# The Employment Relation and the Theory of the Firm: Arm's Length Contracting vs Authority[1]

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**Abstract**

We develop a theory of the firm based on the notion of authority and present a model which captures the main elements that characterize a firm as envisioned by Ronald Coase (1937). Bilateral spot contracting between a buyer and a seller of services may result in inefficient trade due to transactions costs (here asymmetric information). An authority mode can improve efficiency through repeated interaction by changing the timing of payments (or bonuses) to when private information gets revealed. Whether an authority relation emerges or not depends on the frequency of interaction and the inefficiency of spot contracting. The paper extends the analysis to a trilateral contract setting and develops a theory of the boundaries of the firm and the internal hierarchical structure based on returns to scope arising out of efficiency rents.

[1] Preliminary Draft - Comments Welcome

## 1 Introduction

In this paper we re-examine an important theme in the article by Coase (1937) on the theory of the firm that has been somewhat neglected by the recent property rights theory of Grossman and Hart (1986) and Hart and Moore (1990). In a nutshell the property rights theory (in its simplest form) views the firm as a collection of assets owned by some owner-manager. The owner has residual rights of control over the use of the asset and ownership serves the purpose of protecting the manager's returns from (asset specific) investment in human capital. Ownership strengthens the bargaining position of the manager in multilateral negotiations with other input suppliers so that the manager is able to appropriate a bigger share of the surplus created by her investment in human capital.

The property rights view does not draw a distinction between transactions inside the firm and other transactions in the market place: all transactions take place in the open market. Only the price varies with different allocations of asset ownership.[2] In contrast Ronald Coase and Oliver Williamson, followed by others draw an important distinction between "internal" and "external" transactions. Their main focus is on the question of what determines whether a transaction is internal or external to the firm as opposed to which assets should be controlled by a given manager.

Some of the determinants of the choice between internal and external transaction modes Ronald Coase points to are described in the following famous passage:

> There are, however, other disadvantages - or costs - of using the price mechanism. It may be desired to make a long-term contract for the supply of some article or service. This may be due to the fact that if one contract is made for a longer period, instead of several shorter ones, then certain costs of making each contract will be avoided. Or, owing to the risk attitude of the people concerned, they may prefer to make a long rather than a short-term contract.

[2] The equilibrium terms of trade may also depend on the degree to which the contracting parties are "locked in" by their ex-ante asset specific investments.

Now, owing to the difficulties of forecasting, the longer the period of the contract is for the supply of the commodity or service, the less possible, and indeed, the less desirable it is for the person purchasing to specify what the other contracting party is expected to do. It may well be a matter of indifference to the person supplying the service or commodity which of several courses of action is taken, but not to the purchaser of that service or commodity. But the purchaser will not know which of these several courses he will want the supplier to take. Therefore, the service which is being provided is expressed in general terms, the exact details being left until a later date. All that is stated in the contract is the limits to what the person supplying the commodity or service is expected to do. The details of what the supplier is expected to do are not stated in the contract, but are decided later by the purchaser. *When the direction of resources (within the limits of the contract) becomes dependent on the buyer in this way, the relationship which I term a "firm" may be obtained. A firm is likely therefore to emerge in those cases where a very short-term contract would be unsatisfactory.* It is obviously of more importance in the case of services - labor - than it is in the case of the buying of commodities. In the case of commodities, the main items can be stated in advance and the details which will be decided later will be of minor significance.

We may sum up this section of the argument by saying that the operation of a market costs something and by forming an organisation and allowing some authority (an "entrepreneur") to direct the resources, certain marketing costs are saved. The entrepreneur has to carry out his function at less cost, taking into account the fact that he may get factors of production at a lower price than the market transactions which he supersedes, because it is always possible to revert to the open market if he fails to do this. [Coase (1937) pp. 391-392; italics added]

In this paper we provide a simple model capturing the main elements in this passage. We allow for two modes of transacting, the contracting and the authority mode. In the contracting mode, the services to be provided by the seller as well as the terms of trade are spelled out in detail in a spot contract. In the authority mode, the buyer writes a long-term employment contract with the seller, specifying only the terms of employment, leaving the details of which service to provide in any given period unspecified. In this mode, the buyer directs the seller to perform a specific service in any given period. The seller only has the choice of executing the order, or quitting. There are no ongoing negotiations about which service to provide, and at what terms.

What are the costs of contracting which make it possible for authority to supersede the contracting mode? In our model, the main source of contracting costs is asymmetric information. We assume that the buyer knows more about the potential costs of performing a service than the seller. The latter only learns his true costs after the fact. The spot contract cannot specify terms contingent on realized costs, as costs (in utility terms) are essentially unobservable to the seller or third parties. The most the seller can hope for is to obtain compensation for expected costs. But a spot contract where terms of trade only reflect expected costs may induce the buyer to sometimes demand excessively costly services. This is the source of inefficiency which an authority mode may be able to overcome.

How can the authority mode overcome this contractual inefficiency? Because the authority mode is based on a long-term contract and an ongoing relationship, the timing of the seller's payments can be made more flexible. The buyer can now compensate the seller with a bonus after the latter has carried out a particularly costly service. The buyer's incentive to pay such bonuses is supported by the seller's threat to dissolve the relationship should the buyer not compensate him adequately. Given that the buyer is induced to always fully cover the seller's costs the buyer is also induced to choose the action which maximizes net surplus. In other words, the buyer chooses the first-best action in the authority mode, and thus generates an efficiency gain, which would be lost should the seller decide to quit. It is the prospect of losing this rent which preserves the buyer's incentives

to fully cover the seller's costs and induce him to stay.

What determines which mode is used in this model? As Ronald Coase suggests in the passage above, the frequency with which the seller needs the service, the degree of uncertainty, and the degree of the seller's indifference over different courses of action affect the choice between the contracting and authority mode. The more frequently the service is needed, the lower the degree of uncertainty, and the greater the seller's indifference between different courses of action, the more likely it is that the authority mode dominates. This simple model therefore captures all the main elements of Ronald Coase's theory of the choice between internal and external transactions.

In the passage quoted above Coase goes as far as identifying the internal transacting mode with a firm, but he has recently retracted from this viewpoint (see Coase (1991)). In light of research on the theory of the firm subsequent to his (1937) article, he now views the firm as a multifaceted organization based inter alia on asset ownership and an employment relation[3]. We share this view but we have deliberately chosen to abstract from other important facets of firms in order to focus on the difference between internal and external transacting modes.

Our paper is by no means the first attempt at modeling the authority relation. The first formal model goes back at least to Simon (1951). In that article Simon compares two long-term contracts, one where the service to be provided by a seller at some point in the future is precisely specified in a contract. The other where, the service to be provided is left to the discretion of the buyer within some contractually specified limits referred to as the "acceptance set". He identifies the latter contract as an employment relation. The choice of contract is then determined by the degree of uncertainty at the time of contracting about which precise service the buyer would prefer in the future, as well as the degree of

[3]Indeed, in a recent comment Ronald Coase writes "So far what I said still seems to me to be correct. But I conclude: *When the direction of resources (within the limits of the contract) becomes dependent on the buyer in this way, the relationship which I term a "firm" may be obtained.* I would prefer now to say, as I did in my notes made in the middle 1930s, that such relationship approaches the firm relationship, that relationship coming about only when the organiser has contracts with several factors whose activities he coordinates." [Coase (1991) pp 68]

indifference of the seller to providing a specific service within the "acceptance set". Simon's theory of the choice between transacting modes raises several important questions. To begin with, why must the buyer and seller agree to a trade before the uncertainty is resolved? Why not wait for the uncertainty to be resolved, and then write a spot contract? A second question relates to the extreme form of the sales contract. Why can't the buyer and seller agree to some form of state-contingent delivery contract? Presumably, state-contingent contracts involve higher transactions costs since they must specify the precise service to be provided under different circumstances. However, it remains unclear why it would be cheaper to write a contract specifying an "acceptance set" than a contract specifying a state-contingent delivery plan.

Perhaps the most devastating criticism of Simon's employment relation comes from Alchian and Demsetz (1972), who question the very notion of authority. They ask rhetorically what the difference is between an employer ordering about an employee and a customer ordering a grocer to supply different goods and services. They argue that there is no difference and, by implication, that there is no meaningful distinction to be drawn between internal and external transacting modes. They propose instead a theory of the firm based on the idea of team production. They argue that when the joint input of several agents is required for production of a good or service, a monitor is needed to provide adequate incentives to each team member. The firm's manager is then seen as a monitor and the employees as team members.

Following Alchian and Demsetz (1972) the literature evolves into roughly two separate directions. One strand is concerned primarily with issues of ownership, control and integration, and the other focuses on implicit labor contracts. In an attempt to resolve the weaknesses of Simon's model, Oliver Williamson has proposed a theory of the firm based on the notions of specific investments and ex-post opportunism (see Williamson, 1975, 1979, and 1985 ). With specific investments agents are locked into an internal bargaining mode. In order to protect these investments from ex-post opportunism the parties must engage in long-term contracts akin to Simon's employment contract. Taking on board the

Alchian and Demsetz critique, Oliver Williamson steers away from interpreting these long term contracts as employment contracts, and instead proposes the broader notion of a "non-market governance system". In a further step, Grossman and Hart (1986) and Hart and Moore (1990) abandon entirely the distinction between internal and external transacting modes and build a theory of the firm on the sole notion of ownership (or residual right of control) of assets.

