiating over equilibria, the firm and worker select the equilibrium that maximizes their joint returns. For example, if they could sustain both the values g^R and g^F, then they are assumed to select the preferred plan yielding g^R. In our framework, there will always be an equilibrium that is maximal in every period.

such as theft.

An agent obtains a current-period private benefit when he chooses low effort. Alternatively, the agents can agree to dissolve their relationship at the start of the period, and obtain current-period benefits outside of the relationship. A key assumption of our model is that these unemployment benefits become unavailable once agents have agreed to a contract and proceeded to phase 2, i.e. the agents must make a commitment to production activities that rule out outside benefits in the current period. We have also assumed that low effort conveys a larger private benefit than does unemployment (this is the assumption $x^j > b^j$, $j = w, m$). The most direct way to interpret this assumption is that employment relationships convey perks that are themselves attractive, apart from personal costs associated with high effort. Further, unemployment may involve private costs, such as psychic harm and search costs, that are not incurred within active relationships. Note that private benefits are zero for agents in a relationship who exert high effort, which serves to normalize utility.[4]

Low effort and severance. We have assumed that low effort by either the worker or manager leads the employment relationship to be severed. There are two basic motivations for this assumption. First, low effort may induce rapid decay in the productivity of the relationship, to the point where returns to continuation fall short of operating costs. For the manager, low effort might also be directly tied to liquidation, e.g. the manager may sell off essential assets. Second, contractual enforcement mechanisms used by the partners to sustain cooperation may entail a costly and time-consuming dispute resolution process in the event that either agent chooses low effort; see Ramey and Watson (1997b) for a detailed discussion of such mechanisms. When dispute resolution costs are sufficiently high, the worker and manager will opt to sever their relationship instead.

As another possibility for contractual agreement, the agents might seek to temporarily

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[4]Our setup admits the "standard" shirking model, in which firms behave more passively. The standard model is obtained by setting $b^m = x^m = 0$, so that the manager obtains neither unemployment benefits nor benefits from low effort. In this case, the manager's incentive to agree to the contract at phase 1 are identical to its incentive to choose high effort at phase 2, so in effect the manager does not make an effort choice.

suspend their relationship when high effort is unsustainable, e.g. through a layoff, in order to preserve match capital. Such suspensions will be infeasible, however, if returns from the relationship would experience rapid deterioration in the absence of active inputs of effort. For example, production equipment or organization may depreciate during the suspension, or market dominance may be permanently lost. Further, as will become clearer below, contracts that support temporary suspension will be infeasible if a third party enforcement authority is unable to tell whether or not suspension resulted from a breach of contract by one of the parties.

While severance following low effort is taken as the benchmark case, the model can also cover situations in which temporary suspension is feasible. This is done by setting $w^j = g^j - \alpha^j$, $j = w, m$, where g^w and g^m give the discounted values to the worker and manager, respectively, of continuing the relationship into the next period, and α^m and α^w are the costs of maintaining the relationship while not producing.

Contracted transfer payments. The model allows for contracts specifying an up-front transfer to the worker, s_0^k, as well as a transfer that is made conditional on choices of high effort by both agents, s_C^k. The former can be interpreted as a "salary," in that it is paid in return for the worker's commitment to forgo his unemployment benefit and commit to production activities for some interval of time, while the latter represents a "performance payment," received only after the successful completion of production.[5] The transfers s_A and s_B are used to impose direct punishments for low effort, and can be interpreted as damages stipulated by the contract for nonperformance, or penalties imposed by an external legal or regulatory authority.

Contract duration. We have assumed that agents can only write short-term contracts, specifying transfers that are enforceable within the current period. In this contracting environment, the transfers s_A and s_B can be thought of as severance payments (in addition to

[5] MacLeod and Malcomson's (1989,1993,1998) bonus payment is like s_C^k, although they assume it is discretionary. In our framework, firms would never make discretionary transfers following production, and so only what is enforceable matters.

punishments), since the relationship is dissolved following low effort. Note that agents are free to sever their relationship following outcome C, but such a decision is made in phase 1 of the *next* period, after the current contract expires. Thus, by "short-term contract" we mean that the agents cannot stipulate to transfers conditional on whether they reach agreement in the negotiation phase of the next period.[6]

3. External Enforcement and Verifiability

3.1. Full Verifiability. The agents' ability to find a contract that supports the robust solution will depend on whether they are able to enforce the needed contingent transfer payments. This in turn depends on what external enforcement authorities can observe about the current-period effort choices. We begin by considering the case of full verifiability, in which the external authority can perfectly observe which of the outcomes A, B or C is realized. In this case, the robust solution is supported, and therefore it is selected by the agents. This is confirmed by checking the four conditions of our contracting solution.

