A Note on Dynamic Patterns of Implicit Contracts with Imperfect Public Monitoring*

Florian Englmaier† Carmit Segal‡

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Abstract

We are analyzing a situation where a worker and a firm interact repeatedly. Though there is an underlying contracting problem in that the worker's effort is observable but not contractible, the repeated interaction in principle enables the parties to rely on a implicit (or relational) contract to implement the efficient outcome: the worker works hard and is paid ex-post a bonus by the firm that observes the high effort. We assume there are some states of the world in which the firm is hit by an adverse shock and cannot pay the (full) promised bonus. Furthermore, the workers cannot observe the true state of the world. In this situation the firm always has an incentive to claim that it was hit by the adverse shock and to renege on the promised bonus. In this situation we characterize an equilibrium that has the same properties as Green and Porter (1984): along the equilibrium path there are periods of cooperation (high effort and bonus payment) and punishment (low effort and no bonus payments). Though in equilibrium there is no untruthful claim of an adverse shock by the firm, the punishment phases are still needed to sustain cooperation. We discuss unions, 'financial literacy campaigns', and some of the innovative HRM practices as solutions to this problem.

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†Harvard Business School, fenglmaier@hbs.edu

‡Harvard Business School, csegal@hbs.edu

1 Introduction

Contracting problems are one of the core issues in the analysis of the relation between worker and firm. Implicit (or relational) contracts have been widely employed to analyze these topics.[1] Usually in models of implicit contracts information that is observable to the contracting parties, but not verifiable, is utilized in the context of a repeated game between firm and worker. These models added numerous important insights to our understanding of the firm-worker relationship and its potential consequences for labor market outcomes. However, these models generally have been less concerned with generating realistic dynamic patterns of these relations. In reality, firm-worker relations in ongoing organizations most often seem to be characterized by periods of very good cooperation, followed by periods of, sometimes fierce, conflicts that in turn are usually followed again by periods of good cooperation. Mas (2005), and Krueger and Mas (2004) present evidence from Caterpillar and Bridgestone/Firestone that documents that these quarrels can be very costly to firms. We present a model that aims to generate such patterns.

The base line model analyzes a situation where a worker and a firm interact repeatedly. Though there is an underlying contracting problem in that the worker's effort is observable but not contractible, the repeated interaction in principle enables the parties to rely on an implicit (or relational) contract to implement the efficient outcome: the worker works hard and is paid ex-post a bonus by the firm that observes the high effort.

We now assume that there are some states of the world in which the firm is hit by a transitory adverse shock and cannot pay the promised bonus. Furthermore, the worker cannot observe the true state of the world. In this situation the firm always has an incentive to claim that it was hit by the adverse shock and has to renege on the promised bonus. We characterize an equilibrium in this situation that has the same properties as Green and Porter (1984): along the equilibrium path there are periods of cooperation (high effort and bonus payment) and punishment (low effort and no bonus payments). Though in equilibrium there is no untruthful claim of an adverse shock by the firm, the punishment phases are still needed to sustain cooperation. Thus, in this framework, "firm-worker-quarrels" can be interpreted

[1] Examples for theoretical work are Shapiro and Stiglitz (1984), Bull (1987), MacLeod and Malcomson (1989, 1998), Baker, Gibbons, and Murphy (1994), or Levin (2003). Examples that highlight the empirical relevance of implicit contracts are Beaudry and DiNardo (1991) or Hayes and Schaefer (2000).

as an equilibrium property and not as failures of the implicit contract.

In the context of this model we can take a new perspective on several institutions like unions or several of the novel HRM practices that are increasingly employed by firms. The model gives a theoretical underpinning for the importance that is attributed to transparency within an organizations as it was often stressed by former GE CEO Jack Welch or 80s LBO artist Gordon Cain. Unions can be analyzed from this perspective, too. Consider the case where the true state of the world is observable, although it requires a costly investment to do so. Assume that the costs are such that it does not pay for an individual worker to acquire this information, but it would be worthwhile for all workers. The workers in our model are faced with such a collective action problem (similar to Shleifer and Vishny's (1986) model of corporate governance). If it were solved, the efficiency of the entire interaction could be largely improved as full cooperation without punishment phases could be achieved on the equilibrium path. Unions can serve as a coordination device to overcome this collective action problem. Interpreting the role of unions from this new perspective can help to shed light on a very puzzling empirical regularity: nominal wage cuts are almost never observed. But if they are observed they occur almost always in unionized firms. We would argue that this is the case as unionization allows the firm to credibly transmit that it is indeed in a dire state and has to cut wages.

Note also that the basic behavioral patterns predicted by our model match neatly into observations made e.g. by Bewley (1999). He analyzes a large survey among managers and finds that management is very reluctant to cut worker's pay even in the presence of adverse economic conditions as it is afraid of adverse effects on workers' productivity. Many researchers stress the effect on "morale" that such an act that is perceived as unfair would have, cf. e.g. Fehr and Schmidt (1999). In our model the equilibrium strategies of firms and workers will generate punishment phases after wage cuts, i.e. non paid bonuses, and thus management will be very reluctant to cut pay unless they have no other chance.