The other strand of work is devoted to modelling the employment contract and does not consider the choice between internal and external transacting modes. Beginning with Williamson, Wachter and Harris (1975), and continuing with Bull (1987), MacLeod and Malcomson (1989), and Levin (1998) this line emphasizes the implicit nature of the agreement between employer and employee. Even if it was feasible, no formal contract may be required to support an employment relation beyond a flow transfer, which can be interpreted as a wage payment. As long as each party sticks to their promise, the relationship continues. Otherwise, it dissolves with one of the parties quitting. If there is little discounting, it is well known that the first-best outcome can be supported with such an implicit contract. The mere threat of quitting if a promise is broken is sufficient to induce the employee to work and the employer to adequately compensate the employee.

This literature only emphasizes the ongoing nature of the employment relation. It does not consider authority as an intrinsic element of the employment relation. The employee is assumed to supply effort, which increases output. Effort provision is costly and the employer must compensate the employee for these costs. The problem is that only the employer is able to observe effort (or output). Third parties are not able to verify the amount of effort supplied by the employee, so that explicit contracts where compensation is directly tied to diligence are not feasible. The employee has no choice but to rely on the credible promise of the employer to treat him fairly. If there was no ongoing relation there could be no (efficient) exchange. The service provider would anticipate that effort would not be rewarded after the fact and, therefore, would simply not put in any effort. Besides observing and compensating the employee for his efforts the employer is completely passive in these models. He never directs the employee nor exercises

any other form of authority.

Our paper makes two contributions to this literature. First and foremost, it models the employment relation as an authority relation by assuming that only the employer knows what is the best service to provide at any given time. In our model the employee does not supply any effort (his only decision is whether to execute the employer's directions or not). Secondly, our paper allows for a spot-contracting (negotiation) mode besides the authority mode and contrasts the relative efficiency of each mode.

Three other recent papers also study related ideas. Wernerfeld (1997) builds a reduced form model of the choice between internal and external transactions, where internal supply is directed and external supply is either negotiated or determined by a posted price list. This model is designed to capture the trade-off highlighted originally by Herbert Simon.

Kreps (1999) considers a simple model of an employment relation similar to ours and also justifies authority as a way of facilitating mutually beneficial cooperation. However, he does not analyze the alternative spot contracting problem, nor does he base authority on an informational advantage of the employer.

Perhaps the closest paper to ours is Baker, Gibbons, and Murphy (2001) who compare market-based spot contracts, and employment contracts both within a fully integrated firm, and on the open market. But their paper differs significantly from ours. In the first place, any sort of an authority relation is entirely absent from their considerations. While the seller of services supplies effort in their model, the downstream party, the buyer, is completely passive. Hence, they do not capture all the elements of the authority relation that Coase has outlined. On the other hand, they do include productive assets in their model, and present a richer multilateral theory of the firm with a role for ownership.

Besides providing a model of command and authority, the other advance in this paper following Baker, Gibbons, and Murphy (2001) is the analysis of a "chain of command" structure in a trilateral setting involving a buyer, an intermediary, and a seller. This trilateral setting enables us to describe how transactions "internal" to the firm, and those "external" to it can co-exist. It also allows to model how

authority extends to the intermediary when the buyer and intermediary integrate with the seller into a single fully integrated vertically structure. Looked at another way, this trilateral setting enables us to explain the emergence of, and describe the functioning of hierarchical "chain-of-command" structures that arise in a fully integrated firm.

Finally, this richer setting helps us address the issue of how the boundaries of a firm arise and change. More precisely, the model enables us to analyze which transactions are likely to be "out-sourced", and which ones produced within partially integrated firms either consisting of the buyer, and intermediary, or those consisting of the intermediary and seller. We find that the comparison between partial and full integration underscores the importance of "returns to scope" on the one hand, and "spill-overs" in efficiency gains on the other in determining firm size. We show that if a move from partial integration, by say the buyer and intermediary, to full integration undermines the efficiency rents of the buyer-intermediary vertical structure (that is, full integration has negative "spill-overs" on that structure), or if the marginal returns from further integration are sufficiently decreasing, then equilibrium firm size is partial integration.

## 2 The Model

We consider a contractual situation between two risk-neutral parties - a buyer and a seller of services - who may interact repeatedly over time. At any given date $t$ the buyer can write a contract with the seller specifying the nature of the service to be provided as well as financial terms. For simplicity there are only two types of services (or actions) that the seller can provide. We denote them by $a_1$ and $a_2$. At any given time the buyer demands at most one of these two services. Provision of the service is observable and verifiable, so that a contract can be written specifying a payment contingent on execution of the action.

We normalize the two parties payoffs to zero in the event of no trade. If they agree on the provision of a service $a_i$ at some price $p_i$ $(i = 1, 2)$ their payoffs are respectively

$$v(a_i, \theta) - p_i$$

for the buyer, and

$$p_i - c(a_i, \theta)$$

for the seller, where $\theta$ denotes a state of nature. In other words, both buyer and seller payoffs vary with the underlying state of nature $\theta \in \Theta$, where $\Theta$ denotes a finite set of states of nature.

To keep the analysis as simple as possible we assume that

$$v(a_i, \theta) \in \{v, V\} \text{ and } c(a_i, \theta) \in \{0, C\}$$

with

$$0 < v < V \text{ and } V - C < v.$$

Moreover we shall assume that at each date $t$ there is an independent draw of a new state $\theta$, with each state being equiprobable. This assumption captures in a stark way the idea that the precise nature of a service required by the buyer at any given moment changes rapidly and in an unpredictable manner. The set of states comprises all possible configurations of payoffs for the two actions, $\{c(a_1, \theta), c(a_2, \theta), v(a_1, \theta), v(a_2, \theta)\}$, so that there are exactly sixteen distinct states of nature.

Since all states are equiprobable, the two actions $a_1$, and $a_2$ are indistinguishable before the state of nature is realized. They also remain indistinguishable *ex-post* in four of the sixteen states of nature. Under these assumptions, provision of some service is efficient in all states of nature. The (first-best) efficient service in any given state is the one maximizing net gains from trade: $v(a_i, \theta) - c(a_i, \theta)$.

A key assumption underlying the entire analysis is that the buyer (or principal) privately observes the realized state of nature at any given date before any contract is drawn. The seller only learns his true cost of providing the service while providing it. In other words, the buyer has superior information about the seller's cost of providing the service[4]. This is an important departure from the

[4] The critical informational assumption to obtain an efficient mode of transaction based on command and authority is that one of the contracting parties (the one ultimately exercising authority) has superior information. If the buyer had private information about $v(a_i, \theta)$ and the seller about $c(a_i, \theta)$ then authority could not emerge as an efficient mode of transacting.

standard informational assumption in most principal-agent problems, where the agent is assumed to have the informational advantage.

The buyer and seller are drawn from a pool of anonymous buyers and sellers. Once they are matched they can choose to engage in a spot transaction or to repeatedly interact over time.

Thus, we distinguish between two alternative modes of contracting: a market mode and an employment mode. Under the market mode, buyer and seller are drawn from the pool of buyers and sellers every period. They meet in the market place and write a spot contract for the provision of a service in that period. Following provision of the service the seller is compensated and the contractual relationship dissolves. Under the employment mode, buyer and seller write a long term (employment) contract specifying:

1. a wage payment in every period,

2. a discretionary bonus to be paid at the end of each period, which varies with the agent's cost of performing the prescribed task,

3. a signing up fee as well as a severance payment.

The employment contract does not specify what tasks the agent is required to perform. Instead, it is a mutual understanding that the agent will execute the action prescribed by the principal at any time in the (foreseeable) future, as long as the principal sticks to the implicit agreement of compensating the agent with discretionary bonus payments for exceptionally high incurred costs in executing prescribed actions.

The contract can be terminated at will by either party, in which case the contractual relationship ends forever.

The best way of understanding these two modes is to imagine a market where a large number of buyers and sellers meet anonymously every period. When a buyer and seller meet, they have a choice of transacting for only one period and returning to the market in the future to match with other buyers and sellers, or

removing themselves from the market place by entering a long term employment contract which they are free to rescind at any time.

Whichever mode the parties choose, we assume that their presence in the market may end forever at the end of any period $t$ with an exogenously given probability $\delta > 0$. This probability of termination serves the dual function of discounting the future and measuring the expected frequency of interaction of contracting parties in this market.

## 3 The Spot Contracting Mode

In this section, we describe the spot contracting relation and characterize the (second-best) efficient spot contract in every possible state of nature. At the beginning of any period buyer and seller write a spot contract specifying what service the seller provides as well as the terms of trade. The buyer knows her own payoff as well as the seller's cost of providing the service. She makes a take-it-or-leave-it contract offer which the seller can accept or reject. If the seller rejects, he gets a reservation payoff of $\overline{u}$. Thus, a spot contract is a pair $\{a, p(a)\}$, where $p(a)$ denotes the payment to the seller for providing service $a$. This spot contracting game is a simple informed Principal problem (see Myerson (1983) and Maskin and Tirole (1989)) which could potentially have many different solutions. Before characterizing equilibrium spot contracts it is helpful to consider a slightly modified problem, which admits a unique solution. This uniquely optimal contract is also a solution to the spot contracting game and provides a natural focal point.

The modified problem we consider first is a contracting problem where buyer and seller agree on an incentive compatible state-contingent spot contract before the state of nature is realized and observed by the buyer.

