Delegated contracting, information, and internal control

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Abstract

This paper studies a particular form of internal control available to a (top) principal when delegating the offer of a Baron–Myerson style contract to an intermediary. We show that by examining the contract offered to the productive agent, the principal can reduce the loss of control.

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1. Introduction

What is the value of communication between the top two layers of a vertical hierarchy? Can the principal improve sequential contracting by structuring communication with an intermediate player (manager, prime contractor) to whom he delegates the offer of a partially verifiable sub-contract? This question is of particular interest for the analysis of delegated contracting, a scheme in which the principal cannot interact with the productive agent at the lowest layer, but relies on designing output targets and budgets together with some possible form of internal control.

Delegated contracting schemes have been studied within the larger literature on centralized versus decentralized contracting to explain the particular loss of control arising in public bureaucracies and large firms. Melumad, Mookerjee and Reichelstein (1992) have shown that three-tier hierarchies do not come with additional costs if top–down contracting permits the principal to tax away any rent of the intermediary ex ante. In turn, McAfee and McMillan’s (1995) seminal paper shows that even if the intermediary has no private information, the fact that she is protected by limited liability leads to a double-marginalization of rents, a typical control loss affecting vertical relationships. In the view of Melumad, Mookerjee and Reichelstein (1997), delegated contracting still offers the potential advantage of giving the intermediary full information about the agent’s type when designing the sub-contract.

Faure-Grimaud and Martimort (2001) (hereafter, FGM) have redefined delegated contracting to include the task of forwarding a Baron and Myerson (1982)2 style contract to the agent. Information, rents, and communication now become intertwined: the intermediary is hired because of her ability to costlessly filter out an unwanted third type of agent before offering a BM contract to the two remaining types, which she still cannot distinguish. This gives the intermediary some option to use the ex ante information to her advantage, increasing the principal’s risk of being left without production.3

To further close the lacuna on delegated contracting, this paper explores the principal’s options for making use of existing and accessible information to limit the discretion given to players located at lower tiers. In FGM, delegated contracting is carried out in an output- and message-contingent grand contract based on information prior to (sub-) contracting. Using a state-contingent analysis, I explore
the underlying problem of partial verifiability of the sub-contract that follows from the noncontractibility of the intermediary's offer. Melumad and Reichelstein (1987, 1989) have already shown that message-dependent contracts with communication may reveal an advantage over BM contracts. This paper follows their original idea, although the intermediary is hired to offer only a BM contract. Baron and Besanko (1992) have studied a similar delegated contract, arguing that under the presence of informational asymmetries it is the organizational structure, the locus of information, and the nature of communication that call for the "designer's choice of the scope of control." While their 'Hierarchy III' comes close to the setting studied in this paper, the contracting scheme used here faces the problem of partial verifiability of the intermediary's action.

This paper's contribution is twofold. First, it provides an extended analysis of how communication and information flow can be structured with the choice of contracting. In FGM, communication between principal and intermediary is possible, but their analysis does not focus on how decision making can be improved when the principal has a choice between centralized and delegated contracting. Second, the paper shows that a simple form of control may improve delegated contracting. This form of control permits some discussion of related benchmarks. Budgeting and the according designing of output targets are already used in FGM. It is thus straightforward to extend managerial accounting toward internal control performed through an examination of the written document of which the intermediary must be knowledgeable. This form of control differs from standard forms of auditing where the principal aims to detect the type of a productive agent. This paper thus offers a rationale for particular forms of control typically used in vertical hierarchies with no access to the productive agent.