Since the outcome must be C in every period under the robust solution, the worker's total compensation is given by the stream of payments $s_0^G + s_C^G$ and $s_0^B + s_C^B$ for periods having the good state and bad state, respectively. Note that we are assuming the agents select the same contract in each period.[7] Bargaining in each period determines the discounted value of this payment stream. This is characterized by

[6] In our setting, short– and long-term contracts differ *only* to the extent that agents can enforce a transfer conditional on outcome D occuring in the next period. To see this, consider two contracting environments: (a) short-term, as described in the text; and (b) long-term, with a recontracting option in each period. Fix the scope of what can be verified and enforced within a given period, and assume that the agents have symmetric information whenever they negotiate. Then (a) and (b) support exactly the same behavior over time, if in setting (b) the agents cannot condition transfers on outcome D occurring in the next period. Further, the latter restriction on setting (b) may be implied by limited liability, in that the legal institution might not enforce transfers conditional on severance unless there is cause for awarding damages. In most of the work presented here, options for long-term contracting do not affect our results.

[7] This is without loss of generality, given that each period the agents maximize their joint value over feasible equilibria.

$$s_0^k + s_C^k + g^{wR} = \pi^w(z^k + g^R - b - w) + b^w + w^w,\ k = G, B, \tag{2}$$

where g^{wR} indicates the discounted future value to the worker of continuing the relationship:

$$g^{wR} = \frac{\beta((1-\rho)(s_0^G + s_C^G) + \rho(s_0^B + s_C^B))}{1-\beta}.$$

These equalities capture the first and third conditions of equilibrium. To verify the second condition, note that outcome C is consistent with the agents' private incentives at phases 2 and 3 if and only if:

$$z^k - s_C^k + g^R - g^{wR} \geq x^m - s_A + w^m, \tag{3}$$

$$s_C^k + g^{wR} \geq x^w + s_B + w^w. \tag{4}$$

Inequalities (3) and (4) can be satisfied for each k by making s_A sufficiently positive and s_B sufficiently negative, i.e. by imposing sufficiently large punishments for choosing low effort. Since the robust solution maximizes the joint value of the relationship in each period (from phase 1, where negotiation occurs), the fourth contracting condition also holds.

Beyond the requirements on s_A and s_B, there is wide latitude for selecting salary and performance payments that satisfy (2), and there is essentially no distinction between the two kinds of payment. For example, contracts might involve performance payments only, or salaries only; in the latter case, the worker's incentive to choose high effort is supported by the loss of future-period salary payments, rather than current- and future-period performance payments.

3.2. Severance Payment Only. Now suppose the enforcement authority can enforce payments conditional on severance of the relationship due to low effort, but the authority cannot ascertain which agent's low effort choice caused the separation. That is, the authority cannot distinguish between outcomes A and B. Remember that the agents cannot contract on severance following outcome C, since this would occur in the next period. However, the agents can still specify the transfer s_C^k contingent on C occurring. Further, at the time of negotiation there is no outstanding contract specifying transfers in the event of outcome D.

Given the limitation on what can be observed, the contract can specify only a single severance transfer s, where $s_A = s_B = s$. Let us check whether the robust solution can be supported. Adding the incentive conditions (3) and (4) gives

$$z^k + g^R \geq x + w, \tag{5}$$

which fails when $k = B$, given the assumptions in (1). Thus, in the bad productivity state, either the manager or the worker will have an incentive to choose low effort, no matter what value of s is proposed. Limitations on verifiability, in the form of inability to condition severance transfers on the reason for severance, imply that the robust solution becomes infeasible. The key problem is that the joint surplus from cooperative behavior, given by $z^B + g^R$, falls short of the *sum* of the agents' returns from low effort, which are $x^m + w^m$ and $x^w + w^w$.