### 3.1 The Ex-Ante Spot Contract

Applying the revelation principle, an ex-ante efficient spot contract is a pair of state contingent action and compensation schedules $\{a(\theta), p(a(\theta))\}$ which maximizes the buyer's expected payoff subject to meeting incentive compatibility and individual rationality constraints. In other words, the spot contracting problem

can be reduced to the following buyer constrained optimization problem:

$$\begin{cases} \max\limits_{a(\theta),p(a(\theta))} [v(a(\theta),\theta) - p(a(\theta),\theta)] \\ \text{subject to} \\ p(a(\theta),\theta) - c(a(\theta),\theta) \geq \overline{u} \qquad \text{(IR)} \\ v(a(\theta),\theta) - p(a(\theta),\theta) \geq v(a(\widehat{\theta}),\theta) - p(a(\widehat{\theta}),\widehat{\theta}) \\ \text{for all } (\theta,\widehat{\theta}) \in \Theta \times \Theta \qquad \text{(IC)} \end{cases} \tag{1}$$

The first immediate observation is:

**Lemma 1:** The only incentive compatible contracts are those which specify a constant payment for the same action chosen in two different states of nature $p(a(\theta),\theta) = p(a(\theta))$.

**Proof.** Suppose to the contrary that $a = a(\theta)$ for the pair of states of nature $(\theta,\hat{\theta})$ and that $p(a,\theta) > p(a,\hat{\theta})$, then

$$v(a(\theta),\theta) - p(a(\theta),\theta) = v(a,\theta) - p(a,\theta) < v(a,\theta) - p(a,\hat{\theta})$$

which violates the incentive compatibility constraint:

$$v(a(\theta),\theta) - p(a(\theta),\theta) \geq v(a(\widehat{\theta}),\theta) - p(a(\widehat{\theta}),\hat{\theta}) = v(a,\theta) - p(a,\hat{\theta})$$

for all $(\theta,\hat{\theta}) \in \Theta \times \Theta$. ■

Thus incentive compatible contracts take the form $\{a(\theta), p(a(\theta))\}$. Moreover, in our symmetric set-up it is also the case that:

**Lemma 2:** An optimal contract is such that $p(a(\theta)) = p$.

**Proof.** To see this, note that any contract with

$$\Delta p = |p(a_1) - p(a_2)| = |p_1 - p_2| > V - v$$

induces the same choice of service by the buyer in all states of nature. She then simply picks the cheapest service available, say service $a_1$ (if $p_1 < p_2 + v - V$). The net expected surplus from such a contract is:

$$\frac{1}{4}v + \frac{1}{4}V + \frac{1}{4}(V - C) + \frac{1}{4}(v - C)$$

Or,

$$\frac{1}{2}v + \frac{1}{2}V - \frac{1}{2}C. \tag{2}$$

Such a contract is dominated by a contract with $\Delta p \leq V - v$. Under any such contract, the buyer optimizes in a lexicographic order by first selecting the service in each state that maximizes $v(a, \theta)$; and secondly, when both services have the same gross return ($v(a_1, \theta) = v(a_2, \theta)$), by picking the cheapest service. Note that picking the cheapest service is not cost-minimizing, so that the buyer could do strictly better in this class of contracts by setting $\Delta p = 0$, so that she can always choose the least costly service whenever both services yield the same expected payoff. The difference in net surplus between a contract with $0 < \Delta p \leq V - v$ and a contract with $0 = \Delta p$ is given by

$$[\frac{1}{4}v + \frac{3}{4}V - \frac{3}{8}C] - [\frac{1}{4}v + \frac{3}{4}V - \frac{1}{2}C] = \frac{1}{8}C, \tag{3}$$

and the difference in surplus between a contract with $\Delta p = 0$ and a contract with $\Delta p > V - v$ is

$$[\frac{1}{4}v + \frac{3}{4}V - \frac{3}{8}C] - [\frac{1}{2}v + \frac{1}{2}V - \frac{1}{2}C] = \frac{1}{2}(V - v) + \frac{1}{8}C. \tag{4}$$

Thus, the ex-ante second-best contract is such that

$$p(a_1) = p(a_2) = p = \frac{3}{8}C + \overline{u}.$$

■

The contract with $p(a(\theta)) = p$ does not achieve the same surplus as a first-best contract, which implements an action-plan to maximize $v(a, \theta) - c(a, \theta)$, and achieves an expected surplus of

$$\frac{3}{8}v + \frac{5}{8}V - \frac{1}{4}C. \tag{5}$$

In other words, under the ex-ante second-best contract there is a shortfall in profits of

$$\frac{3}{8}v + \frac{5}{8}V - \frac{1}{4}C - [\frac{1}{4}v + \frac{3}{4}V - \frac{3}{8}C] = \frac{1}{8}(v - (V - C)) > 0. \tag{6}$$

We summarize this discussion in the proposition below.

**Proposition 1** *The (ex-ante) second-best spot contract is such that:*

1. $p(a(\theta),\theta) = p(a(\theta))$, *and*
2. $p(a_1) = p(a_2) = p = \frac{3}{8}C + \overline{u}$.
3. *The buyer selects the service maximizing* $v(a,\theta)$,*and when indifferent, the service minimizing* $c(a,\theta)$. *The expected efficiency loss under this contract is* $\frac{1}{8}(v-(V-C))$.

**Proof.** See the discussion above. ■

The ex-ante optimal contract thus takes a very simple form. It is a sales contract specifying a state independent identical price for each service. The price is set at a level such that the seller is compensated for the costs he is expected to incur. Under such a contract an inefficiency arises since the buyer's objective is to maximize $(v-p)$ instead of $(v-c)$. We now return to the ex-post informed principal contracting game and show that one equilibrium in this game replicates this ex-ante optimal contract.

### 3.2 The Interim Spot Contract

In the informed principal contracting game the buyer offers a spot contract $\{a,p\}$ having already observed the sate of nature $\theta \in \Theta$. Based on the form of the contract and the prescribed action the seller then forms beliefs about his costs. Let $E(c(a,\theta) \mid \{a,p\})$ denote the seller's expectation about costs conditional on observing $\{a,p\}$. Then, the seller accepts a contract offer if and only if

$$p(a) \geq E(c(a,\theta) \mid \{a,p(a)\}) + \overline{u}.$$

A Perfect Bayesian equilibrium of this contracting game is defined as follows.

**Definition:** *A Perfect Bayesian Equilibrium (PBE) of the informed principal game is a set of (possibly mixed) strategies* $\{a(\theta),p(\theta)\}$ *and conditional expectations* $E(c(a,\theta)|\{a,p\})$ *for the seller such that*

*(i) for all $\theta$, $\{a(\theta), p(\theta)\}$ is such that*

$$(a(\theta), p(\theta)) \in \arg\max_{a, p(a)} \begin{cases} v(a,\theta) - p(a) \\ \\ \text{subject to:} \\ \\ p(a) \geq E(c(a,\theta)|\{a, p(a)\}) + \overline{u} \end{cases}$$

*(ii) $E(c(a,\theta)|\{a,p\})$ is derived from prior beliefs using Bayes' rule and,*

*(iii) if a contract $\{a,p\} \neq \{a(\theta), p(\theta)\}$ for all $\theta \in \Theta$ is offered then, $E(c(a,\theta)|\{a,p\})$ can take any value in $[0, C]$.*

It is easy to see that one PBE of the ex-post contracting game is to set $\{a(\theta), p(\theta)\}$ such that $p(\theta) = p = \frac{3}{8}C + \overline{u}$ and,

$$a(\theta) = \begin{cases} \max_a v(a,\theta) \text{ if } \ v(a_1,\theta) \neq v(a_2,\theta) \\ \\ \min_a c(a,\theta) \text{ if } \ v(a_1,\theta) = v(a_2,\theta) \end{cases}.$$

This equilibrium is supported by conditional expectations such that $E(c(a,\theta) \mid \{a, \frac{3}{8}C + \overline{u}\}) = \frac{3}{8}C$ for all $a \in \{a_1, a_2\}$ and $E(c(a,\theta) \mid \{a,p\}) = C$ for all $p \neq \frac{3}{8}C + \overline{u}$. Indeed, given these conditional expectations the buyer's best response is to choose $\{a(\theta), p(\theta)\}$ as specified above. Any other contract would require a price $p = C + \overline{u}$ to be acceptable to the seller. Given the buyer's strategy the seller's conditional expectation $E(c(a,\theta) \mid \{a, \frac{3}{8}C + \overline{u}\}) = \frac{3}{8}C$ is, of course, consistent with Bayesian updating.

There are inevitably other equilibria. For example, one equilibrium is to have $\{a(\theta), p(\theta)\} = \{a_1, \frac{1}{2}C + \overline{u}\}$. This strategy is a best response for the buyer given conditional expectations for the seller of $E(c(a,\theta) \mid \{a_1, \frac{1}{2}C + \overline{u}\}) = \frac{1}{2}C$ and $E(c(a,\theta) \mid \{a,p\}) = C$ for all $p \neq \frac{1}{2}C + \overline{u}$. Once again, these conditional expectations are consistent with Bayesian updating. However, the analysis of the ex-ante contracting problem suggests that the most natural and robust equilibrium is the one which solves the ex-ante contracting problem. We shall therefore proceed with the assumption that the spot contract is such that:

$$p(\theta) = p = \frac{3}{8}C + \overline{u} \tag{7}$$

and,

$$a(\theta) = \begin{cases} \max_a v(a,\theta) \text{ if } \ v(a_1,\theta) \neq v(a_2,\theta) \\ \\ \min_a c(a,\theta) \text{ if } \ v(a_1,\theta) = v(a_2,\theta) \end{cases}. \tag{8}$$

Note that this contract is the one which minimizes the inefficiencies of spot contracting and therefore maximizes the difficulty of identifying a more efficient employment contract which supersedes it.