2. The model

2.1. General setup and the intermediary's rents in the original FGM setting

This section offers a generalized notation to extend the stylized contractual scheme of FGMs three player model with a (top) principal, an intermediary, and a productive agent (firm). The productive agent can be of three types: \( q \), \( \theta \), \( \bar{\theta} \), and \( \tilde{\theta} \), such that \( \Delta \theta \equiv \bar{\theta} - \tilde{\theta} \). Type \( \theta \) has excessive marginal cost, and therefore should never be offered a contract according to the principal's will. To avoid having the \( \theta \)-type in the regime, the principal hires the intermediary who can costlessly observe type \( \tilde{\theta} \) with a known precision \( p \). When \( \tilde{\theta} \) is not detected, the agent's type can still be \( q \) (with a probability \( \nu \)) or \( \theta \) (with a probability \( 1 - \nu \)) at the sub-contracting stage. The resulting priors are \((1 - p)q; (1 - p)(1 - r)\), and \( p \), respectively. The principal maximizes his expected net surplus \( S(q) - s \), which includes the budget \( s \) paid to the intermediary to forward production transfers \( t \) to the productive agent. Transfers are designed to permit the offer of a BM-style contract to the agent that includes the virtual costs \( \Delta \theta \tilde{q} \), which induces realization of outputs together with the (limited) use of budgeting in the intermediary to forward production transfers \( t \) to the productive agent. In FGM's model, the agent's rents follow the basic screening setup with two players, making it possible to express the intermediary's rents as \( \nu s - \Delta \theta \tilde{q} \) and \( \bar{\nu} \tilde{s} - \Delta \theta \tilde{q} \) following the use of budgeting. These rents also reflect the surplus of the intermediary–agent coalition. The intermediary's surplus is assumed to be risk averse, with a VNM utility function of \( V(s - t) = \frac{1}{2} \theta^2 s^2 + r \), and \( r \) denoting her degree of risk aversion.

In the original FGM setting, delegation-proofness is reached by satisfying the following constraints of the intermediary. That is, two downward incentive constraints, namely

\[
\nu s - \Delta \theta \tilde{q} \geq 0
\]

and

\[
\bar{\nu} \tilde{s} - \Delta \theta \tilde{q} \geq 0.
\]

Both Eqs. (3) and (4) ensure that the intermediary, in addition to being risk averse, is always protected by limited liability below zero wealth, regardless of the sub-contract being accepted or rejected by the agent.

Since the intermediary's contract offer is unobserved, she can require a rent that prevents her from offering a shutdown contract to the agent, which, in FGM (2001, p. 80), leads to the following incentive constraint:

\[
V(\tilde{s}) \geq 0.
\]

The intermediary can only costlessly detect \( \tilde{\theta} \)-type agent. If not observing this type, she could still offer a shutdown contract and reap the virtual cost \( \Delta \theta \tilde{q} \) herself. To restore delegation-proofness, a rent is paid to satisfy Eq. (5).

2.2. Timing, communication and the resulting information structure

To explore how communication influences the information structure I consider the timeline of the contracting game\(^4\) (Fig. 1).

Two observations help explain the information structure and the impact of communication.

- The intermediary's report on the agent's type is always truthful if a sub-contract was accepted. This follows from the observability of realized outputs together with the (limited) use of budgeting in the setting. Although outputs remain verifiable, the transfers eventually paid to the agent are only partially so, which follows the nature of the BM contract.
- The intermediary has an informational advantage over the principal; namely the ability to make an unobserved offer at stage \( t = 3 \). In one state of nature this advantage cannot be limited. This is the case when the intermediary has tried to offer a shutdown contract but the agent was of type \( \tilde{\theta} \) and turned down the contract offer. When no sub-contract was signed, no hard information can become available.

There is a particular form of internal control that follows from the timing of the contracting game. Since budgeting is now used in the FGM setup, an examination of documents permits a

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\(^4\) Baron and Besanko (1992, p. 239). FGM's setting can also be seen as a borderline case of collusion in which no communication is needed between intermediary and agent, her always reaping the benefits of collusion when successful. Second, the intermediary's contract offer always involves the informed principal problem; revealing a piece of information that the intermediary possesses. Since this choice is binary and involving access to the agent, this chain of arguments cannot be followed here. For a treatment see Laffont and Martinort (1990).

\(^5\) This type is always known ex post when a subcontract was signed.
straightforward measure of control. All this comes without loss of generality.

