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Abstract

We look at a principal–agent model in which the agent has to perform an action, the difficulty of which is better known ex interim than ex ante. We compare two contracting regimes; one with commitment to an ex ante negotiated contract, and one with an ex interim negotiated contract. The ex ante contract can not be too steep, but attempts to negotiate a steeper ex interim contract may result in bargaining failure. We find that the relative efficiency of the two contracting regimes depends on the nature of the differences between tasks. In a dynamic version of the analysis, we further find that the comparison depends on the frequency with which new tasks are needed. The argument can be interpreted as an analysis of the tradeoff between weak incentives in the firm and the possibility of unsuccessful negotiations in the market.

I. INTRODUCTION

The paper compares more or less frequently negotiated incentive contracts in a dynamic environment. Given a series of tasks of varying difficulty, a long-term contract will on the average not be second best, but if the players try to negotiate a sequence of short-term contracts they will occasionally fail to reach agreement. The efficiency and sustainability of the two contracting regimes is found to depend on how the tasks differ and how often they change. The comparison can be interpreted as the tradeoff between weak incentives in the firm and the costs of bargaining in the market.

The first step of the argument is made in the context of a single period principal-agent model in which the agent has to perform an ex ante unknown "ideal" task. The difficulty of the ideal task is ex ante unknown, but as it is identified, both players get private and public information about its difficulty. We compare the most efficient contracts from two different regimes: in the "Spot contracting" regime the players try to negotiate a contract after the ideal task has been identified (ex interim), and in the "Robust contracting" regime the parties are constrained to an ex ante negotiated contract. The advantage of Spot contracting is that more information is known at the time of contracting, such that the incentives can be tailored to the task. The problem is that the players negotiate the contract under asymmetric information and thus risk suffering bargaining failures. The pros and cons of Robust contracting are the reverse. Negotiation takes place ex ante, before any informational asymmetries are realized, but the contract can not depend on the difficulty of the ideal task. Comparing the two regimes, we therefore find that incentives are steepest under Spot contracting, while Robust contracting is more likely to implement the ideal task. In terms of efficiency, the result is, roughly, that Robust contracting is relatively more attractive when the players have more private and less common information about the difficulty of specific tasks.

Informally taking a further step, we proceed to imbed the model in a dynamic setting in which the agent has to perform a sequence of different ideal tasks. In this context, we look at the players' temptation to renegotiate a Robust contract as well as conditions under which the prospect of future bargaining will enhance the efficiency of Spot contracting. Both game forms are found to be asymptotically efficient, but the cost of contracting suggests that we should be more likely to see Robust contracts when the ideal tasks change frequently. We go on to suggest that the dynamic version of the model speaks to the theory of the firm by illuminating the tradeoff between weak incentives in settings where one player "follows orders" and the costs of bargaining in the market.

Contracts between manufacturers and sales people illustrate the basic tradeoffs in the model. Over time, the manufacturer will often want to realign sales person territories and change the set of products sold. If the sales person is an employee, these adjustments are normally handled without any change in the compensation contract; the sales person still gets a salary and a percentage of sales as commission. In contrast, if the sales person is an independent representative, all changes in territory and many changes in products will trigger renegotiation of the contract. These renegotiations occasionally fail, leading to dissolution of the relationship and/or expensive legal action (Novick, 1988, Chpts. 11 and 12). On the other hand, independent representatives will normally have steeper commission rates than employees (Kotler, 2000, p. 498).

The paper has some relation to the literature on commitment. In particular Fudenberg, Holmstrom, and Milgrom (1990) who also compare the performance of a single long–term agency contract to that of a sequence of short–term contracts. They show that the former can be better if there is asymmetric information at the time of recontracting, exactly the case we are looking at. However, the possibility of failed negotiations does not play a role in their analysis.

The most closely related work is that of Bajari and Tadelis (2001) and Tadelis (2002), who also show that robust incentives can not be too steep when there is possibility of bargaining failure. In the former paper, the central endogenous variable is the probability of renegotiation as determined by the extent to which an incentive contract is complete. This is then compared to an alternative contract that is completely flat and therefore can be costlessly renegotiated. Based on these results, Tadelis (2002) assumes that steeper contracts cause renegotiation costs to go up. In both cases, the idea is that steepness affects bargaining costs. In the present paper, the causality goes the other way. Bargaining costs are incurred on a per renegotiation basis, but a more frequently renegotiated contract can be steeper because more relevant information is known at the time of writing.

We next derive the central result of the paper in a very simple one-period setting, while the dynamic extension is discussed in Section III. Sections IV and V contain a discussion of limitations and an interpretation of the results as speaking to the theory of the firm.