## 4 The Employment Relation: how does it work and when is it efficient?

We consider a situation where a buyer and seller have elected to remove themselves from the large pool of anonymous agents that constitute the market, and enter into a long-term employment contract. Such a contract entails an obligation on the part of the employee to carry out the employer's directions or commands. In exchange the employer commits to a flow wage payment $w$, and also promises discretionary bonus payments $b$. The contract is open-ended and at will. In other words, either employer or employee are free to quit at any time. In particular, the employer is free to fire the employee should the latter fail to execute her commands. The employment contract may specify a severance payment upon termination as well as a signing-up payment when employment begins.

The contract has an indefinite duration and ends either when one of the parties decides to quit or when an exogenous event occurs which induces separation. Recall that the probability of such an event occurring at any given time is denoted by $\delta > 0$.

We consider an employment relation that prevails between two non-anonymous infinitely lived agents. The employment contract only specifies a constant wage per period $w$ and otherwise leaves everything to be determined on an ongoing basis by the two parties.

We specify the following sequence of events in every time period $t$ under the employment contract:

1. The buyer learns the state of nature that prevails in period $t$ and directs the seller to provide a given service $a_t \in \{a_1, a_2\}$.

2. The seller responds by either executing the buyer's demand, thereby learning the cost $c(a_t, \theta)$ of doing so, or by quitting having decided not to execute her order.

3. If the seller executes the buyer's order, the buyer must choose whether to pay a compensatory bonus to the seller.

Let $h_t = \{(c_0, a_0), (c_1, a_1), \ldots, (c_{t-1}, a_{t-1})\}$ denote the information available to both parties at time period $t$. It is the sequence of *executed actions* and *realized costs* for the first $t$ periods of time, beginning with time period $t = 0$.

Given $(h_t, \theta_t)$ where $\theta_t$ is the prevailing state at time period $t$, the buyer's strategy is a pair $\{a_t(\theta_t, h_t), b_t(\theta_t, h_t)\}$ and the seller's strategy is an execute/quit rule $x_t(a_t, h_t) \in \{0, 1\}$, where $x = 1$ when the seller decides to execute the prescribed action and $x = 0$ when he decides to quit.

We solve for the optimal employment contract with an associated subgame-perfect equilibrium which maximizes the expected surplus from the employment relation. We restrict attention to the class of employment contracts inducing first-best equilibrium play. These contracts are such that:

1) The bonus payment induces the buyer to always choose a cost minimizing action. This requires that

$$b \geq V - v. \tag{9}$$

Indeed, when this inequality holds it is not in the buyer's interest to ask the seller to choose the high cost action in order to gain $(V - v - b)$.

2) The wage payment induces the seller to participate:

$$w + \frac{1}{4}(b - C) \geq \overline{u}. \tag{10}$$

Recall that there are four states out of sixteen where both actions involve high costs, $c(a_i, \theta) = C$, $i = 1, 2$. In all other states the seller will not incur high costs as long as the buyer orders first-best cost-minimizing actions.

3) The buyer orders first-best actions - $a_t(\theta_t, h_t) = a^{fb}(\theta_t)$ - and honors promised bonus payments - $b_t(\theta_t, h_t) = \min\{c(a_{t-1}, \theta_{t-1}), b\}$ - as long as the employee has executed all previous orders; otherwise $a_t(\theta_t, h_t) = \max_a v(a, \theta_t)$ and $b_t(\theta_t, h_t) = 0$.

4) The seller executes the buyer's orders - $x_t(a_t, h_t) = 1$ - as long as the seller has made the promised bonus payments - $b_{t-1}(\theta_{t-1}, h_{t-1}) = \min\{c(a_{t-2}, \theta_{t-2}), b\}$ - otherwise he refuses to carry out the order - $x_t(a_t, h_t) = 0$.

The buyer's present expected payoff under any such contract and equilibrium is given by:

$$\frac{1}{\delta}\left(\frac{3}{8}v + \frac{5}{8}V - \frac{1}{4}b - w\right). \tag{11}$$

The optimal employment contract therefore maximizes this payoff subject to the incentive compatibility (9) and individual rationality (10) constraints. Both constraints are clearly binding at the optimum, so that the buyer's present expected payoff under the optimal employment contract is:

$$\frac{1}{\delta}\left(\frac{3}{8}v + \frac{5}{8}V - \overline{u} - \frac{1}{4}C\right). \tag{12}$$

We thus obtain:

**Proposition 2** *The optimal employment contract is such that:*

1. *The bonus payment compensating high-cost actions is* $b = V - v$, *and*
2. *the flow wage payment is* $w = \overline{u} + \frac{1}{4}[v - (V - C)]$.
3. *The buyer selects the first-best action maximizing* $[v(a, \theta) - c(a, \theta)]$.

**Proof.** See the discussion above. ■

The buyer's present expected payoff under the optimal employment contract in (12) compares with the present expected payoff by engaging in a sequence of spot contracts given by

$$\frac{1}{\delta}[\frac{1}{4}v + \frac{3}{4}V - \frac{3}{8}C - \overline{u}]. \tag{13}$$

The equilibrium under the employment relation obtains if and only if it is in the buyer's interest to pay the bonus $b_t(\theta_t, h_t) = \min\{c(a_{t-1}, \theta_{t-1}), b\}$ in all realized states of nature $\theta_t$.

If the buyer decides to deviate and set $b_t(\theta_t, h_t) = 0$ the employment relation dissolves, so that the most she can hope to obtain from such a deviation is

$$b + \frac{1-\delta}{\delta}\left(\frac{1}{4}v + \frac{3}{4}V - \frac{3}{8}C - \overline{u}\right),$$

or

$$V - v + \frac{1-\delta}{\delta}\left(\frac{1}{4}v + \frac{3}{4}V - \frac{3}{8}C - \overline{u}\right).$$

If she does not deviate, on the other hand she obtains at least

$$\frac{1-\delta}{\delta}\left(\frac{3}{8}v + \frac{5}{8}V - \frac{1}{4}C - \overline{u}\right).$$

Thus, the buyer pays the bonus if and only if,

$$\frac{1-\delta}{\delta}\left(\frac{3}{8}v + \frac{5}{8}V - \frac{1}{4}C - \overline{u}\right) \geq V - v + \frac{1-\delta}{\delta}\left(\frac{1}{4}v + \frac{3}{4}V - \frac{3}{8}C - \overline{u}\right). \quad (14)$$

Note that if this condition holds, it is a best response for the seller to execute the prescribed action as long as he continues receiving compensatory bonus payments and otherwise to quit. Similarly, if this condition holds it is a best response for the seller to choose $a_t(\theta_t, h_t) = a^{fb}(\theta_t)$ and $b_t(\theta_t, h_t) = \min\{c(a_{t-1}, \theta_{t-1}), b\}$ as long as the employee has executed all previous orders (and otherwise to set $a_t(\theta_t, h_t) = \max_a v(a, \theta_t)$ and $b_t(\theta_t, h_t) = 0$).

We shall take it that if condition (14) does not hold then the employment relation is not sustainable. We can then define a cut-off for the frequency of transactions as measured by $(1-\delta)$, such that if $\delta \leq \widehat{\delta}$ the internal transaction mode organized around an authority relation dominates the spot contracting mode. This cut-off is given by

$$\widehat{\delta} = \frac{v - (V - C)}{7(V - v) + C} \quad (15)$$

Note that the numerator is strictly positive under our assumptions, and is strictly less than the denominator.

We can summarize this discussion in the following

**Proposition 3** *If* $\delta < \frac{v-(V-C)}{7(V-v)+C}$ *then the employment relation dominates spot contracting.*

**Proof.** See the discussion above. ■

This proposition summarizes in simple terms the main factors that underlie the choice between spot contracting and authority, as envisioned by Ronald Coase:

i) should the employee be indifferent between which course of action is ordered by the employer then the employment relation would always emerge as the efficient mode of transacting here. This is easily seen by setting $C = 0$ in equation (15),

ii) the less frequent the interaction (the higher is $\delta$) the less likely it is that a buyer and seller engage in an employment relation,

iii) the larger the inefficiency of spot contracting (as measured by the difference $[v - (V - C)]$ ) the more likely is the employment relation,

iv) the larger the scope of "exploitation" of the employee by the employer (as measured by the size of $C$) the more likely is the emergence of an employment relation.

By allowing for general probability distributions over states of nature this theory would also be able to determine how the employment relation is less likely to emerge when there is less uncertainty as to the nature of the service desired by the buyer.

**Remark:** We have assumed above that the buyer decides to withhold the bonus payment from the seller after the seller has executed her directives. The cutoff value changes if we assume that the buyer decides to withhold payment of the bonus *at the time when she selects the seller's service.* Assuming that this is the case, the most that the buyer can hope to gain by withholding the bonus payment is

$$V + \frac{1-\delta}{\delta}(\frac{1}{4}v + \frac{3}{4}V - \frac{3}{8}C - \overline{u}),$$

while, by complying with the employment agreement, and paying the bonus, she gains at least

$$\frac{1-\delta}{\delta}(\frac{3}{8}v + \frac{5}{8}V - \frac{1}{4}C - \overline{u})$$

These payoffs lead to a cutoff value for the frequency of interaction equal to

$$\tilde{\delta} = \frac{v - (V - C)}{7V + v + C},$$

and we conclude, exactly as in the proposition above, that if the probability of separation is less than $\frac{v-(V-C)}{7V+v+C}$, then the employment relation dominates bilateral spot contracting[5].