Our basic model is admittedly rather restrictive. However we firmly belief that the basic logic can be employed in much richer settings, too. Giving the firm a richer strategic choice, namely also being able to decide on the level of employment, will generate an equilibrium where wage cuts may have to be accompanied by (temporary) reductions in employment in order to deter the firm from trying to renege on the promised bonus payments. This pattern of temporary layoffs closely resembles the phenomenon of "recalls" that has received a lot of attention from labor economists. Finally, considering heterogeneous workers can help to endogenously generate "seniority" based layoff rules.

The remainder of the paper is structured as follows. The next section lays out the basic model and the structure of the implicit contract under symmetric information. The following section introduces asymmetric information with respect to the state of the world and lays out the structure of the resulting implicit contract. The next section summarizes the results and discusses how institutions like unions or novel human resource management practices can help to mitigate the problems from asymmetric information. Before we conclude we sketch properties and possible insights we could get from a richer model. The Appendix contains derivations of key conditions.

2 The Baseline Model

One firm and one worker are interacting repeatedly with an infinite horizon. The discount factor for the firm is β and the discount factor for the worker is δ. The worker decides whether or not to exert effort that has a positive effect on the firm's profit but is costly to him. The worker's effort choice is observable by the firm, but not contractible. For simplicity we abstract from any explicit performance contracts. The firm has all the bargaining power and makes a take it or leave it offer to the worker.

The worker's utility is increasing and concave in monetary compensation, a contractible base salary w and a discretionary bonus b, and decreasing in the costs of effort. Specifically, the worker can decide whether to exert effort, $e = 1$, or shirk, $e = 0$.

Thus the agent's utility in period t is given by $U_t = u\left(w + \tilde{b}\right) - c\left(e\right)$ with $u^{'} > 0, u^{''} < 0$.

To ease notation we assume $c\left(e = 0\right) = 0$ and define $c\left(e = 1\right) = c$. The worker's outside option is $\bar{U}$.

If firm and worker interact only once it is impossible to implement high effort. Hence, the firm will employ the worker, pay him a fixed wage w s.t. $u(w) = \bar{U}$ and the worker will choose $e = 0$.

There are two states of the world, good and bad (G and B) that affect the firm's profit as well. Thus the firm's profits can take on four values: $\Pi(G, e = 1)$, $\Pi(G, e = 0)$, $\Pi(B, e = 1)$, and $\Pi(B, e = 0)$. The probability for the good state, G, is π and for the bad state, B, it is $(1 - \pi)$.

The state of the world is realized after the agent has made his effort choice. We assume that

$$[\pi\Pi(G, e = 1) + (1 - \pi)\Pi(B, e = 1)] - [\pi\Pi(G, e = 0) + (1 - \pi)\Pi(B, e = 0)] >> c$$

i.e., in expectation it is always efficient to implement high effort, i.e. $e = 1$.

We make additional assumptions on the profits. For simplicity we assume that

$$\Pi(B, e = 0) - w = \Pi(G, e = 0) - w = 0,$$

i.e. if the worker is shirking the firm just generates enough surplus to provide the worker with his outside option. These assumptions are innocuous but facilitate the exposition tremendously.

We are looking for an implicit contract that, with a combination of contractible wage and discretionary bonus, implements high effort. An implicit contract is a pair of strategies for firm and worker that form a Nash Equilibrium.

It is illustrative to consider for a moment the case where only the good state of the world can occur. The firm's profit is then either $\Pi(G, e = 1)$ or $\Pi(G, e = 0)$.

In this situation, the following implicit contract implements high effort.

The firm's strategy is to pay the worker a bonus $b^{const} > 0$ in addition to the base salary w s.t. $u(w) = \bar{U}$ as long as the agent chooses $e = 1$. If the worker chooses $e = 0$ the firm does not pay the bonus in this period and pays w s.t. $u(w) = \bar{U}$ forever after.

The worker's strategy is to choose $e = 1$ as long as the firm has paid the bonus in all previous periods and to choose $e = 0$ forever as soon as the firm has defaulted on the bonus once.

Thus the firm and the worker return to the equilibrium of the stage game once cooperation has broken down.

Recall that the firm has all the bargaining power and hence will pay the lowest possible bonus. This b^{const}, the minimal bonus in the stationary game that implements $e = 1$, is implicitly defined by

$$\sum_{t=0}^{t=\infty} \delta^t \left(u\left(w + b^{const}\right) - c\right) = \sum_{t=0}^{t=\infty} \delta^t \bar{U}$$

This formula is derived in Appendix A.

The firm has to be at least weakly better off from implementing $e = 1$. Thus the following condition defines the maximum level $b_{\max}^{const}$ the bonus can take on

$$b_{\max}^{const} = \beta \left[\Pi\left(G, e = 1\right) - w\right].$$

This formula is derived in Appendix B.

As we assume that effort is sufficiently productive, it always pays to implement $e = 1$. Thus we can be sure that $b_{\max}^{const} > b^{const}$ and the above contract works.