II. STATIC MODEL

A seller may create value for a buyer by exerting effort on one of a large number of possible tasks. Only the ideal task has value, and the identity of this task is ex ante unknown. We use the subscript j to indicate a specific task, and introduce ex interim information in a very simple way by assuming that output is given by

$$x_j = e_j + \varepsilon_{js} + \varepsilon_{jp} + \varepsilon_{jb} + \varepsilon_t, \qquad (1)$$

where e_j is effort, ε_{js}, ε_{jp}, and ε_{jb} are task-specific difficulty parameters, and ε_t is noise.[1] We assume that ε_{js}, ε_{jp}, ε_{jb}, and ε_t are independently distributed as $N(0,\sigma_s^2)$, $N(0,\sigma_p^2)$, $N(0,\sigma_b^2)$, and $N(0,\sigma_t^2)$, respectively. The seller's cost of effort is $e_j^2/2$, and if he gets payments w, his utility is $-\exp[-\gamma(w- e_j^2/2)]$, where $\gamma>0$. The buyer is risk-neutral and each unit of the ideal task is worth 1 to her, while non-ideal units are worth nothing.

In the Robust contracting regime the players negotiate a contract ex ante. Ex interim, the identity of the ideal task is revealed to both players. Based on this, the seller can infer ε_{js}, the buyer can infer ε_{jb}, and both players can infer ε_{jp}. In the Spot contracting regime the players point negotiate over $w_j(x_j)$ at this point. Because they have two-sided asymmetric information, these negotiations may fail (Myerson and Satterthwaite, 1983). To keep the analysis simple, we make an assumption about the probability of bargaining failure in the Spot contracting regime:

(A1) The probability of failed bargaining is a constant λ.

[1] An alternative, perhaps more appealing formulation is one in which the buyer's valuation and the seller's costs are imperfectly known ex ante. Such a formulation yields similar results.

This assumption is very strong since one would expect specific bargaining outcomes to depend on the realizations of ε_{js}, ε_{jp}, and ε_{jb}. In particular, since bargaining is more likely to fail when gains from trade are smaller, *(A1)* burdens the Spot contracting regime with "too much" inefficiency. However, the simplification is defensible because the expected losses from bargaining failure remain positive, while they are zero in the Robust contracting regime (where the players negotiate under symmetric information).

Still aiming to keep the analysis simple, we furthermore assume that:

(A2) The negotiated Spot contracts are independent of the realizations of ε_{js} and ε_{jb}.

Also this assumption is very strong because one would expect the negotiated contracts to depend on the players' private information at the time of bargaining. Ex post, this would reduce the players' uncertainty and thus the risk-costs associated with Spot contracts. So *(A2)* endows the Spot contracting regime with incentives that are "too flat". However, the simplification is defensible because we find that even the incentives resulting from *(A2)* are steeper than those in the Robust contracting regime.

Given the structure of the model, we can invoke the usual arguments to focus on linear contracts of the form $w_j(x_j) = \alpha_j x_j + \beta_j$ in the Spot contracting regime and $w(x_j) = \alpha x_j + \beta$ in the Robust contracting regime (Holmstrom and Milgrom, 1987). We assume that the buyer selects α_j (α), while the players negotiate over β_j (β) to determine the amount of surplus the seller can expect. After the seller has chosen and expended effort, the noise is realized and output is measured.

In the context of this model, the two contracting regimes can be more specifically defined and analyzed as follows.

-*Spot contracting*: At the start of the game, the ε_{js} and ε_{jp} associated with the ideal task are revealed to the seller, while the buyer learns the realizations of ε_{jp} and ε_{jb}. The players then proceed to negotiate over $w_j(x_j)$. Per *(A1),* these negotiations fail with probability λ. After agreement on a contract, the seller chooses a level of effort, output is observed, and payments are made. Neither gets any payoff without a contract.

In this regime, the seller's certainty equivalent payoff is given by

$$\alpha_j(e_j + \varepsilon_{js} + \varepsilon_{jp}) + \beta_j - e_j^2/2 - \gamma\alpha_j^2(\sigma_b^2 + \sigma_t^2)/2. \qquad (2)$$

So he sets $e_j^s=\alpha_j$, and if bargaining succeeds, the negotiated fixed payment is

$$\beta_j^s = - \alpha_j^2/2 - \alpha_j\, \varepsilon_{jp} + \gamma\alpha_j^2\ (\sigma_b^2 + \sigma_t^2)/2 + \pi, \qquad (3)$$

where π is the seller's expected surplus and we rely on *(A2).* Given this, the buyer's expected payoff is

$$\alpha_j + \varepsilon_{jp} + \varepsilon_{jb} - \alpha_j^2/2 - \gamma\alpha_j^2\ (\sigma_b^2 + \sigma_t^2)/2 - \pi, \qquad (4)$$

and she therefore sets

$$\alpha_j^s = 1/(1+ \gamma[\sigma_b^2 + \sigma_t^2]). \qquad (5)$$

Because negotiations may fail, no task is implemented with probability λ.