## 5 Chain-of-Command and the Boundaries of the Firm

In this section we move from bilateral to trilateral contracting. We introduce a third party, an intermediary, through whom the transactions between the buyer and the seller must flow. A concrete example may help to illustrate the discussion which follows.

The buyer of services can be thought of as a firm of designers and architects, the intermediary a firm of building contractors, and the seller as either a mason, an electrician, a plumber, a painter, etc. The designers conceive of houses to be built for clients, then issue instructions to the firm of contractors who, in turn, engage the services of workers subject to the quality and budget specifications laid out by the firm of architects. Transactions between the three firms can either take place in a market, or through the authority mode. A richer class of possible transaction arrangements now emerges. The extremes of a pure authority relation, where the three firms merge into a single vertically integrated firm, and pure arm's-length contracting are the analogs of the contracting modes considered above. Between these extremes, partial vertical integration between the designers and the contractors, or between the contractors and the worker, with arm's-length contracting with the remaining agent are two other possibilities.

Let us outline the elements of the model with three agents. The buyer requires two types of services, denoted $l_1$ and $l_2$, from the intermediary at any given time $t$. The intermediary, in turn, requires $a_1$ or $a_2$ from the seller to carry out the service $l_i$ requested by the buyer. Other things being equal, the intermediary, bearing the cost of producing $l_j$, will select $a_i$ to minimize his costs. The performance of the service by the intermediary, and by the seller are of course verifiable and observable making it possible to write contracts that are contingent upon parties executing the actions required of them.

[5] Note that $\tilde{\delta} < \hat{\delta}$ since $V > V - v$.

If the buyer contracts with the intermediary, who agrees to provide her a service $l_i$ at a price $q_i = q(l_i, \theta)$ (for $i = 1, 2$), her payoff is

$$v(l_i, \theta) - q(l_i, \theta).$$

The intermediary, in turn, must procure the seller's services to fulfill his contract with the buyer. If he contracts on the action $a_j$ at price $p(a_j, \theta)$ with the seller his payoff is

$$q(l_i, \theta) - c(a_j, l_i, \theta) - p(a_j, \theta),$$

where $c(a_j, l_i, \theta)$ denotes the intermediary's cost.

Finally, the seller's payoff is simply

$$p(a_j, \theta) - k(a_j, l_i, \theta),$$

where $k(l_i, a_j, \theta)$ denotes the seller's cost.

Thus, as in the bilateral case the payoffs of both the intermediary, and the buyer vary with the underlying states of nature $\theta \in \Theta$, where $\Theta$ denotes a finite set of states of nature. As before, we assume that $v(l_i, \theta) \in \{v, V\}$, where $0 < v < V$. We also assume that the intermediary's cost of producing $l_i$ can only take two values: $c(a_j, l_i, \theta) \in \{0, c_I\}$, with $0 < c_I$. Finally, the seller's cost can take three possible values for reasons we explain below: $k(l_i, a_j, \theta) \in \{0, c, c_A\}$, with $0 < c_A$ and $0 < c$. We assume further that for all states of nature $\theta \in \Theta$ with $l_i$ and $l_j$ such that $v(l_i, \theta) = v$ and $v(l_j, \theta) = V$ we have

$$v(l_i, \theta) - \min_{a_h}\{c(a_h, l_i, \theta) + k(l_i, a_h, \theta)\} > v(l_j, \theta) - \min_{a_h}\{c(a_j, l_j, \theta) + k(l_j, a_h, \theta)\},$$

so that as before the efficient action $l_i$ is always that for which $v(l_i, \theta) = v$.

As in the bilateral case, at every time period, there is an independent draw of one state of nature. We replicate the information structure in the bilateral case by assuming that the buyer has superior information over the intermediary. She observes the values $v(l_i, \theta)$ and how total expected costs $E_\theta[c(l_i, a_j, \theta) + k(l_i, a_j, \theta)]$ vary with $l_i$. The intermediary, on the other hand, only sees how the seller's costs vary with $a_j$. He cannot (perfectly) infer the value of $v(l_i, \theta)$ nor of $c(l_i, a_j, \theta)$ from his observation of the seller's costs.

Thus, just as the buyer has superior information over the intermediary, the latter has superior information over the seller. But note that the buyer has no informational advantage over the seller. She does not know which is the best course of action $a_i$ in any given state to minimize production costs of $l_j$. Finally, the seller only learns his realized costs after the fact. Given this information structure there is scope for exploitation of the intermediary by the buyer, as well as of the seller by the intermediary.

To simplify the state space as much as possible we assume that for any given state $\theta$ either

$$v(l_1,\theta) = v \text{ and } v(l_2,\theta) = V$$
$$\text{or}$$
$$v(l_2,\theta) = v \text{ and } v(l_1,\theta) = V.$$

Furthermore each configuration of values is equally likely so that the $l_i$ appear indistinguishable ex ante.

As for the cost configurations we shall allow for two possible extreme cases. In the first case we allow for exploitation of the seller by the intermediary only when the buyer chooses the inefficient action $l_j$ such that $v(l_j,\theta) = V$. In the second case, exploitation of the seller by the intermediary is allowed only when the buyer selects the efficient action $l_i$ such that $v(l_i,\theta) = v$. For reasons that will become clear below we refer to the first case as the "negative spill-over" case and the second the "positive spill-over" case.

**Case 1: Negative spill-over**

Take the subset of states $\theta$ such that $v(l_1,\theta) = v$ and $v(l_2,\theta) = V$, and suppose that the buyer selects $l_2$. Then the following cost configurations are equally likely:

| | $c(a_h)+k(a_h)$ |
|---|---|
| $a_1$ | $c_I + c_A$ |
| $a_2$ | $c_I$ |

| | $c(a_h)+k(a_h)$ |
|---|---|
| $a_1$ | $c_A$ |
| $a_2$ | $c_I$ |

| | $c(a_h)+k(a_h)$ |
|---|---|
| $a_1$ | $c_A$ |
| $a_2$ | $0$ |

and

| | $c(a_h)+k(a_h)$ |
|---|---|
| $a_1$ | $c_I$ |
| $a_2$ | $c_I + c_A$ |

| | $c(a_h)+k(a_h)$ |
|---|---|
| $a_1$ | $c_I$ |
| $a_2$ | $c_A$ |

| | $c(a_h)+k(a_h)$ |
|---|---|
| $a_1$ | $0$ |
| $a_2$ | $c_A$ |

Thus, the intermediary cannot infer his own costs from the observation of $k(a_h)$. However, he is able to lower his own costs on average by always forcing the seller to choose his high cost action $c(a_h) = c_A$. Indeed, then his expected costs are only $\frac{c_I}{3}$, while if he always selects the seller's low cost action his expected costs are $\frac{2c_I}{3}$. Overall costs are minimized by always selecting the seller's low cost action if

$$\frac{c_I}{3} < c_A.$$

We shall proceed with this assumption.

Suppose now that the buyer selects $l_1$. Then the cost configuration is simply:

| | $c(a_h) + k(a_h)$ |
|---|---|
| $a_1$ | $0$ |
| $a_2$ | $0$ |

In other words, total costs are the same for both actions and are equal to zero. This means that if the buyer selects the efficient action $l_1$ then there is no room for exploitation of the seller by the intermediary.

For the complementary subset of states $\theta$ such that $v(l_1, \theta) = V$ and $v(l_2, \theta) = v$ the symmetric assumptions hold with the label for $l_1$ and $l_2$ switched around.

**Case 2: Positive spill-over**

Take again the subset of states $\theta$ such that $v(l_1, \theta) = v$ and $v(l_2, \theta) = V$, and suppose that the buyer selects $l_2$. Then the cost configuration is:

| | $c(a_h) + k(a_h)$ |
|---|---|
| $a_1$ | $c$ |
| $a_2$ | $c$ |

Now there is no room for exploitation of the seller by the intermediary when the buyer selects the inefficient action $l_2$.

On the other hand, when the buyer selects $l_1$ the following cost configurations are now the equally likely outcomes:

| | $c(a_h) + k(a_h)$ |
|---|---|
| $a_1$ | $c_I + c_A$ |
| $a_2$ | $c_I$ |

| | $c(a_h) + k(a_h)$ |
|---|---|
| $a_1$ | $c_A$ |
| $a_2$ | $c_I$ |

| | $c(a_h) + k(a_h)$ |
|---|---|
| $a_1$ | $c_A$ |
| $a_2$ | $0$ |

and

| | $c(a_h)+k(a_h)$ |
|---|---|
| $a_1$ | $c_I$ |
| $a_2$ | $c_I+c_A$ |

| | $c(a_h)+k(a_h)$ |
|---|---|
| $a_1$ | $c_I$ |
| $a_2$ | $c_A$ |

| | $c(a_h)+k(a_h)$ |
|---|---|
| $a_1$ | $0$ |
| $a_2$ | $c_A$ |

We continue to assume that $\frac{c_I}{3} < c_A$, so that again overall costs are minimized by always selecting the seller's low cost action. We also make the assumption that

$$V - c < v - (c_A + \frac{c_I}{3})$$

so that $l_1$ is the efficient action even if the intermediary does not cost minimize.

Again, the symmetric assumptions hold (with the label for $l_1$ and $l_2$ switched around) for the complementary subset of states $\theta$ such that $v(l_1, \theta) = V$ and $v(l_2, \theta) = v$.