Now we turn our attention again to the original setting where the state can be G (good) or B (bad). To make this situation interesting we assume that the profit in the bad state is not high enough to pay b^{const} even if the agent has chosen $e = 1$. For clarity of exposition we assume that the firm cannot save or borrow money at the capital market. Allowing for this would not change the basic qualitative features of the model as long as there is still asymmetric information and an upper bound on how much the firm can borrow.

$$0 < \Pi\left(B, e = 1\right) - w = \bar{b} < b^{const}$$

Thus the simple contract described above can no longer be used to implement $e = 1$. In these bad states the agent actually gets a utility below his outside option and so a higher bonus $\hat{b} > b^{const}$ in the good state is needed such that the agent still finds it worthwhile to choose $e = 1$. Due to the agent's risk aversion it will be optimal for the firm to minimize the agent's wage fluctuation and pay him $\bar{b}$ in the bad state and thus forego any profits in these periods, $\Pi\left(B, e = 1\right) - w - \bar{b} = 0$.

We define the firm's profit in the good state when the agent exerts effort as

$$\Pi\left(G, e = 1\right) - w - \hat{b} = \Delta_{e=1}.$$

The following condition implicitly defines the minimum $\hat{b}$ that implements $e = 1$. Note that the worker does not know the state of the world when he chooses his effort. Furthermore, note also that in equilibrium he has to be indifferent between choosing $e = 0$ and $e = 1$, and that $\bar{b}$ is exogenously fixed as $\bar{b} = \Pi(B, e = 1) - w$.

$$\sum_{t=0}^{t=\infty} \delta^t \left[\pi(u(w + \hat{b})) + (1 - \pi)\left(u\left(w + \bar{b}\right)\right) - c\right] = \sum_{t=0}^{t=\infty} \delta^t \bar{U}$$

This formula is derived in Appendix C.

The interpretation of the above condition is as follows. The implicit contract has to generate enough expected utility in the future to make it worthwhile for the worker to forego his outside option and to incur the effort costs.

Now let us turn to incentive compatibility for the firm. The firm has to prefer to pay the bonus in both states of the world, B and G. Analyzing the problem yields that the condition in the good state is more restrictive and determines the upper bound for $\hat{b}$, $\hat{b}_{\max}$, that the firm would be willing to pay in order to implement $e = 1$.

$$\hat{b}_{\max} = \frac{\beta\pi}{(1 - \beta + \beta\pi)} \left[\Pi(G, e = 1) - w\right]$$

This formula is derived in Appendix D.

The interpretation of this formula is fairly straightforward. The firm's profits in the bad state are always 0. So the expected profits in the good state have to be sufficiently higher with $e = 1$ than with $e = 0$ in order to make up for the expected costs of paying the bonus. As we have assumed that effort is sufficiently productive it holds that $\hat{b}_{\max} > \hat{b}$.

Let us summarize these findings in the following proposition.

Proposition 1 *In a situation with stochastic shocks to the firm's profit as described above the following two strategies form an implicit contract that implements $e = 1$. The worker chooses $e = 1$ as long as the firm has paid the bonus, $\bar{b}$ in the bad state and $\hat{b}$ in the good state, in all previous periods. Once the firm has defaulted on paying the bonus the worker chooses $e = 0$ forever. The firm pays the base wage w and the bonus, $\bar{b}$ in the bad state and $\hat{b} > \bar{b}$ in the good state, in all periods as long as the worker has always chosen $e = 1$. The firm stops paying any bonus immediately after the worker has once chosen $e = 0$. $\bar{b}$ is defined* *by* $\Pi(b, e = 1) - w = \bar{b}$, w *is defined by* $u(w) = \bar{U}$ *and* $\hat{b}$ *is implicitly defined by*

$$\left[\pi(u(w + \hat{b})) + (1 - \pi)\left(u\left(w + \bar{b}\right)\right)\right] - c = \bar{U}.$$

3 Asymmetric Information Model

In this section we are going to assume that the true state of the world, G or B, is only observable to the firm. As a result, the above described implicit contract no longer works to implement $e = 1$ as the firm always has an incentive to claim that the state is B and save $\hat{b} - \bar{b}$ in bonus payments.

In this new environment the implicit contract has to be refined in order to still implement $e = 1$. We amend the equilibrium strategies such that whenever the firm announces that the state is B and the bonus payment will be $\bar{b}$ there follows a punishment phase of T periods where the worker chooses $e = 0$ and only w is paid, i.e. the equilibrium of the stage game is played. After these T periods firm and worker revert to the old cooperative equilibrium where the firm pays a bonus $\hat{b}^{asym}$ whenever the state is good and the worker has chosen $e = 1$. Another bad state with a bonus payment of $\bar{b}$ then triggers a new punishment phase. This type of reasoning borrows heavily from Green and Porter (1984) and Radner (1985).

Note that we do not have to check again that it is optimal for the firm not to default completely on the bonus. This would be detected by the worker and the condition is the same as the one under symmetric information.