2.3. Rents and grand contract under internal control

We now restate the rents paid to the intermediary. The use of internal control reduces $V(\bar{\nu})$, and the new incentive constraint reads

$$V(\bar{\nu}) \geq \left[ gV(\bar{\nu} + \Delta\hat{\theta} - \bar{p}) + (1-\nu)V(\bar{\nu} + \Delta\hat{\theta}) \right].$$  

(5a)

The intermediary is now imposed a penalty $\bar{p}$ with probability $\nu$ if the examination of the written sub-contract detects the offer of a shutdown contract, while with probability $1-\nu$ she keeps her information rent as before. This simple control scheme does not need to involve probabilistic auditing; as long as the principal commands a costly but fully revealing examination technology it is sufficient for the principal to have one state of nature examined, following the intermediary's report.

Because of limited wealth of the agent already expressed in FGM, the assumption of endogenous punishment is straightforward and $\bar{p}$ is set equal to $\Delta\hat{\theta}q$. This reduces Eq. (5a) to

$$V(\bar{\nu}) \geq \left[ gV(\bar{\nu} + (1-\nu)V(\bar{\nu} + \Delta\hat{\theta}) \right].$$  

(5b)

Control costs $c(\nu)$ are assumed to be strictly convex, with $c(0)=0$, $c' > 0$, and $c'' < 0$. The inada conditions $c(0)=0$, $c'(1)=\infty$ are assumed to hold. With Eq. (1) binding to prevent the intermediate type from misreporting, Eq. (5b) now rewrites into

$$V(\bar{\nu}) \geq \nu(1-\nu)V(\bar{\nu} + \Delta\hat{\theta}) \dot{q}.$$  

(5c)

Solving Eq. (5c) for the risk averse intermediary now reduces the intermediary's rent from $\nu = \frac{\ln(1-e^{-c(\nu)})}{\nu} \rightarrow \nu = \frac{\ln(1-e^{-c(\nu)})}{\nu}$, to $\nu = \frac{\ln(1-e^{-c(\nu)})}{\nu}$. This expression is decreasing in $\nu$; other things equal, a higher probability of examination reduces the rent that the intermediary can require to give up gambling.

The grand contract, in fact to output targets $q$ and budgets $s$, now includes the probability of an examination $\nu \hat{\theta}$, leading to the following expression for the principal's program in its reduced form:

$$\max \left\{ (1-p) \left[ S(q) - q^\theta - \theta q - \frac{1}{\bar{r}} \ln \frac{\nu}{1-\nu} e^{-\Delta\hat{\theta}q} c(\nu) \right] + (1-\nu) \left[ S(q) - \hat{\theta} \hat{q} - \frac{1}{\bar{r}} \ln \frac{\nu}{1-\nu} e^{-\Delta\hat{\theta}q} c(\nu) \right] - p\bar{s}, \right\}$$  

(6)

Proposition 1. The optimal grand contract under internal control entails:

• Constraints (1), (2), and (3) are binding. Constraint (5) is replaced by Eq. (5c), which is binding as well. All other constraints are strictly satisfied.

• The principal implements a decreasing schedule of outputs with no distortion for the most efficient type of productive agent:

$$S(q) = \theta.$$  

• A accepts or rejects; production takes place; $I$ reports $A$'s type to $P$.

3. Discussion

3.1. Limits on punishment

While any rent payment to the intermediary in state $\bar{\theta}$ is excluded in this form of contracting, she may still require an upper bound on the penalty to accept the contract. This could make it harder for the principal to exercise internal control. This subsection shows that the findings are robust under limits on punishment. To model such limits in a tractable way, the stakke $\Delta\hat{\theta}q$ is multiplied with a factor $\gamma \in [0,1]$, with a lower $\gamma$ implying a higher bound on the penalty and a higher rent payment to the intermediary. Condition (5a) now changes into

$$V(\bar{\nu}) \geq \nu(1-\nu)V(\bar{\nu} + \theta q) + (1-\nu)V(\bar{\nu} + \Delta\hat{\theta}) \dot{q}.$$  

(5aLP)

For $\gamma = 0$, Eq. (5a LP) reduces to Eq. (5) in the original FGM setting with no punishment possible. In turn, $\gamma = 1$ yields Eq. (5a), the setting under full endogenous punishment. If this upper bound on the penalty is required, the principal satisfies Eq. (5a LP) by increasing $\bar{\theta}$ to

$$\frac{1}{\bar{r}} \ln \frac{\nu}{1-\nu} e^{-c(\nu)} \left( e^{-\Delta\hat{\theta}q} - (1-\nu) e^{\Delta\hat{\theta}q} \right)$$  

(6)

For any given $\gamma$, this rent of the intermediary is increasing in $\nu$: in settings where state $\bar{\theta}$ is more likely to occur, the rent of the intermediary is higher.