## 5.1 Spot Contracting Between the Buyer, the Intermediary, and the Seller

As we have done so far, we shall take the ex-ante optimal spot contract between the buyer, the intermediary, and the seller to be the contractual outcome under spot contracting. That is, we shall select the interim Bayesian equilibrium in the spot-contracting game which achieves the same allocation as the ex-ante optimal contract. With three players and multilateral asymmetric information, we are faced with a potentially complex mechanism design problem. However, since the buyer's and intermediary's information sets do not overlap, intuition suggests that the multilateral contracting problem can be separated into two bilateral problems: the contract between the buyer and the intermediary, and the contract between the intermediary and the seller. This is indeed the case. In fact, the model has been set up to obtain this simple structure.

We explain below that when the intermediary and seller sign a contract with a fixed price $p$ then the best response for the buyer and intermediary is to sign a contract fixing one of the actions $l_i$ for delivery in all states, whether there are positive or negative spill-overs. On the other hand, when the buyer and intermediary sign a contract with a fixed action $l_i$, then the best response for

the intermediary and seller is to sign a contract with a fixed price $p$. A similar argument as in lemmas 1 and 2 applies to obtain the latter result.

**Spot Contracting Between the Buyer and the Intermediary**

Consider first the spot contract between the buyer and the intermediary and assume that the intermediary and seller write a contract with a fixed price $p$. This spot contracting problem then takes the following simple form:

$$\begin{cases} \max\limits_{q(l_i),l_i} [v(l_i,\theta) - q(l_i)] \\ \\ \text{subject to} \\ \\ q(l_i) - E_\theta[c(l_i,a,\theta)] - p \geq \overline{u}_I \qquad \text{(IR)} \end{cases} \tag{16}$$

**Case 1: Negative Spill-overs:**

Given that $l_1$ and $l_2$ are ex-ante indistinguishable a (weakly) optimal contract is to fix one of the actions for delivery in all states $\theta$, say $l_1$. Then in half the states of nature the first-best action is chosen and in the other half the second-best action. Given that the intermediary and seller have signed a fixed price contract, the intermediary's expected costs are easily determined. The intermediary will attempt to minimize costs at the expense of the seller whenever $l_1$ is a second best action. Thus,

$$E_\theta[c(l_i,a,\theta)] = \frac{1}{2}\frac{c_I}{3}.$$

**Case 2: Positive Spill-overs:**

It is again weakly optimal to fix $l_1$ for delivery in all states of nature. The only difference with the previous case is that now the intermediary's costs are equal to $c$ when $l_1$ is a second-best action and $\frac{c_I}{3}$ when $l_1$ is first best. The intermediary's expected costs are therefore

$$E_\theta[c(l_i,a,\theta)] = \frac{1}{2}c + \frac{1}{2}\frac{c_I}{3}.$$

We highlight these results in the proposition below

**Proposition 4** *The (weakly) optimal second-best spot contract between the buyer and intermediary is such that:*

1. $l(\theta) = l_1$

2. $q(l_1) = \frac{1}{2}\frac{c_I}{3} + p + \overline{u}_I$ *in case 1 (negative spill-overs), and* $q(l_1) = \frac{1}{2}c + \frac{1}{2}\frac{c_I}{3} + p + \overline{u}_I$ *in case 2 (positive spill-overs).*

**Proof.** See the discussion above. ■

**Spot Contracting Between the Intermediary and the Seller**

Now consider the spot contract between the intermediary and the seller when the buyer has fixed $l(\theta) = l_1$:

$$\begin{cases} \min\limits_{a_h} \; E_\theta[c(l_1, a_h, \theta) \mid k(a_h)] - p(a_h, k(a_h)) \\ \\ \text{subject to} \\ \\ p(a_h, k(a_h)) - E_\theta[k(a_h, l_1, c_A)] \geq \overline{u}_A \qquad \text{(IR)} \\ \\ E_\theta[c(l_1, a_h, \theta) \mid k(a_h)] - p(a_h, k(a_h)) \geq \\ E_\theta[c(l_1, a_h, \theta) \mid k(a_h)] - p(a_h, \widehat{k}(a_h)) \\ \\ \text{for all } (k(a_h), \widehat{k}(a_h)) \in \{0, c, c_A\} \times \{0, c, c_A\} \qquad \text{(IC)} \end{cases} \tag{17}$$

Here, $\overline{u}_A$ denotes the seller's reservation utility. The intermediary knows the true cost of the agent $k(a_h)$ and the optimal contract minimizes the intermediary's expected total cost subject to incentive compatibility and individual rationality constraints. Note that this optimization problem has the same structure as problem (1). The same arguments as in the proofs of lemma 1 and 2 apply here, so that the optimal contract is such that $p(a_h, k(a_h)) = p$ for $h = 1, 2$ and all $k(a_h) \in \{0, c, c_A\}$. As a result the intermediary always picks the action which minimizes $E_\theta[c(l_1, a_h, \theta) \mid k(a_h)]$. The seller's expected costs under the optimal contract are therefore

$$E_\theta[k(a_h, l_1, c_A)] = \frac{1}{2}c_A$$

in both case 1 and 2. We conclude that,

**Proposition 5** *The optimal (ex-ante) spot contract between the intermediary and the seller is such that:*

1. $p(a_h, k(a_h)) = p = \frac{1}{2}c_A + \overline{u}_A$ *for* $h = 1, 2$ *and all* $k(a_h) \in \{0, c, c_A\}$.

2. *The intermediary selects the action minimizing* $E_\theta[c(l_1, a_h, \theta) \mid k(a_h)]$.

**Proof.** See the discussion above. ■

To complete our discussion of spot contracting, we finally consider contracting situations where one agent (either the buyer or the seller) contracts with a vertically integrated firm. Consider first the contracting problem between the buyer and the vertically integrated structure of the intermediary and seller.

**Spot Contracting Between the Buyer and the Intermediary-Seller Vertical Structure (Firm U)**

When intermediary and seller form an employment relation they are able to minimize costs more effectively. Thus, the buyer now faces the following problem

$$\begin{cases} \max\limits_{q(l_i), l_i} [v(l_i, \theta) - q(l_i)] \\ \\ \text{subject to} \\ \\ q(l_i) - E_\theta[\min\limits_{a_h}\{c(l_i, a_h, \theta) + k((l_i, a_h, \theta)\}] \geq \overline{u} \qquad \text{(IR)} \end{cases} \tag{18}$$

In trying to determine the precise value for $\bar{u}$ the reservation utility, we are led to the following considerations. Firm U's reservation utility is the sum $\bar{u}_I + \bar{u}_A$ plus the minimum share $\phi$ of the efficiency rent $\Delta$ of the vertical structure required to sustain the employment relation. Thus, $\bar{u} = \bar{u}_I + \bar{u}_A + \phi\Delta$. It is entirely conceivable that the buyer could appropriate a share of this efficiency rent $\Delta$. Indeed, this very possibility might reduce her incentive to move towards full integration, as we shall see.

**Spot Contracting Between the Seller and the Buyer-Intermediary Vertical Structure (Firm D)**

Finally, consider the contracting problem between the seller and the vertical buyer-intermediary structure. Again, when buyer and intermediary form an employment relation they are able to determine the choice of $l_i$ more effectively. In fact, they can always choose the first-best action. This means that in case 1

(with negative spill-overs) the seller's cost is always $k((l^{FB}, a_h, \theta) = 0$ (where the superscript $FB$ refers to the first-best action $l(\theta)$). Therefore, the contract simply boils down to a fixed price $p = \bar{u}_A$. In case 2, on the other hand, the seller's costs are always $k((l^{FB}, a_h, \theta) = c_A$. Again, the contract reduces to a fixed price $p = \bar{u}_A + c_A$. Note that if the seller had bargaining power he might also be able to appropriate a fraction of the efficiency rent of the downstream vertical structure. As before, his incentive to move towards full integration would then be reduced. This completes our discussion of spot contracting. We now move to an analysis of equilibrium vertical integration.

## 5.2 Vertical Integration, Chain-of-Command and Out-sourcing

Between the extremes of a fully vertical integrated firm consisting of the buyer, the intermediary and the seller, and complete disintegration there are situations in which two of the three parties integrate to form a firm, and write spot contracts with the third. We now delineate the circumstances in which the three forms of integration arise. We begin with case 1.

**Case 1: Negative Spill-overs**

The reason why this case is referred to as the 'negative spill-over' case is that when the buyer and intermediary form an employment relation, and thereby guarantee that the action $l_i$ such that $v(l_i, \theta) = v$ is always chosen, they impose a negative spill-over on the efficiency rents of the (upstream) intermediary-seller employment relation. In fact, in this extreme case there are no efficiency rents to be obtained in the authority relation between the intermediary and seller when the buyer and intermediary are integrated. Indeed, when the first best action is chosen by the buyer in this case the seller's cost are independent of $a_h$ (and normalized to zero). So that there is no room for exploitation of the seller by the intermediary.

This extreme case is meant to illustrate that only partial integration may obtain when the authority relation between two agents (here the buyer and intermediary) has efficiency enhancing effects on other vertical relations. By reducing (or eliminating) the efficiency gain in the intermediary-seller authority relation,

integration by the buyer and intermediary makes further integration either non sustainable or non necessary[6].