However, for this new pair of strategies to be an equilibrium it has to hold that

a) the firm prefers to announce the state truthfully.

b) the worker prefers to execute the punishment.

c) the worker still prefers to choose $e = 1$ as long as the bonus is paid (and the game is not in a punishment phase).

We check these conditions now, starting with a). For the firm to prefer to announce the state truthfully the expected profits from this strategy have to exceed the expected profits from defecting. We only have to check this for the good state as the firm cannot deviate from truthtelling in the bad state as it cannot pay the high bonus.

By announcing state B when the actual state is G the firm saves $\hat{b}-\bar{b}$ on bonus payments. However, by announcing state B the firm triggers a punishment phase of T periods.

Define the continuation value of the firm's profits for announcing the state truthfully if the state is G as $V_F^C(G,1)$, where

$$V_F^C(G,1) = \Pi(G,1) - w - \hat{b}^* + \beta\left[\pi V_F^C(G,1) + (1-\pi) V_F^C(B,1)\right].$$

Define the continuation value of firm's profits if the state is B as $V_F^C(B,1)$, where

$$\begin{aligned} V_F^C(B,1) &= 0 + \beta V^P \\ &= \beta V^P. \end{aligned}$$

Define the continuation value of firm's profits at the beginning of a punishment period as V^P, where

$$\begin{aligned} V^P &= \sum^T \beta^t 0 + \beta^T \left[\pi V^C(G,1) + (1-\pi) V^C(B,1)\right] \\ &= \beta^T \left[\pi V^C(G,1) + (1-\pi) V^C(B,1)\right]. \end{aligned}$$

We can use this expressions to solve for these continuation values

$$\begin{aligned} V^C(G,1) &= \left[\Pi(G,1) - w - \hat{b}^*\right] \frac{1}{\left[1 - \frac{\beta\pi}{[1-(1-\pi)\beta^{T+1}]}\right]} \\ V^C(B,1) &= \left[\Pi(G,1) - w - \hat{b}^*\right] \frac{\beta^{T+1}\pi}{((1-(1-\pi)\beta^{(T+1)}) - \beta\pi)} \\ V^P &= \left[\Pi(G,1) - w - \hat{b}^*\right] \frac{\beta^T\pi}{[1-(1-\pi)\beta^{T+1} - \beta\pi]} \end{aligned}$$

The continuation value of the firm's profits if it announces state B when the true state is G, $V^D(G,1)$, is given by

$$\begin{aligned} V^D(G,1) &= \Pi(G,1) - w - \bar{b} + \beta V^P \\ V^D(G,1) &= \left[\Pi(G,1) - w - \bar{b}\right] + \left[\Pi(G,1) - w - \hat{b}^*\right] \frac{\beta^{T+1}\pi}{[1-(1-\pi)\beta^{T+1} - \beta\pi]} \end{aligned}$$

The firm has to prefer to announce the state truthfully. Thus it has to hold that

$$\begin{aligned} V^D(G,1) &\leq V^C(G,1) \\ \left[\Pi(G,1) - w - \bar{b}\right] &\leq \left[\Pi(G,1) - w - \hat{b}^*\right]\left[\frac{1-\beta^{T+1}}{\left[1-(1-\pi)\beta^{T+1}\right]-\beta\pi}\right]. \end{aligned}$$

Note that $\frac{1-\beta^{T+1}}{[1-(1-\pi)\beta^{T+1}]-\beta\pi}$ is increasing in T and that for $T=0$ this condition is violated as it would imply that

$$\left[\Pi(G,1) - w - \bar{b}\right] < \left[\Pi(G,1) - w - \hat{b}^*\right]$$

and thus that

$$\hat{b}^* < \bar{b}$$

which we know cannot be true. Thus there exists a $T>0$ for which this condition holds. In equilibrium the firm will be just indifferent and thus

$$\frac{\left[\Pi(G,1) - w - \bar{b}\right]}{\left[\Pi(G,1) - w - \hat{b}^*\right]} = \left[\frac{1-\beta^{T+1}}{\left[1-(1-\pi)\beta^{T+1}\right]-\beta\pi}\right]$$

implicitly defines the efficient length of the punishment phase T.

Now we check condition b), namely that the worker prefers to execute the punishment. Given the strategy of the firm, i.e. pay only w s.t. $u(w)=\bar{U}$ for T periods after announcing state B, the worker would not benefit at all from exerting high effort as he does not receive the discretionary bonus. Thus he has no incentive whatsoever to choose $e=1$ in these T periods..

Finally we check condition c) and show that the worker still prefers to choose $e=1$ as long as the firm has never defaulted on the bonus. The worker does not know which state will realize when he makes his effort choice and thus does not know whether he will receive bonus $\bar{b}$ or $\hat{b}^*$.