Despite their inability to achieve the robust solution, the agents can find a contract that supports the fragile solution. We can specify $s_0^G + s_C^G$ to satisfy

$$s_0^G + s_C^G + g^{wF} = \pi^w(z^G + g^F - b - w) + b^w + w^w, \tag{6}$$

where g^{wF} gives the worker's discounted future value of continuation in the fragile solution:

$$g^{wF} = \frac{\beta((1-\rho)(s_0^G + s_C^G) + \rho(b^w + w^w))}{1 - \beta(1-\rho)}.$$

Thus, the first and third equilibrium conditions are satisfied. Since $z^G + g^F > x + w$, we can find a value $s_C^G - s$ satisfying:

$$z^G - (s_C^G - s) + g^F - g^{wF} \geq x^m + w^m, \tag{7}$$

$$(s_C^G - s) + g^{wF} \geq x^w + w^w, \tag{8}$$

and clearly each agent has an incentive to choose high effort in the good state. Thus, the relationship continues as long as the good state is realized, while in the bad state the relationship is severed. Finally, the fourth equilibrium condition follows from the fact that $z^G + g^F > b + w$, i.e. the fragile solution is superior to immediate severance, while the robust solution is infeasible. Importantly, severance is inefficient for the agents, since $z^B + g^R > b + w$ implies that the agents would prefer the robust solution if it could be implemented. Observe further that there is a large range of payment profiles that can support the fragile solution: for example, if higher s_C^G is specified, then the severance transfer s will be correspondingly increased to preserve (7) and (8), and s_0^G will be reduced to maintain (6). As in the case of full verifiability, here the worker's total compensation, driven by relative bargaining powers, does not determine the exact form of compensation.

The analysis is similar for the case in which disagreement or low effort imply temporary layoff as opposed to severance. For example, suppose $\alpha^w = \alpha^m = 0$. In this instance, assumption (1) is replaced by $b < z^B < x < z^G$. Under the robust solution with temporary layoffs, we have $w = g^R$; since (6) continues to be necessary for satisfaction of the incentive constraints, it follows that the robust solution cannot be implemented as a consequence of $z^B < x$. Further, it is easy to verify that the fragile solution, which involves layoffs in the bad state, can be implemented, and the assumption $b < z^B$ implies that the layoffs are inefficient.

3.3. Other Cases. *Limited Liability.* Agents may be protected from liability for payments in the event that the relationship is severed. This serves as a further restriction on the case of severance transfers only, where $s_A = s_B = 0$ is now imposed. It is easy to see that there is a solution to (6)-(8) satisfying this restriction: s_C^G is pinned down by (7) and (8), and s_0^G is then chosen to satisfy (6). Interestingly, a contract of this form may involve bond-posting by the worker. For example, a high positive value of s_C^G may be specified in order to sustain the worker's incentives to choose high effort, combined with a negative value of s_0^G that implements the bargaining solution. Here the worker makes an up-front transfer s_0^G, and receives recompense s_C^G only in the event that high effort is realized. To the extent that s_C^G is fixed by (7) and (8), higher values of π^m correspond to larger bonding measures.

Noncontractible Worker Effort. The actions of some agents may be unobservable to the enforcement authority, even as transfers can be conditioned on the behavior of other agents. Consider the case in which the worker's effort is noncontractible in this sense. Thus, the authority cannot distinguish between outcomes B and C, although A is still separately observable.[8] In contrast to the case of severance payments only, it is possible to implement the robust solution in this environment. First, the manager's incentive constraint (3) can be satisfied by choosing sufficiently large s_A. Since $s_B = s_C^k$, however, the worker's constraint (4) now becomes

$$g^{wR} \geq x^w + w^w. \tag{9}$$

Observe that current-period choices of s_0^k and s_C^k cannot affect whether (9) is satisfied. It follows that the robust outcome is sustainable if and only if (9) holds at values of the transfer payments that solve (2), which will tend to occur when π^w is large or when x^w is small. Thus, through their effect on the worker's expected future compensation, bargaining weights have an impact on incentives, although they have no implications for the form of compensation (salary versus performance pay).