Thus, there are only three possible vertical structures in this case, : i) spot contracting, ii) partial integration between the buyer and intermediary, iii) partial integration between the intermediary and seller. The present expected net surpluses under these respective structures are as follows:

1. Spot Contracting: In this situation the buyer and intermediary always choose $l_1$ and half the time $l_1$ is first-best. The present expected net surplus is therefore:
$$\frac{1}{\delta}\left[\frac{1}{2}v + \frac{1}{2}(V - c_A - \frac{c_I}{3}) - \overline{u}_A - \overline{u}_I\right]$$

2. Buyer-Intermediary Integration: Here the buyer always chooses the first-best action. This yields a total present expected net surplus of:
$$\frac{v - \overline{u}_A - \overline{u}_I}{\delta}$$

3. Intermediary-Seller Integration: Here again the buyer always chooses $l_1$ in spot contracting with the upstream vertical structure. The difference with spot contracting is that the intermediary and seller can now achieve lower costs under an authority relation. The present expected net surplus is therefore:
$$\frac{1}{\delta}\left[\frac{1}{2}v + \frac{1}{2}(V - \frac{2c_I}{3}) - \overline{u}_A - \overline{u}_I\right]$$

[6] Two issues are of potential concern here. First, if there are no benefits from the intermediary and seller forming an employment relation, when the intermediary is integrated with the buyer, there are also no costs. We break this indifference by assuming that there is a small fixed cost of integration.

Second, if the contracting problem between the intermediary and seller are so different, depending on whether the buyer chose the first or second best action, wouldn't it be possible to find a multilateral spot contract implementing the first-best? Here an important implicit assumption we make is that the intermediary does not observe his or the seller's costs at the time of contracting with the buyer. He only observes these costs later when he negotiates with the agent. Thus, at the time of contracting with the buyer he cannot determine whether the buyer chose a first or second best action.

This still leaves open the question whether a Maskin revelation scheme where the seller and intermediary are induced to truthfully report the seller's costs would not implement the first-best. We have not explored this issue. Note, however, that we have made minimal assumptions about the richness of the underlying state space. By introducing more uncertainty or states of nature it is possible to eliminate the possibility that sophisticated spot contracts could achieve the first-best.

Thus the gains in efficiency that result when two agents pair off to form a firm are given by:

a) Intermediary-Seller Integration:

$$\Delta_{IS} = \frac{1}{2\delta}(c_A - \frac{c_I}{3})$$

b) Buyer-Intermediary Integration:

$$\Delta_{BI} = \frac{1}{2\delta}(v - V + c_A + \frac{c_I}{3})$$

Moreover,

$$\Delta_{BI} - \Delta_{IS} = v - V + \frac{2c_I}{3}.$$

Since by assumption $c_A > \frac{c_I}{3}$ and $v > V - c_A - \frac{c_I}{3}$ we have $\Delta_{IS} > 0$, and $\Delta_{BI} > 0$. However, the sign of $\Delta_{BI} - \Delta_{IS}$ is ambiguous.

If the buyer and intermediary have all the bargaining power when spot contracting with the seller (as we have been assuming so far) they are able to appropriate the full incremental surplus $\Delta_{BI}$. The intermediary and seller, on the other hand, may have to share some of the efficiency gains $\Delta_{IS}$ with the buyer. The latter will refrain from extracting too high a rent if this undermines the sustainability of the employment relation.

When is downstream integration (between the buyer and intermediary) an equilibrium outcome? If the buyer deviates by choosing a second-best action and not compensating the intermediary she gets an incremental flow payoff of $(V - v)$ since both intermediary and seller anticipate a first-best action involving no costs[7].

[7]Note that the timing here is somewhat delicate. When the intermediary is ordered to perform the second-best action he does not observe his or the agent's cost. But, later when he contracts with the agent he oserves the agent's cost and realizes that the buyer has deviated. We assume that the intermediary at that point is already engaged and commited to carrying out the action. He is free to quit, however, once he has carried out what he promised to do. One reason for carrying through the action (from outside the model) might be that otherwise he would be punished for negligence or professional misconduct.

Note that this modeling difficulty is easily overcome by enriching the state space and allowing for positive seller costs (equal to $c_A$) even under the first best action $l^{FB}$. In that case the intermediary would not be able to infer from the observation of the agent's costs that the buyer has cheated.

Suppose for now that following the deviation the employment relation breaks down and the whole vertical structure reverts to spot contracting thereafter. Then the buyer stands to lose

$$\frac{(1-\delta)}{2\delta}(v - V + c_A + \frac{c_I}{3})$$

by deviating to a second best action.

Thus, a downstream employment relation is sustainable for all $\delta \leq \widehat{\delta}_{BI}$, where $\widehat{\delta}_{BI}$ is given by the solution to

$$V - v = \frac{(1-\delta)}{2\delta}(v - V + c_A + \frac{c_I}{3})$$

or

$$\widehat{\delta}_{BI} = \frac{v - V + c_A + \frac{c_I}{3}}{V - v + c_A + \frac{c_I}{3}}.$$

Under upstream integration between the seller and intermediary the flow payoff to the intermediary from deviating is $c_I$. This is the cost the intermediary can save by asking the seller to take the action $a_h$ with cost $c_A$. Following such a deviation, of course, the seller dissolves the employment relation. Suppose as before that then transactions revert back to spot contracting. The permanent loss from breaking up the employment relation is then

$$\frac{1-\delta}{2\delta}(c_A - \frac{c_I}{3}).$$

The upstream employment relation is therefore sustainable for all $\delta \leq \widehat{\delta}_{IS}$, where $\widehat{\delta}_{IS}$ is given by

$$\widehat{\delta}_{IS} = \frac{c_A - \frac{c_I}{3}}{\frac{5c_I}{3} - c_A}.$$

Since both deviation flow payoffs and efficiency gains from integration differ across the two vertical structures it is not possible to unambiguously rank the two cut-offs $\widehat{\delta}_{BS}$ and $\widehat{\delta}_{IS}$.

We summarize this discussion in the proposition below:

**Proposition 6** *When $0 < \delta < \min\{\widehat{\delta}_{BI}, \widehat{\delta}_{IS}\}$ then both upstream and downstream integration are sustainable. When $\widehat{\delta}_{BI} > \widehat{\delta}_{IS}$ and $\widehat{\delta}_{IS} \leq \delta < \widehat{\delta}_{BI}$ then only downstream integration is sustainable. Vice versa, when $\widehat{\delta}_{BI} < \widehat{\delta}_{IS}$*

*and* $\widehat{\delta}_{BI} \leq \delta < \widehat{\delta}_{IS}$ *then only upstream integration is sustainable. When* $\delta \geq \max\{\widehat{\delta}_{BI}, \widehat{\delta}_{IS}\}$ *then only spot contracting is feasible.*

**Proof.** See the discussion above. ■

The cut-offs $\widehat{\delta}_{BI}$ and $\widehat{\delta}_{IS}$ are obtained when spot contracting is the fall-back transaction mode following breakdown of one of the employment relations. However, this is not necessarily the only possible outcome. Now, when one relation dissolves the other one may form instead. In that case the costs from dissolving the relation may be lower than what we have assumed. The effect on incentives to remain integrated when other forms of integration may arise following dissolution of the employment relation is unambiguously to reduce the sustainability of integration. To the extent that we have taken the least efficient fall-back transaction mode we may exaggerated the sustainability of integration in the analysis above.

Another natural question that arises here is: when $0 < \delta < \min\{\widehat{\delta}_{BI}, \widehat{\delta}_{IS}\}$ which form of integration is most likely? One can imagine a bidding process between the seller and the buyer to get to integrate with the intermediary. There are constraints on this form of bidding, however. Each employment relation has to remain sustainable after the payment of the bid. How such a bidding game will play out remains to be determined in future research.

**Case 2: Positive Spill-overs**

In diametric opposition to the previous case, here the choice by the buyer of the first-best action opens up the possibility for the intermediary to exploit the seller in spot transactions. Therefore, integration by the buyer and intermediary, resulting in a guaranteed choice of the first best action $l^{FB}$, creates the need here for further integration to include the seller under the whole vertical structure. This is why we refer to this case as a 'positive' spill-over case. This case illustrates how full integration may arise under a chain-of-command structure (provided that efficiency gains from integration do not decrease too rapidly).

There are four possible vertical structures here: i) spot contracting, ii) partial integration between the buyer and intermediary, iii) partial integration between

the intermediary and seller, and iv) full integration. The present expected net surpluses under these respective structures are as follows:

1. Spot Contracting: As before the buyer and intermediary always choose $l_1$ and half the time $l_1$ is first-best. The present expected net surplus under positive spill-overs is then:
$$\frac{1}{\delta}\left[\frac{1}{2}(v - c_A - \frac{c_I}{3}) + \frac{1}{2}(V - c) - \overline{u}_A - \overline{u}_I\right]$$

2. Buyer-Intermediary Integration: Again the buyer always chooses the first-best action here. The present expected net surplus is therefore:
$$\frac{1}{\delta}\left[(v - c_A - \frac{c_I}{3}) - \overline{u}_A - \overline{u}_I\right]$$

3. Intermediary-Seller Integration: Here the intermediary and seller can achieve cost savings, but these are realized only when the buyer selected the first-best action. Since he is equally likely to choose a first or second best action under spot contracting (by assumption) the present expected net surplus is:
$$\frac{1}{\delta}\left[\frac{1}{2}v + \frac{1}{2}(V - \frac{2c_I}{3}) - \overline{u}_A - \overline{u}_I\right]$$

4. Full Integration: Under full integration the first best action $l^{FB}$ is always chosen and costs are always minimized so that the net expected surplus is:
$$\frac{1}{\delta}\left[(v - \frac{2c_I}{3}) - \overline{u}_A - \overline{u}_I\right]$$

Thus, the full efficiency gains obtainable by moving from spot contracting to full integration are

$$\Delta_{BIS} = \frac{1}{2\delta}\left[v - V + c_A + \frac{2c_I}{3} + c\right],$$

and the gains from partial integration are (as before)

$$\Delta_{IS} = \frac{1}{2\delta}(c_A - \frac{c_I}{3}),$$

for intermediary-seller integration, and (now)

$$\Delta_{BI} = \frac{1}{2\delta}\left[(v - c_A - \frac{c_I}{3}) - (V - c)\right],$$

for buyer-intermediary integration.