Define his expected utility as

$$\pi u(w+\hat{b}^*) + (1-\pi)\, u\left(w+\bar{b}\right) - c = EU_{e=1}^{asym} - c.$$

The continuation value for the worker's utility from exerting high effort, V_W^C, is given by

$$V_W^C = EU_{e=1}^{asym} - c + \delta\left(\pi V_W^C + (1-\pi)V_W^P\right)$$

where V_W^P defines the continuation value for the worker's utility at the beginning of a punishment phase which is defined as

$$\begin{aligned} V_W^P &= \sum_{t=0}^{T-1} \delta^t 0 + \delta^T V_W^C \\ V_W^P &= \delta^T V_W^C. \end{aligned}$$

We can use these two expressions to solve for V_W^C

$$\begin{aligned} V_W^C &= EU_{e=1}^{asym} - c + \delta\left(\pi V_W^C + (1-\pi) V_W^P\right) \\ V_W^C &= EU_{e=1}^{asym} - c + \delta\left(\pi V_W^C + (1-\pi)\delta^T V_W^C\right) \\ V_W^C &= \left(EU_{e=1}^{asym} - c\right) \frac{1}{1 - \delta\pi - (1-\pi)\delta^{T+1}}. \end{aligned}$$

The continuation value for the worker's utility from exerting low effort, V_W^D, is given by

$$V_W^D = \sum_{t=0}^{\infty} \delta^t \bar{U}.$$

When the agent chooses $e = 0$ he will get no bonus now or forever after and is just left with his outside option utility, $\bar{U}$.

To ensure incentive compatibility the agent has to weakly prefer to choose $e = 1$.

$$\begin{aligned} V_W^C &\geq V_W^D \\ \left(EU_{e=1}^{asym} - c\right) \frac{1}{1 - \delta\pi - (1-\pi)\delta^{T+1}} &\geq \sum_{t=0}^{\infty} \delta^t \bar{U} \end{aligned}$$

In equilibrium this condition will be binding.

$$\left(EU_{e=1}^{asym} - c\right) \frac{1}{1 - \delta\pi - (1-\pi)\delta^{T+1}} = \sum_{t=0}^{\infty} \delta^t \bar{U}$$

Compare this with the condition under symmetric information

$$\left(EU_{e=1}^{sym} - c\right) \frac{1}{1-\delta} = \sum_{t=0}^{t=\infty} \delta^t \bar{U}$$

where

$$EU_{e=1}^{sym} = \pi u(w + \hat{b}) + (1-\pi)\, u\left(w + \bar{b}\right).$$

The right hand side of both expressions is identical. Observe however that

$$\frac{1}{1-\delta\pi-(1-\pi)\delta^{T+1}}<\frac{1}{1-\delta}$$

for all $T>0$. This implies that

$$\begin{aligned} EU_{e=1}^{sym} &< EU_{e=1}^{asym} \\ \pi u(w+\hat{b})+(1-\pi)\,u\left(w+\bar{b}\right) &< \pi u(w+\hat{b}^{*})+(1-\pi)\,u\left(w+\bar{b}\right) \\ u(w+\hat{b}) &< u(w+\hat{b}^{*}). \end{aligned}$$

This implies that under asymmetric info the bonus paid to the worker in the good state has to exceed the bonus in the bad state.

We summarize these findings in the following proposition.

Proposition 2 *In a situation in which stochastic shocks to the firm's profit can only be observed by the firm itself, the following two strategies form an implicit contract that implements $e=1$. The worker chooses $e=1$ as long as the firm has not announced a bad state and has always paid the bonus, $\bar{b}$ in the bad state and $\hat{b}^{*}$ in the good state, in all previous periods. When the firm announces the bad state and pays $\bar{b}$ the worker chooses $e=0$ for T periods. Thereafter he moves back to choosing $e=1$ as long as the firm announces the good state and pays the bonus. Once the firm has defaulted on paying the bonus the worker chooses $e=0$ forever. The firm pays the base wage w and the bonus, $\bar{b}$ in the bad state and $\hat{b}$ in the good state, in all periods as long as the worker has always chosen $e=1$. After a bad state has occurred the firm pays no bonus for T periods. The firm stops paying any bonus immediately after the worker has once chosen $e=0$. $\bar{b}$ is defined by $\Pi(B,e=1)-w=\bar{b}$, w is defined by $u(w)=\bar{U}$ and $\hat{b}^{*}$ and T are implicitly defined by the following conditions*

$$\begin{aligned} \frac{\left(\pi u(w+\hat{b}^{*})+(1-\pi)\,u\left(w+\bar{b}\right)-c\right)}{1-\delta\pi-(1-\pi)\delta^{T+1}} &= \frac{1}{1-\delta}\bar{U} \\ \frac{\left[\Pi\left(G,1\right)-w-\bar{b}\right]}{\left[\Pi\left(G,1\right)-w-\hat{b}^{*}\right]} &= \left[\frac{1-\beta^{T+1}}{\left[1-(1-\pi)\,\beta^{T+1}\right]-\beta\pi}\right]. \end{aligned}$$

4 Institutions

This section describes the possible roles that different institutions may have in the light of the model presented above. In particular, institutions may serve to move the nature of the interaction from one of asymmetric to one of symmetric information. First, we briefly compare the properties of the implicit contract under symmetric and asymmetric information and summarize the patterns derived from the models above.