3.2. Comparing delegated contracting with centralization

Analyzing first the intermediary's rent $r$ from a comparative statics perspective reveals that both $\gamma$ and $\Delta\theta$ determine the principal's

$^7$ The internal control scheme presented here assumes that there is no useful information to be detected when no contract exists, which is equivalent to the case when the intermediary reports $\bar{\theta} = \bar{\theta}$. Otherwise, the principal can extend the scheme toward an examination both after a $\bar{\theta}$ and a $\bar{\theta}$ report. This would require the introduction of a limited liability constraint different from 0 so that a penalty can also be imposed without production taking place. The probability of examination then changes to $\bar{\theta}$ and a punishment $k$ is inflicted on the intermediary in the case of a detected lie after a $\bar{\theta}$ report. The principal's program then changes to

$$\max \left\{ (1-p) \left[ S(q) - q^\theta - \theta q - \frac{1}{\bar{r}} \ln \frac{\nu}{1-\nu} e^{-\Delta\hat{\theta}q} c(\nu) \right] + (1-\nu) \left[ S(q) - \hat{\theta} \hat{q} - \frac{1}{\bar{r}} \ln \frac{\nu}{1-\nu} e^{-\Delta\hat{\theta}q} c(\nu) \right] \right\}$$  

While under this scheme, the second-best distortions derived in Proposition 1 remain unchanged, the principal's option to examine the setting after $\hat{\theta}$ report improves contracting because of the level effect created by the additional punishment in case of a detected lie. Like in Proposition 1, the principal always inflicts a punishment in the same state of nature he examines the contract and incurs the costs of examination. I am grateful to an unknown referee for pointing me toward this option. A detailed discussion is available from the author.

$^8$ See Proof of Proposition 2 for a derivation of this term.
surplus. The more risk averse the intermediary, the easier it is for the principal to satisfy truth-telling: the intermediary’s temptation to misbehave is less when she is more risk averse, and it vanishes in the limit when \( \rho \) goes to infinity.

Second, \( \Delta \theta \), besides being an expression of the intermediary’s rent, is also a measure of uncertainty for the principal. Since he has no influence over the size of \( \Delta \theta \), it is of interest to examine the uncertainty that he faces when offering the grand contract. The cross-derivative of the principal’s program furthermore reveals that this uncertainty is strictly increasing with the degree of risk aversion, \( \rho \):

\[
\frac{\partial}{\partial \Delta \theta} \left[ e^{\nu} \left( 1 - \nu \right)^2 r \rho q e^{-\rho \Delta \theta q} \right] \left( 1 - \left( 1 - \nu \right) e^{-\rho \Delta \theta q} \right)^2.
\]

The derivative itself is decreasing in both \( \Delta \theta \) and \( \rho \).

Third, continuing the comparative statics analysis now permits conclusions regarding the relative performance of institutions. We assume that the principal has the choice between using delegated contracting with control and direct contracting, which comes at an existing sub-contract after the intermediary’s report of \( \bar{\theta} - \hat{\theta} \). This reduces the distortion of the output target offered to the intermediary and improves contracting. The discussion of the three possible reports reveals:

**Case 1.** Assume the intermediary reports \( \bar{\theta} = \hat{\theta} \). No sub-contract exists and the report can either be true or false. If the report is true, the intermediary did her duty by not offering a sub-contract when observing that \( \bar{\theta} = \hat{\theta} \). If the report is false, the intermediary offered a shutdown contract and lost her gamble. Although she did not act following the principal’s intention, she was unable to reap any rent. The agent’s true type is then \( \theta = \hat{\theta} \).