Finally, the gains from moving from partial to full integration are:

$$\Delta_{IS}^{BIS} = (\Delta_{BIS} - \Delta_{IS}) = \frac{1}{2\delta}\left[v - V + c_I + c\right]$$

for a move from upstream integration (between intermediary and seller) to full integration, and

$$\Delta_{BI}^{BIS} = (\Delta_{BIS} - \Delta_{BI}) = \frac{1}{2\delta}\left[2c_A + c_I + 2c\right]$$

for a move from downstream integration (between buyer and intermediary) to full integration.

When is full integration an equilibrium outcome? To answer this question we must consider the incentives to deviate of both buyer and intermediary. This incentive depends both on the total size of the efficiency gain from full integration and on how this gain is shared between the intermediary and buyer. We denote by $\alpha$ the share of the efficiency gain going to the buyer and $(1-\alpha)$ the share going to the intermediary.

The size of the efficiency gain depends on what happens following a deviation: does the entire vertical structure collapse, or do the parties revert back to partial integration? We shall consider both possibilities. We begin by assuming that if either buyer or intermediary deviate then parties revert back to spot contracting.

- **Spot contracting versus full integration:** The buyer's payoff from deviating is as before $(V - v)$ and she stands to lose

  $$\frac{(1-\delta)\alpha}{2\delta}\left[v - V + c_A + \frac{2c_I}{3} + c\right]$$

  following the deviation.

  The intermediary's maximum payoff from deviating is $c_I$ as before, and he stands to lose

  $$\frac{(1-\delta)(1-\alpha)}{2\delta}\left[v - V + c_A + \frac{2c_I}{3} + c\right].$$

In the remainder of this section we restrict attention to the case where

$$V - v > c_I.$$

In this case the buyer's payoff from deviating is higher than the intermediary's[8]. A necessary condition for full integration is,

$$\frac{(1-\delta)(1-\alpha)}{2\delta}\left[v - V + c_A + \frac{2c_I}{3} + c\right] \geq c_I.$$

Setting $(1-\alpha)$ such that:

$$\frac{(1-\delta)(1-\alpha)}{2\delta}\left[v - V + c_A + \frac{2c_I}{3} + c\right] = c_I \tag{19}$$

we find that full integration is sustainable if and only if the buyer's incentive constraint

$$V - v \leq \frac{(1-\delta)\alpha}{2\delta}\left[v - V + c_A + \frac{2c_I}{3} + c\right]$$

, where $\alpha$ is given by equation (19), is satisfied. In other words, full integration is sustainable for all $\delta \leq \widehat{\delta}_{BIS}$, where $\widehat{\delta}_{BIS}$ is given by the solution to

$$V - v = \frac{(1-\delta)(v - V + c_A + \frac{2c_I}{3} + c) - 2\delta c_I}{2\delta}$$

or

$$\widehat{\delta}_{BIS} = \frac{v - V + c_A + \frac{2c_I}{3} + c}{V - v + c_A + \frac{8c_I}{3} + c}. \tag{20}$$

- **Partial versus full integration:** Consider first the buyer's incentives to sustain full integration, when the intermediary and seller remain integrated following a deviation by the buyer. Suppose, for simplicity, that when the buyer spot transacts with the intermediary-seller vertical structure she does not appropriate any of the efficiency gains from the intermediary-seller authority relation (so that $\phi = 0$). Then the buyer's gain from deviating is as always

$$V - v,$$

and her future loss is now

$$(1-\delta)\Delta_{IS}^{BIS} = \frac{(1-\delta)}{2\delta}\left[v - V + c_I + c\right].$$

[8] The alternative case, where $(V - v \leq c_I$ is easily handled.

Thus, full integration is sustainable under this scenario for all $\delta \leq \widehat{\delta}_{IS}^{BIS}$, where $\widehat{\delta}_{IS}^{BIS}$ is given by

$$V - v = \frac{(1-\delta)}{2\delta}\left[v - V + c_I + c\right]$$

or,

$$\widehat{\delta}_{IS}^{BIS} = \frac{v - V + c_I + c}{V - v + c_I + c}.$$

Note that this scenario only makes sense if partial integration between the intermediary and seller is also sustainable. This is the case if $\delta \leq \widehat{\delta}_{IS}$.

Consider now the sustainability of full integration for the intermediary, when the buyer and intermediary remain integrated following a deviation by the intermediary. Suppose also that the intermediary gets a zero net surplus under partial integration with the buyer (as we have assumed so far). Then he has no incentive to deviate from full integration if[9]

$$c_I \leq (1-\delta)\Delta_{BI}^{BIS}$$

or if $\delta \leq \widehat{\delta}_{BI}^{BIS}$, where $\widehat{\delta}_{BI}^{BIS}$ is given by the solution to

$$c_I = \frac{(1-\delta)}{2\delta}\left[2c_A + c_I + 2c\right],$$

or

$$\widehat{\delta}_{IS}^{BIS} = \frac{2c_A + c_I + 2c}{2c_A + 3c_I + 2c}.$$

Here also we must ensure that partial integration between the buyer and intermediary is sustainable, which requires that $\delta \leq \widetilde{\delta}_{BI}$, where $\widetilde{\delta}_{BI}$ is the solution to[10]

$$V - v = \frac{(1-\delta)}{2\delta}\left[(v - c_A - \frac{c_I}{3}) - (V - c)\right].$$

[9] Recall that we are assuming here that the seller has no bargaining power when negotiating with the buyer-intermediary vertical structure. Note also that we implicitly assume that the intermediary (who has the informational advantage over the seller) negotiates with the seller. If the vertical structure could commit to the buyer negotiating with the seller an efficiency improvement could be obtained. However, there is no way of guaranteeing that the buyer wont consult the intermediary, so that this improvement is not really available.

[10] Note that the cut-off $\widetilde{\delta}_{BI}$ obtained in the positive spill-over case is different in general from the cut-off $\widehat{\delta}_{BI}$ in the negative spill-over case.

That is,

$$\widetilde{\delta}_{BI} = \frac{v - V - c_A - \frac{c_I}{3} + c}{V - v - c_A - \frac{c_I}{3} + c}.$$

To summarize, when $\delta \leq \min\{\widetilde{\delta}_{BI}, \widehat{\delta}_{IS}\}$ then both forms of partial integration are sustainable and may form natural fall-back structures when only one of the relevant parties (buyer or intermediary) deviates under full integration. In that case, a move from partial to full integration is sustainable only if

$$\delta \leq \min\{\widehat{\delta}_{IS}^{BIS}, \widehat{\delta}_{BI}^{BIS}\}.$$

**Proposition 7** *A move from spot contracting to full integration is sustainable if* $\delta \leq \widehat{\delta}_{BIS}$*, where* $\widehat{\delta}_{BIS}$ *is given by equation (20). A move from spot contracting to either upstream or downstream partial integration is sustainable if* $\delta \leq \min\{\widetilde{\delta}_{BI}, \widehat{\delta}_{IS}\}$*. When partial integration is sustainable, a move from partial to full integration is sustainable if* $\delta \leq \min\{\widehat{\delta}_{IS}^{BIS}, \widehat{\delta}_{BI}^{BIS}\}$*. When* $\min\{\widehat{\delta}_{IS}^{BIS}, \widehat{\delta}_{BI}^{BIS}\} < \min\{\widetilde{\delta}_{BI}, \widehat{\delta}_{IS}\}$ *there are diminishing 'returns to scope', which prevent a move from partial to full integration. When* $\min\{\widehat{\delta}_{IS}^{BIS}, \widehat{\delta}_{BI}^{BIS}\} \geq \min\{\widetilde{\delta}_{BI}, \widehat{\delta}_{IS}\}$*, on the other hand, there are increasing 'returns to scope', which allow a move from partial to complete integration.*

As one might expect, since $\widehat{\delta}_{IS} > \max\{\widehat{\delta}_{IS}^{BIS}, \widehat{\delta}_{BI}^{BIS}\}$ full integration (which implements the first-best outcome here) is easiest to sustain when a deviation by a single player is 'punished' by a complete dissolution of the organisation. In practice such extreme punishments may be hard to coordinate. In addition, they may not be desirable if on occasion an agent makes mistakes.

## 6 Conclusion

We have shown in this paper how an authority mode (based on command rather than negotiation) may emerge as an efficient transaction mode, when the employer has superior information about what course of action is most desirable, and when employer and employee interact sufficiently frequently over time. We have also shown how authority can be extended to a third party in a three agent contracting problem. We have derived conditions under which a chain-of-command

structure may emerge, where each vertical relation between two agents is similar to the bilateral authority relation derived first in a bilateral setting.

While this model captures important elements of the employment/authority relation it also has many missing ones. First and foremost, the notion of authority through commands as a coordination procedure is entirely absent from this model. Second, the idea that an employer hires an employee (who might sometimes be idle) as a way of assuring that the employee's services are available when needed is also absent. Third, the notion of authority as 'precedence rule', as explored in Aghion and Tirole (1998) and Hart and Moore (2000) is also missing. All these facets are relevant and part of most authority relations. Like bargaining, the authority relation may involve extremely complex issues and strategic interactions, which cannot be fully captured within a single model. Given its prevalence and importance it has been relatively under-researched by economists. It deserves the same (or more) attention as bargaining has received over the past two decades.

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