Under symmetric information high effort, $e = 1$, is always chosen and the bonus is either $\bar{b}$ or $\hat{b}$. Under asymmetric information there are periods of $e = 1$ with payments of $\hat{b}^* > \hat{b}$ or $\bar{b}$, where the latter immediately triggers a punishment phase, and periods of shirking, $e = 0$, with no bonus at all. Thus along the equilibrium path there are cooperative and non-cooperative phases, neatly resembling the actual situation in ongoing organizations. During the punishment phases the efficient level of effort, $e = 1$, is not implemented and thus profits are lost as compared to the case with symmetric information as the parties "miss out on some good periods". In addition, in the good states the firm has to pay a higher bonus to the worker. Thus the model implies that the firm would like to change the nature of the interaction to be one with symmetric information. The following labor market institutions may help the firm achieve this goal.

4.1 Unions

As discussed above, overcoming the asymmetric information problem would lead to a situation where more rents would be generated. Unions may be one institution that could well help to achieve this goal. The idea that unions may improve welfare is not a new one. Malcomson (1983) has argued that unions may be beneficial in the context of optimal risk sharing between workers and firms by overcoming the collective action problem between workers. Hogan (2001) uses this argument to show that unions enable firms to increase the size of their labor force.

In the context of our model unions may be beneficial in the following way. Consider the case where the true state of the world is observable, although it requires a costly investment to do so. The costs are such that it does not pay for an individual worker to acquire this information, but it would be worthwhile for all workers. This is evocative of Shleifer and

Vishny's (1986) model of corporate governance where monitoring effort is underprovided as the small shareholders of a dispersedly held firm are prone to free-riding on other shareholders' monitoring effort. The workers in our model are faced with a very similar collective action problem. If it were solved, the efficiency of the entire interaction could be largely improved as full cooperation without punishment phases could be achieved on the equilibrium path. Unions can serve as a coordination device to overcome this collective action problem. Interpreting the role of unions from this perspective can help to shed light on a very puzzling empirical regularity: nominal wage cuts are almost never observed. But if they are observed they occur almost always in unionized firms. We would argue that this is the case as unionization allows the firm to credibly transmit that it is in a dire state and has to cut wages. In a non-unionized firm this information could not be as credibly transmitted and wage cuts would thus lead to a very harsh reaction by the workers.[2]

In a similar vein, Freeman and Lazear (1994) stress the important role of work councils in facilitating the transmission of information between management and workers.

4.2 Improving financial Literacy

Firms can take steps to lower individual workers' costs of observing the true state of the world. This could explain the endeavors of firms to improve the financial literacy of their staff. A prominent example is Gordon Cain who was one of the precursors of the LBO wave in the 80s and who dedicated careful attention to make the workers of acquired firms aware of the true financial situation of their firms such that they were willing to support his suggested course of restructuring. A more recent example is Jack Welch who stresses in his books, e.g. Welch and Welch (2005), the importance of transparency for a successful management strategy. For him it is pivotal that workers understand the situation of the firm and are willing to follow management's suggestions to cope with challenges.

[2] Of course there is also a cost associated with unions. Allowing the workers to organize themselves will most likely help them to bargain for a greater share of the profits. However, note that these profits are now bigger. Thus, for the firm it might be still worth while to receive now a smaller share of a bigger pie.

4.3 New HRM Practices

Firms employ more and more novel human resource management practices. For evidence on these c.f. Ichniosky, Shaw, and Prennushi (1997) and the references therein. Many of those novel human resource management practices, like team-based work organization, problem solving teams, or carefully designed communication procedures can be interpreted as allowing the worker to understand the situation of the firm in a more holistic manner and thus be better able to judge the true situation of the firm.

5 A Sketch of a Richer Model

We believe that the basic logic of our model carries over to richer settings than those of our admittedly very stylized model. In a richer model one would like to see firms employing more than one worker. In this setting the firm has an additional strategic variable next to the bonus payment, namely its employment level. Grossman and Hart (1981) analyze a similar setting in the context of optimal risk sharing between workers and firms.

The structure of an equilibrium following our basic logic should have high effort all along the way but the firm would be forced to reduce employment after announcing a bad state and thus forego profits if it lied about the state. This model would endogenously generate recalls on the equilibrium path, an issue that has been widely studied among labor economists because of its important effects on the unemployment rate.[3]

More generally, in the light of our suggested interpretation of the role for institutions like unions, we could derive novel predictions about the relation between layoffs and unionization. Medoff (1979) and Grossman (1983) are early examples of studies on this issue.

If we model the labor market more completely, with several firms where the shocks to those firms can be imperfectly correlated we can derive also implications for fluctuations of unemployment. Kennan (2005) does this in his analysis of a matching model of the labor market under asymmetric information.

[3]Some examples of such studies are Katz (1986), Katz and Meyer (1990), Anderson (1992), Idson and Valetta (1996), or Burgess and Low (1998).

Another interesting extension would be to allow for heterogeneous workers. Given these heterogeneous agents we would get endogenously a ranking what worker to lay off or send on recall under which conditions. So we could endogenously generate "seniority" based firing rules.