- *Robust contracting*: Before the ideal task is identified, the players negotiate a contract $w(x_j)$. Because this contract is negotiated before any asymmetric information is revealed, the negotiation succeeds with probability one. After negotiations, the ε_{js} and ε_{jp} associated with the new ideal task are revealed to the seller, while the buyer learns the realizations of ε_{jp} and ε_{jb}. At this point the players can neither renegotiate the contract, nor exit the relationship. Instead, the buyer asks the seller to work on the ideal task, the latter chooses a level of effort, output is observed, and payments are made.

A Robust contract gives the seller an expected certainty equivalent payoff of

$$\alpha e_j + \beta - e_j^2/2 - \gamma\alpha^2(\sigma_s^2 + \sigma_p^2 + \sigma_b^2 + \sigma_t^2)/2. \tag{6}$$

So he will set $e_j^r = \alpha$, and the negotiated fixed payment is

$$\beta^r = -\alpha^2/2 + \gamma\alpha^2(\sigma_s^2 + \sigma_p^2 + \sigma_b^2 + \sigma_t^2)/2 + \pi. \tag{7}$$

Given this, the buyer's expected payoff is

$$\alpha - \alpha^2/2 - \gamma\alpha^2(\sigma_s^2 + \sigma_p^2 + \sigma_b^2 + \sigma_t^2)/2 - \pi. \tag{8}$$

She therefore sets

$$\alpha^r = 1/(1 + \gamma[\sigma_s^2 + \sigma_p^2 + \sigma_b^2 + \sigma_t^2]), \tag{9}$$

and the regime implements the ideal task with probability one.

Comparing the two contracting regimes, we see that the incentives are steepest under Spot contracting, while Robust contracting implements more of the ideal tasks. To make statements about the relative efficiency of the two regimes, we first maintain the (unreasonable) assumption that the probability of bargaining failure (λ) is independent of the extent of asymmetric information (σ_s^2, σ_b^2). In this case *(5)* and *(9)* suggest that Spot contracting is relatively more efficient when the seller has more important private information about task-specific difficulty (σ_s^2), when there is more public information about task-specific difficulty (σ_p^2), and when the buyer has less important private information about task-specific difficulty (σ_b^2). Under the realistic assumption that the probability of bargaining failure is larger when there is more asymmetric information, the effect of increases in the seller's private information (σ_s^2) becomes ambiguous. So we can conclude that *Robust contracting is relatively more efficient when the difficulty of tasks appear less similar to the buyer, but more similar to the public.*

We will now look at a dynamic version of the model to discuss the players' incentives to break the robust contract as well as the possibility that they treat spot contract bargaining as a repeated game.

III. DYNAMIC EXTENSION

The static analysis of the Robust contracting regime was based on the assumption that the players refrain from renegotiating the contract. When Robust contracting is most efficient in a static setting, this absence of renegotiation can possibly be justified in a dynamic version by appeal to an implicit contract in the form of a subgame perfect equilibrium of the repeated game. There is a sea of such equilibria: the players may employ trigger strategies prescribing permanent reversal to Spot contracting after any attempt to renegotiate the Robust contract, they may allow each other a limited number of negotiations per block of periods, or the strategies may be more complicated. In the most efficient equlibria, a player will elect to renegotiate only when he or she is faced with an extreme realization of task difficulty in the form of a low $\varepsilon_{js}+\varepsilon_{jp}$ for the seller or a high $\varepsilon_{jp}+\varepsilon_{jb}$ for the buyer. As we know from the folk theorem, deviations from the commitment not to renegotiate become increasingly rare as the inter-period discount rate decreases.

In the context of the model, it does not seem particularly relevant to compare situations with larger or smaller “per-year” discount factors. It is much more interesting to contrast situations in which the ideal task changes more or less frequently. To model this, we hold constant the mean and variance of “yearly” output and look at the effects of having $n>1$ periods per year. In this case the inter-period discount factor is the nth root of the “year-to-year” discount factor and by the usual arguments about the inter-period discount factor, fewer attempts at renegotiation are sustainable if needs for adjustments occur more often. In addition, because the variance in individual realizations is smaller, the slope of the Robust contract is now

$$\alpha^r = 1/(1+ \gamma[\sigma_s^2 + \sigma_p^2 + \sigma_b^2 + \sigma_t^2]/n). \qquad (10)$$

Since the limit of this is 1, we conclude that Robust contracting becomes asymptotically sustainable and first best as the frequency of adjustments grows. So two forces help enhance the sustainability of Robust contracting as adjustments occur more often: High inter-adjustment discount factors makes it is easier to uphold an implicit contract not to renegotiate and the reduced standard deviation of each adjustment allows the use of a closer-to-first-best contract.