**Case 2.** The intermediary reports \( \bar{\theta} > \hat{\theta} \). This report must be true: the form of the intermediary’s report of \( \bar{\theta} - \hat{\theta} \) included in the budget to permit a BM-style contract designed for both types of firms; otherwise, the revealed \( \hat{\theta} \)-type agent would have rejected. The form of delegation-proofness. The term in the large parenthesis is found by modifying Eq. (5a) into Eq. (5a LP):

\[
\frac{\partial}{\partial \Delta \theta} V' \left( \bar{\theta} \right) \geq \frac{e^{\nu}}{1 - \nu} \left( 1 - \nu \right)^2 r \rho q e^{-\rho \Delta \theta q} \left( 1 - \left( 1 - \nu \right) e^{-\rho \Delta \theta q} \right)^2.
\]

The expression in the large parenthesis is the negative of the virtual costs \( \Delta \theta q \) included in the budget to permit a BM-style contract designed for both types of firms; otherwise, the revealed \( \hat{\theta} \)-type agent would have rejected. The form of budgeting used in FGM is sufficient to reveal information in this state.

**Case 3.** The intermediary reports \( \bar{\theta} < \hat{\theta} \). Only this case permits the use of hard information accessible to the principal through managerial control without accessing the productive agent. The accepted sub-contract can be a shutdown contract, in which case the intermediary may have reaped the virtual costs \( \Delta \theta q \) included in the budget to permit a BM-style contract. If the agent is of type \( \bar{\theta} \), examination of the existing contract reveals that a shutdown contract was offered. Contrary to the auditing of a productive agent whereby the principal examines the inefficient state and inflicts a punishment when the agent was found to be efficient, the principal here audits the contract when type \( \bar{\theta} \) is announced and inflicts a punishment when the real type was indeed of type \( \bar{\theta} \) but the intermediary offered a shutdown contract.

**4. Conclusion**

Delegated contracting involves more than restoring delegation-proofness by increasing the rent payment to an intermediary. The same setting permits the principal to make use of what at first seems to be a central drawback of this contractual form — namely, its particular information flow. This paper shows that the principal can extend the grand contract toward an internal form of control that typically applies to vertical hierarchies. The results are robust.

Furthermore, the paper has compared internal control under delegated contracting with direct contracting. Internal control renders delegated contracting more efficient. This explains why delegated hierarchies typically use forms of internal control to limit the discretion of intermediate players. Internal control has an impact even if there is no communication possible between the top and bottom tier of the hierarchy.

Comparisons with other contractual settings permitting a richer treatment of communication are left for future research.

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**Appendix A**

**Proof of Proposition 1.** Deriving Eq. (6) w.r.t. to outputs leads to the requested result.

For any \( \Delta \theta > 0 \), this expression is strictly less than the R.H.S. in the FGM solution, which in the notation adopted here condenses to \( \theta^* \Delta \theta + \frac{1}{1 - \nu} \Delta \theta q \). Internal control involves an examination of the existing sub-contract after the intermediary’s report of \( \bar{\theta} - \hat{\theta} \). This reduces the distortion of the output target offered to the \( \theta \)-type and improves contracting. The discussion of the three possible reports reveals:

**Case 1.** Assume the intermediary reports \( \bar{\theta} = \hat{\theta} \). No sub-contract exists and the report can either be true or false. If the report is true, the intermediary did her duty by not offering a sub-contract when observing that \( \bar{\theta} = \hat{\theta} \). If the report is false, the intermediary offered a shutdown contract and lost her gamble. Although she did not act following the principal’s intention, she was unable to reap any rent. The agent’s true type is then \( \theta = \hat{\theta} \).

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**Proof of Proposition 2.** It is easy to see that the principal’s costs of direct contracting need to be less or equal the cost of the hierarchy under internal control, covering the intermediary’s rent to reach delegation-proofness. The term in the large parenthesis is found by modifying Eq. (5a) into Eq. (5a LP):

\[
V(\bar{\theta}) \geq \frac{e^{\nu}}{1 - \nu} \left[ V(\bar{\theta}) + \Delta \theta q \left( 1 - \nu \right) \right] + (1 - \nu) V(\bar{\theta} + \Delta \theta q).
\]

Solving for \( \bar{\theta} \) is done by using \( V(\bar{\theta}) = \frac{1}{1 - \nu} \) and isolating the resulting \( e^{-\rho \Delta \theta q} \) terms on both sides. Rearranging the terms leads to the expression in the proposition.

**References**