Other possibilities for potentially interesting extensions are to allow for explicit incentive contracts as in Baker, Gibbons, and Murphy (1994) or to consider the effects on investments in human capital.

6 Conclusion

We presented a stylized model that generates non-trivial dynamic patterns in an ongoing firm-worker relationship. Though firm and worker are in an ongoing implicit contract there are phases of cooperation and phases of punishment along the equilibrium path. The reason for the punishment phases is that the firm needs to be deterred from announcing a false state of the world and reneging on the contractually specified bonus payments. The basic logic of the model resembles the reasoning in Green and Porter (1984).

We have shown that the punishment phases that are needed in the case of asymmetric information to implement the high effort levels at least for the cooperative periods reduce the totally accrued profits. Thus being able to shift the situation from one of asymmetric to one with symmetric information could lead to a Pareto improvement. We discussed how institutions like unions, worker councils, or some of the novel human resource management practices can help to achieve this goal.

Finally, we discussed how the model could be extended to account for more realistic employment situations and richer stochastic structures and how it then could be used to shed new light on issues like recalls or unemployment cycles.

7 Appendix

7.1 Appendix A

Given the firm's strategy the worker has to be indifferent between choosing $e = 0$ and $e = 1$.

His discounted utility from exerting effort is given by

$$\sum_{t=0}^{t=\infty} \delta^t \left(u \left(w + b \right) - c \right).$$

His discounted utility from defecting, i.e. choosing $e = 0$ in a given period is given by

$$\sum_{t=0}^{t=\infty} \delta^t \bar{U}.$$

This implicitly defines b^{const} - the minimum bonus that implements $e = 1$ as the worker has to be indifferent between choosing $e = 0$ and $e = 1$.

$$\begin{aligned} \sum_{t=0}^{t=\infty} \delta^t \left(u \left(w + b^{const} \right) - c \right) &= \sum_{t=0}^{t=\infty} \delta^t \bar{U} \\ \sum_{t=0}^{t=\infty} \delta^t u \left(w + b^{const} \right) &= \sum_{t=0}^{t=\infty} \delta^t \left(\bar{U} + c \right) \end{aligned}$$

7.2 Appendix B

Given the worker's strategy the firm has to be at least weakly better off from implementing $e = 1$.

The discounted sum of firm's profits from adhering to pay the bonus b is given by

$$\sum_{t=0}^{t=\infty} \beta^t \left(\Pi \left(G, e = 1 \right) - w - b \right) = \frac{1}{1 - \beta} \left(\Pi \left(G, e = 1 \right) - w - b \right).$$

The discounted sum of firm's profits from defaulting on b is given by

$$\begin{aligned} \Pi \left(G, e = 1 \right) - w + \sum_{t=1}^{t=\infty} \beta^t \left[\Pi \left(G, e = 0 \right) - w \right] &= \Pi \left(G, e = 1 \right) - w + 0 \\ &= \Pi \left(G, e = 1 \right) - w \end{aligned}$$

Thus the following condition defines the maximum level $b_{\max}^{const}$ that the bonus can take on.

$$
\begin{aligned}
\frac{1}{1-\beta}\left(\Pi\left(G,e=1\right)-w-b_{\max}^{const}\right) &= \Pi\left(G,e=1\right)-w \\
\beta\left(\Pi\left(G,e=1\right)-w\right) &= b_{\max}^{const}
\end{aligned}
$$

7.3 Appendix C

The worker has to be indifferent between choosing $e=0$ and $e=1$. Note that the bonus in the bad state, $\bar{b}$, is exogenously fixed. Furthermore recall that the worker does not know the state of the world when he decides how much effort to exert.

The discounted sum of the worker's expected utility from exerting effort $e=1$ is given by the expected utility he gets today and in the future and the effort costs he has to incur.

$$
\sum_{t=0}^{t=\infty}\delta^{t}\left[\pi(u(w+\hat{b}))+(1-\pi)\left(u\left(w+\bar{b}\right)\right)-c\right]
$$

The discounted sum of the worker's expected utility from defecting, i.e. choosing $e=0$ in the current period is given by

$$
\sum_{t=0}^{t=\infty}\delta^{t}\bar{U}.
$$

This comes from the fact that the agent will be employed, will not exert effort and will get paid only w s.t. $u(w)=\bar{U}$.

This implicitly defines the minimum $\hat{b}$ to implement $e=1$ as the worker has to be indifferent between choosing $e=0$ and $e=1$ and $\bar{b}$ is exogenously fixed.

$$
\sum_{t=0}^{t=\infty}\delta^{t}\left[\pi(u(w+\hat{b}))+(1-\pi)\left(u\left(w+\bar{b}\right)\right)-c\right]\geq\sum_{t=0}^{t=\infty}\delta^{t}\bar{U}
$$

In equilibrium this condition will bind

$$
\sum_{t=0}^{t=\infty}\delta^{t}\left[\pi(u(w+\hat{b}))+(1-\pi)\left(u\left(w+\bar{b}\right)\right)-c\right]=\sum_{t=0}^{t=\infty}\delta^{t}\bar{U}.
$$

7.4 Appendix D

The firm has to prefer to pay the bonus in both states of the world, B and G.