The analysis of repeated Spot contracting is also different because of the possibility that the bargaining becomes more efficient than was feasible on a static basis. If bargaining strategies can depend on actions in past bargains, the players could play more efficient equilibria and enhance the performance of Spot contracting. In particular, it may be possible to reduce the probability of bargaining failure by playing strategies that allow the players to pool some of the incentive constraints over several bargaining occasions

(Levin, 2003). Again invoking super-game arguments, failures should be less common if the inter-period discount factor is higher.

Furthermore, there is again a direct effect on incentive-strength mirroring that in *(10),* such that with *n* "yearly" adjustments

$$\alpha_j^s = 1/(1+ \gamma[\sigma_b^2 + \sigma_t^2]/n). \tag{11}$$

So also for Spot contracting, there are two forces helping to enhance its efficiency as adjustments occur more often: High inter-adjustment discount factors makes bargaining more efficient and the reduced standard deviation of each adjustment allows the use of a closer-to-first-best contract.

Since both regimes asymptotically can implement the first best, the arguments in the present paper do not help us choose one or the other. However, this does mean that frequent adjustments render the choice irrelevant. When changes occur with very high frequency, it may be necessary to worry about the additional communication/ bargaining activity demanded by Spot contracting. If the players anyway are going to agree on a contract that differs very little from the most recent one, is it hardly worth spending time discussing it (Wernerfelt, 1997).

IV. LIMITATIONS

The two game forms compared in the previous sections are obviously not the only candidates. A particularly interesting alternative is a mechanism in which the seller can select from an ex ante designed menu of contracts after he has received his private information. The advantage of such an arrangement is that it allows the players to avoid negotiating under asymmetric information and thus the risk of bargaining failure.

However, because the scheme can not offer the seller less risk that Spot contracting and the contracts have to differ in terms beyond the intercept, the “truth-telling” constraints force some distortions on the incentives. So while a menu based game form may be more efficient in some regions of the parameter space, it does not dominate either of the two we look at. (It is also interesting that we see so few “real life” examples from this class of game forms.)

Consistent with the sales force example from the Introduction, the model assumes the availability of a single scale on which all possibly ideal tasks can be measured. In many cases this seems like a fair assumption because agents often perform a rather narrow range of tasks. For example, the tasks could consist of sewing different models of clothes or washing different windows. On the other hand, there are clearly other examples, such as secretarial work, in which the natural units of different tasks are very heterogeneous. In such cases, the only feasible Robust contract is flat. While such contracts obviously have poor incentive properties, they may still be preferred to Spot contracts, especially when combined with some subjective measures.

V. INTERPRETATION

If we interpret the Robust contracting game form as an employment relationship, the paper is part of a literature that highlights a bargaining-cost explanation for the existence of firms. With this interpretation, the paper contributes to the literature on low-powered incentives in the firm. It is widely believed that employees face less steep incentives than independent contractors and the ability to rationalize this is considered an important property of a theory of the firm. Most arguments offered in the literature are based on the definition that the employee does not own the productive assets. This implies that he can not successfully bargain for a large share of surplus (Grossman and Hart, 1986), can not be compensated for hard-to-measure additions to residual claims (Holmstrom and Milgrom, 1994), and should not be tempted to abuse the assets too much (Williamson, 1985, p.132). The present argument is radically different; it does not depend on assets, and the distinction between boss and employee is not drawn based on asset ownership. Consistent with the adjustment–cost theory of the firm (Wernerfelt, 1997; 2002; Simester and Knez, 2002), we instead define employee–status by an agreement to follow a sequence of orders without seeking to renegotiate the contract at each turn.

It is also interesting to compare our findings to Simon's (1951) argument that employment is more attractive when the variance in the cost of tasks is smaller. He makes an implicit super-game argument and relies on the possibility that the employee may quit if faced with a very adverse cost-realization. He does not allow this in the market. We are looking at the polar opposite case by assuming that the players always honor the robust (employment) contract, but may fail to reach agreement in the market. If the probability of failed negotiation depends very steeply on the extent of private information we then get the opposite result, that the market is more efficient if there is less variance in the components of difficulty about which the players are privately informed. However, in the case of public information, our model agrees with Simon since less variance in the components of difficulty about which both players are informed adds to the relative efficiency of employment by limiting the associated decay of incentives.

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