Nonverifiability. Finally, consider the case in which the enforcement authority cannot distinguish between any of the outcomes A, B and C. Thus, there is a single transfer payment s^k that is enforced under all three outcomes. Note first that the robust solution cannot be enforced in this case, as adding (3) and (4) for $k = B$ implies violation of the assumption $z^B + g^R < x + w$. Next, the fragile solution can be enforced if the following conditions hold for the value of g^{wF} determined by (6):

$$z^G + g^F - g^{wF} \geq x^m + w^m, \tag{10}$$

[8] It is implicit in this assumption that the authority cannot tell whether severance is the result of worker low effort in the current period or failure to reach agreement in the following period, i.e. the current-period contract does not extend to cover separations that occur as a result of the worker's low effort.

$$g^{wF} \geq x^w + w^w. \tag{11}$$

As in the previous case, the agents' relative bargaining weights influence whether cooperation can be sustained. Note that these conditions are unaltered if it is instead assumed that the enforcement authority cannot enforce any transfers at all, since all needed transfers can be made using the up-front payment s_0^G.

3.4. Summary. Observability of actions within the relationship by external authorities plays a key role in determining how successful agents can be in solving their contracting problems. Full verifiability implies that the complete range of necessary transfer payments can be enforced, allowing the most efficient solution to be implemented. In contrast, nonverifiability rules out efficiency, and even the fragile solution becomes unenforceable for a range of parameter values. Between these two extremes, various possibilities arise: when severance payments cannot be conditioned on the reason for severance, only the fragile solution is implementable; whereas when worker effort is noncontractible, the bargaining outcome determines the solution, and there will be no production in any state when the worker's bargaining power is sufficiently small. Finally, except in the case of limited liability, the split of the worker's compensation between salary and performance payments plays no role in implementing the various solutions.

4. Efficiency Wages

4.1. Efficiency Wages and Contract Negotiation. The literature on moral hazard in labor relationships has placed great emphasis on solving worker incentive problems through the payment of efficiency wages. Fundamental to the idea of an efficiency wage is that motivating the worker to choose high effort places a binding constraint on wage setting, so that wages cannot be cut without inducing low effort. In other words, when the firm and worker negotiate over wages in a period, they confront a trade-off between the worker's compensation and effort incentives. In this section we show, however, that such a trade-off *never* arises in the contracting setting considered thus far. Thus, there is no scope for efficiency wage effects in contracting models of this form.[9]

Consider the incentive constraints for the manager and worker, which we can write generally as:

$$z^k - s_C^k + g^j - g^{wj} \geq x^m - s_A + w^m,$$

$$s_C^k + g^{wj} \geq x^w + s_B + w^w.$$

Observe that, in addition to the parameters z^k, x^m, x^w, w^m, and w^w, which are fixed from the perspective of the manager and worker, these constraints depend on three sets of parameters. First, there is the joint continuation value g^j, which is maximized when the agents select the best equilibrium (either robust, fragile, or immediate severance). Since higher values of g^j relax the incentive constraints, there is no trade-off between compensation and incentives at the level of equilibrium selection. Second, the constraints involve the manager and worker's shares of the continuation value, described by $g^j - g^{wj}$ and g^{wj}. Given g^j, these values are tied down by negotiation in future periods, which in turn is fully determined by bargaining weights and the fixed disagreement point D. In other words, from the agents' perspective at the negotiation phase in any given period, they have no control over continuation values in a way that forces them to address a trade-off between compensation and incentives.

The third set of parameters comprise the contracted transfers s_A, s_B, and s_C^k. These are directly controlled by the worker and firm in the current period. Note, however, that the up-front transfer s_0^k does not appear in the incentive constraints. As a free parameter, s_0^k can be set to effect any division of the relationship's value between the firm and worker, with no implications for the provision of incentives in the current period.[10] As a result, during

[9] The term "efficiency wages" is also used in connection with the idea that incentive problems lead to involuntary unemployment. Regardless of incentive problems, however, employed workers fare better than unemployed workers whenever employment relationships entail quasirents (as when matching is costly/frictional) and workers have some bargaining power. Further, as argued by Carmichael (1985), involuntary unemployment is not a necessary consequence of incentive problems.

[10] Note that only in the case of nonverifiability is the value s_0^k constrained to equal one of the other

contract negotiation, there is *absolutely no trade-off* between compensating the worker and inducing high effort, and so there is no payment of efficiency wages.[11]

4.2. Worker Liquidity Constraints. Efficiency wage effects emerge if the worker is unable to make payments to the manager, due to insufficient worker liquidity. A worker liquidity constraint can be introduced into the model by requiring that all transfer payments be nonnegative. Let us consider the implications of this constraint in the case of full verifiability. Since $s_B \geq 0$, supporting the robust solution requires that (4) be replaced by

$$s_C^k + g^{wR} \geq x^w + w^w, \tag{12}$$

where g^{wR} is determined by (2). Condition (12) is made as slack as possible by setting the salaries s_0^k equal to zero, and compensating the worker completely through performance payments. If (12) still does not hold, then s_C^k must be raised above the value determined by (2) in order to induce high effort, so that (12) becomes binding in s_C^k. In this case, a trade-off between compensation and incentives is clearly present, and we can say that an efficiency wage is paid in state k.