The firm's decision in the bad state

The total firm profits if bonus is not paid in this case is the sum of the profit today, $\Pi(B, e = 1) - w$, plus the discounted value of the expected profit tomorrow and for all periods thereafter. The expected profit tomorrow (and forever after) is given by

$$\begin{aligned} \pi(\Pi(G, e = 0) - w) + (1 - \pi)(\Pi(B, e = 0) - w) &= \\ \pi 0 + (1 - \pi) 0 &= 0 \end{aligned}$$

Thus the discounted sum of firm's profit if it defaults on the bonus is given by

$$\Pi(B, e = 1) - w + \sum_{t=1}^{t=\infty} \beta^t 0 = \Pi(B, e = 1) - w.$$

The total expected firm profit if the bonus is paid and the state is bad is given by the sum of the profit today, $\Pi(B, e = 1) - w - \bar{b} = 0$, and the discounted value of the expected profit tomorrow and for all periods thereafter. In this case, the expected profit tomorrow (and forever after) is given by

$$\begin{aligned} \pi\left[\Pi(G, e = 1) - w - \hat{b}\right] + (1 - \pi)\left[\Pi(B, e = 1) - w - \bar{b}\right] &= \\ \pi\left[\Pi(G, e = 1) - w - \hat{b}\right] + (1 - \pi) 0 &= \pi\left[\Pi(G, e = 1) - w - \hat{b}\right] \end{aligned}$$

We define:

$$\Pi(G, e = 1) - w - \hat{b} = \Delta_{e=1}$$

Thus the discounted sum of firm's profit if it pays the bonus is given by

$$\sum_{t=1}^{t=\infty} \beta^t \pi \Delta_{e=1}.$$

The firm has to (weakly) prefer paying the bonus

$$\begin{aligned} \Pi(B, e = 1) - w &\leq \sum_{t=1}^{t=\infty} \beta^t \pi \Delta_{e=1} \\ \Pi(B, e = 1) - w + \sum_{t=1}^{t=\infty} \beta^t \pi \hat{b} &\leq \sum_{t=1}^{t=\infty} \beta^t \pi \left[\Pi(G, e = 1) - w\right]. \end{aligned}$$

The firm's decision in the good state

The total firm profit if it defaults on the bonus and the state is good is the sum of the profit today, $\Pi(G, e=1) - w$, plus the discounted value of the expected profit tomorrow and for all periods thereafter, $\pi[\Pi(G, e=0) - w] = 0$. Thus the discounted sum is given by

$$\Pi(G, e=1) - w + \sum_{t=1}^{t=\infty} \beta^t 0 = \Pi(G, e=1) - w.$$

The total firm profit if the bonus is paid and the state is good is the sum of the profit today, $\Pi(G, e=1) - w - \hat{b} = \Delta_{e=1}$, plus the discounted value of the expected profit tomorrow and for all periods thereafter, $\pi\left[\Pi(G, e=1) - w - \hat{b}\right] = \pi\Delta_{e=1}$. Thus the discounted sum is given by

$$\Delta_{e=1} + \sum_{t=1}^{t=\infty} \beta^t \pi \Delta_{e=1}.$$

The firm has to (weakly) prefer to pay the bonus, i.e.

$$\begin{aligned} \Pi(G, e=1) - w &\leq \Delta_{e=1} + \sum_{t=1}^{t=\infty} \beta^t \pi \Delta_{e=1} \\ \hat{b} + \sum_{t=1}^{t=\infty} \beta^t \pi \hat{b} &\leq \sum_{t=1}^{t=\infty} \beta^t \pi [\Pi(G, e=1) - w]. \end{aligned}$$

Now we compare the two conditions for the firm in the good and the bad state:

state G

$$\hat{b} + \sum_{t=1}^{t=\infty} \beta^t \pi \hat{b} \leq \sum_{t=1}^{t=\infty} \beta^t \pi [\Pi(G, e=1) - w]$$

state B

$$\Pi(B, e=1) - w + \sum_{t=1}^{t=\infty} \beta^t \pi \hat{b} \leq \sum_{t=1}^{t=\infty} \beta^t \pi [\Pi(G, e=1) - w]$$

Note that the right hand side of both conditions is identical. Further note that by the assumptions above it is implied that

$$\Pi(B, e=1) - w < \hat{b}$$

Thus the condition in the good state is more restrictive and determines implicitly the upper bound for $\hat{b}$, $\hat{b}_{\max}$, that the firm would be willing to pay in order to implement $e = 1$.

$$\begin{aligned} \hat{b}_{\max} + \sum_{t=1}^{t=\infty} \beta^t \pi \hat{b}_{\max} &= \sum_{t=1}^{t=\infty} \beta^t \pi \left[\Pi \left(G, e = 1 \right) - w \right] \\ \hat{b}_{\max} &= \frac{\beta \pi}{(1 - \beta + \beta \pi)} \left[\Pi \left(G, e = 1 \right) - w \right] \end{aligned}$$

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