As one possibility, suppose that (2) with $s_0^k = 0$ implies the following:

$$s_C^B + g^{wR} < x^w + w^w \leq s_C^G + g^{wR}.$$

Here the agents must agree to a higher value of s_C^B when the bad state is realized, in order to induce the worker to choose high effort. Correspondingly, s_C^G will be chosen at a lower value in order to maintain (2) in the good state. It may be that s_C^G must be lowered so much that (12) becomes binding even in the good state. In any event, we have

contracted transfers. However, in this case the externally-enforced transfers disappear from the incentive constraints altogether.

[11] This is not to say that incentive constraints are unimportant. The main point is that consideration of incentives in employment relationships should center on the satisfaction of incentive constraints given the contracting and matching environment, which may or may not generate phenomena such as efficiency wages. Importantly, the contracting environment is described by bargaining powers, whether negotiation is recurrent, and the extent of verifiability.

$$s_C^B + g^{wR} > \pi^w(z^B + g^R - b - w) + b^w + w^w,$$

and it follows that the worker receives an efficiency wage in the bad state. Observe that the worker obtains a value strictly in excess of his outside option even when $\pi^w = 0$; in this case, compensation is equal in both states, and efficiency wages are paid in both states. We conclude that efficiency wages may emerge when worker liquidity constraints rule out the use of direct penalties or worker bonding to enforce high effort.

It should be noted that the manager must give up some of his bargaining surplus when efficiency wages are needed, which may lead to disagreement and inefficient severance despite the existence of full verifiability. Whenever (12) is binding, the manager obtains a payoff of $z^k + g^R - x^w - w^w$, which can lie below his outside option value $b^m + w^m$ even when agreement is reachable in the absence of liquidity constraints. A similar analysis may be carried out for the other contracting environments, where prospects for obtaining productive solutions are also reduced by the addition of a worker liquidity constraint.

4.3. Relation to Other Models. In this section, we consider how the efficiency wage issue is treated in a few of the standard models of dynamic labor contracting found in the literature. The model of Shapiro and Stiglitz (1984) can be viewed as producing a trade-off between worker compensation and incentives by constraining the kinds of contracts that firms may offer to workers. In essence, firms are required to offer a single stationary wage. Over multiple discrete periods, firms are committed to the same transfer in each period, conditional on no shirking being discovered. In fact, firms would prefer to offer a low wage in the current period, with only the promise of higher wages later.[12]

MacLeod and Malcomson's (1989,1993,1998) theory is designed to rectify such inconsistencies by explicitly modeling the contracting process. They provide a more rigorous foundation for the kinds of market phenomena of interest to the early efficiency wage literature,

[12] Resolving this issue requires a more complete model of contract determination, as Carmichael's (1985) critique of the Shapiro-Stiglitz (1984) model indicates.

such as involuntary unemployment. By tying prevailing labor contracts to a social norm, however, their model does not incorporate trade-offs between compensation and incentives at the level of individual employment relationships. Rather, compensation and incentives are together traded off against social sanctions.[13]

In Ramey and Watson (1997a), firm/worker pairs determine long-term contracts through direct bilateral negotiation, and they are not influenced by social norms. Like the model presented here, however, there is no tension between compensation and incentives, so efficiency wages are not at issue. Through the use of an up-front transfer, a firm and worker can manage any split of the relationship's value, while implementing the best outcome that verifiability will allow. The present model takes the contracting framework a step further by incorporating the negotiation phase in each period of interaction, which implies that ongoing surplus division is moderated by bargaining weights.[14]

5. Market Outcomes

We now describe how employment relationships are formed in steady-state matching equilibria. Assume that the labor market contains a unit mass of workers, each of whom begins a period either matched with a manager in an employment relationship, or else in a pool of unmatched workers seeking to locate a manager. In addition, there is a large number of potential managers. At the beginning of each period, unmatched managers can elect to post vacancies at a cost of $c > 0$. For simplicity, we assume that unmatched workers bear no search costs. The flow of new matches in a period is given by a standard matching func-

[13] In MacLeod and Malcomson (1998), if a firm offers any contract not in accord with the norm, it is branded as a deviant, and workers at this firm shirk forever after. In MacLeod and Malcomson (1989), the social coordination role is modelled more abstractly in terms of prevailing equilibrium beliefs. Incidentally, since a matched firm and worker do not have direct control over their joint plan of behavior in the theory of MacLeod and Malcomson, total inaction can be supported as an equilibrium.

[14] Ramey and Watson (1997a) also incorporates what one might call an "efficiency investment:" since the firm makes a non-contractible investment that affects incentives and value, it faces a direct trade-off between compensating the worker (by raising or lowering the value of the relationship) and satisfying incentive constraints.

tion $m(U, V)$, where U indicates the mass of unmatched workers, and V gives the mass of managers who post vacancies.

The matching process is assumed to take place in phase C, at the same time as production occurs in active relationships. Thus, workers whose relationships are severed in phases D, A or B can enter the current-period matching pool. Further, to ensure that the pool of unemployed workers does not become empty, we assume that with probability ρ^x relationships are severed for exogenous reasons. Exogenous separations occur in phase 1, and workers who experience these separations can also enter the current-period matching pool.

We consider two types of steady-state equilibria of the model, distinguished by whether contracting solutions within relationships are robust or fragile. For robust and fragile equilibria, respectively, the discounted future values of relationships are determined by:

$$g^R = \beta((1-\rho^x)((1-\rho)z^G + \rho z^B + \beta g^R) + \rho^x(b + w^R)),$$

$$g^F = \beta((1-\rho^x)(1-\rho)(z^G + \beta g^F) + (1-(1-\rho^x)(1-\rho))(b + w^F)),$$

where w^R and w^F give the values of outside options in robust and fragile equilibria. The value of the worker's outside option in either case satisfies:

$$w^{wj} = \frac{m(U,V)}{U} g^{wj} + \left[1 - \frac{m(U,V)}{U}\right] \beta w^{wj},\ j = R, F,$$

where g^{wR} and g^{wF} are determined by (2) and (7), respectively. Because of free entry of managers into the vacancy pool, the value of managers' outside option is zero, and we have the following free-entry condition:

$$\frac{m(U,V)}{V}(g^j - g^{wj}) = c,\ j = R, F.$$

Finally, the number of employed workers and the size of the unemployment pool are given by:

$$N = (1-\rho^x)(1-\rho)N + m(U,V),$$

$$U = (1 - (1 - \rho^x)(1 - \rho))N.$$

Observe that the latter two equations conform to the assumption that workers whose relationships are severed enter the unemployment pool in the current period.

We model cyclical shocks as changes in ρ, holding other parameters fixed, and responses to the shocks are determined by steady-state equilibria. Thus, our analysis focuses on highly persistent productivity shocks. Figure 2 shows results for four contracting environments under a particular parameterization of the model. Equilibrium employment and average wages under the four cases are traced out as ρ rises from zero, at the upper right-hand corner of all four curves, to 0.04. For comparison, the values at $\rho = 0.02$ are indicated by dots.[15]

Consider first the case of full verifiability, in which workers and managers are able to write robust contracts. The right-most curve in Figure 2 depicts employment and average wages for this case. A productivity shock taking the form of an increase in ρ shifts the outcome down the curve, so that employment and wages both fall. Since relationships are robust, the rise in ρ has no effect on the breakup probability. Employment is lower only because managers are less willing to post vacancies, given that average productivity is lower. The reduction in wages also reflects lower average productivity, as well as a reduced value of the worker matching probability.

Next, the case of full verifiability with worker liquidity constraints, as discussed in Section 4.2, is considered for two values of the worker matching probability. For $\pi^w = 1/2$, equilibria are robust, and the worker liquidity constraint binds in the bad productivity state; thus, efficiency wages are paid only in the bad state. In this case, wages adjust a little less relative to employment, when compared to the full verifiability case, but the effect is slight. Setting $\pi^w = 0$ yields robust equilibria with efficiency wages paid in both states, and relative wage

[15]Parameter values are $z^G = 1$, $z^B = 0.5$, $x^w = 1.25$, $x^m = 1.45$, $b^w = b^m = 0.2$, $\beta = 0.96$, $m(U, V) = 0.25U^{0.5}V^{0.5}$, $c = 0.157$, and $\rho^x = 0.07$. We also have $\pi^w = 0.5$, except for one case where we set $\pi^w = 0$.

adjustment declines a bit more.[16] In these cases, worker liquidity constraints restrict the decline in wages as ρ rises, and the dampening effect on wage adjustment is more pronounced as the liquidity constraint binds in a larger number of states.

Finally, the case of severance payments only, described in Section 3.2, is shown as the left-most curve. Equilibria are fragile in this case; in particular, (1) holds at the value $w = w^F$. As ρ rises, employment reductions become much sharper due to the increase in the probability of severance. Average productivity is also reduced relative to the earlier cases, since output in bad states is zero, rather than z^B. The latter effect also tends to reduce employment, by depressing vacancies, and it causes wage reductions to be much greater. Thus, the higher breakup probabilities lead shocks to be significantly magnified when contracts are restricted to severance payments only. Observe further that relative wage adjustment is substantially less when compared to the other cases, as the higher probability of breakups serves to shift the cross-sectional distribution of wages toward relatively high-productivity relationships.

Overall, this example demonstrates that efficiency wage effects can dampen wage adjustments, as past authors have suggested, but the scope for efficiency wages as a mechanism for propagating shocks is limited. Fragility effects deriving from limited verifiability, on the other hand, can produce large magnification of shocks, and changes in the composition of jobs generates to significantly more dampening in the adjustment of wages.

6. Conclusion

On the basis of the preceding results, we offer three broad conclusions. First, the particular form of imperfections that are present in the contracting environment can have major implications for economic outcomes. In moving from limited liquidity to limited verifiability, for example, the implications for important variables such as employment, wages and job displacement probabilities can be radically altered. "Reduced form" analysis of contracting imperfections that have been prevalent in much past macroeconomic literature may hide too much of the key underlying structure. Contractual outcomes depend on the way firms and

[16] We have renormalized the $\pi^w = 0$ economy to equate employment and wages at $\rho = 0$ under the various cases.

workers meet and negotiate, which demands a new theoretical perspective and reformulation of conventional notions, such as the idea of efficiency wages.

Second, economic effects deriving from severance of employment relationships warrant very close attention as explanations for observed phenomena, including the occurrence of large cyclical fluctuations in employment, and the relatively dampened character of wage adjustments. Broad cyclical swings in job destruction rates have been documented by Davis, Haltiwanger and Schuh (1996), who also highlight the large number of macroeconomic questions that may be linked to job creation and destruction. From the quantitative standpoint, Den Haan, Ramey and Watson (1997) show that observed fluctuations in job destruction rates can serve as an important mechanism for propagating business cycle shocks. The heavy focus of much past work on wage-setting within a given set of employment contracts may be misplaced.

Third, interactions between capital market imperfections and imperfections in labor contracting can yield interesting new implications. In this paper we have linked the occurrence of efficiency wages with worker liquidity constraints. More broadly, the ability to solve contracting problems is closely tied to capital-market trading, and these ties may prove to be of central importance in accounting for macroeconomic phenomena.

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Figure 1: Timing of Actions in Employment Relationships

In each period:

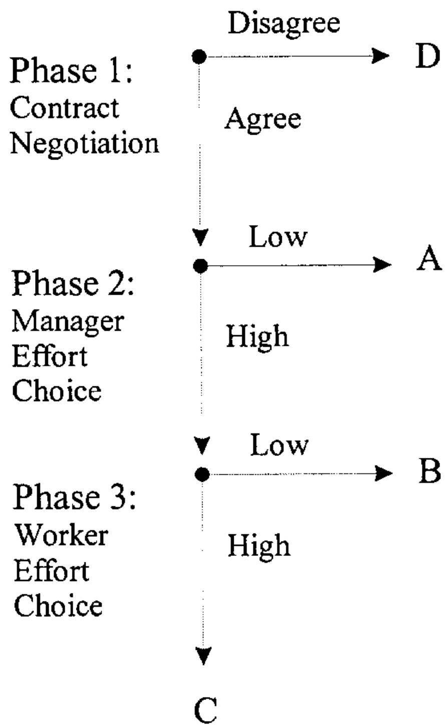

Figure 2: Average Wages and Employment in Steady State Equilibria