On some agency costs of intermediated contracting

Antoine Faure-Grimaud\textsuperscript{a,}*\textsuperscript{,} David Martimort\textsuperscript{b}

\textsuperscript{a}Interdisciplinary Institute of Management, Departments of Economics and Accounting and Finance, London School of Economics, and FMG, Houghton Street, London WC2A 2AE, UK
\textsuperscript{b}Université de Pau et des Pays de l’Adour, IDEI and CEPR, Pau, France

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Abstract

This paper identifies a new agency cost of intermediated contracting. A non productive intermediary can extract some rents when (a) the productive agent has some private information and (b) the intermediary’s sub-contract with the productive agent is not directly controlled by the top principal. We show that the intermediary’s informational rent is an increasing and concave function of the productive agent’s own informational rent. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction

In many settings, writing a centralized comprehensive contract describing all the actions and transfers to different agents part of the same economic transaction is not feasible. Instead, it is often the case that transactions are carried out through a sequence of bilateral contracts. Fitting examples range from cases of delegated procurement, delegation of economic policy from the elected politicians to an administration/agency in charge of dealing directly with the economic agents, and financial intermediation where investors provide funds to financial institutions which then invest in entrepreneurial projects.

To model intermediated contracting in Principal–Agent models, we build a stylized contractual relationship between three participants. A principal wants to procure for himself a good produced by an agent who has some private information about his production cost. In between, an intermediary is

\textsuperscript{*}Corresponding author. Tel.: +44-171-955-7580; fax: +44-171-955-6887.
E-mail address: a.faure-grimaud@lse.ac.uk (A. Faure-Grimaud).
needed to contract bilaterally with both sides of the market. When the sub-contract between this intermediary and the agent is not observable, intermediated contracting is plagued with agency costs. Indeed, a privately informed agent may get an informational rent that the intermediary may be tempted to capture by manipulating the sub-contract offered to the agent. Making the intermediary internalizing the principal’s objectives requires further distortions of production with respect to direct contracting. We show that these extra costs are increasing in the informational rent of the agent at the bottom level but at a decreasing rate which depends on the intermediary’s risk aversion. These properties of the agency cost of intermediated contracting are used in Faure-Grimaud and Martimort (2000a,b).

2. The model of intermediated contracting

It is assumed that there is no direct communication between the agent and the principal. Necessarily, the principal and the agent have to get in touch with the intermediary to trade. Sub-contracting is not contractible: the contract between the principal and the agent cannot specify a particular sub-contract between the intermediary and the agent.

2.1. Information

The agent has some private information \( \theta \) about his constant marginal cost of production. \( \theta \) is drawn from a commonly known distribution on \( \Theta = \{ \theta, 0, \theta_u \} \), \( \Delta \theta = \theta - \theta > 0 \) with respective probabilities \( (1 - \epsilon)\nu; (1 - \epsilon)(1 - \nu) \) and \( \epsilon \). \( \theta_u \) represents an extremely inefficient type which is learned by whoever contracts with the agent, either the intermediary with intermediated contracting or the principal with direct contracting. Shut-down of this type is optimal both under direct and intermediated contractings.

2.2. Preferences

- **Agent**: The risk neutral agent’s utility is \( u = t - \theta q \); where \( t \) and \( q \) denote, respectively, the transfer the agent receives from the intermediary and the output produced.
- **Intermediary**: The intermediary receives a monetary transfer \( s \) from the principal. He pays a transfer \( t \) to the agent to complete the task. Let his Von Neuman–Morgenstern utility function be

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1 Crémer and Riordan (1987), Baron and Besanko (1992), Melumad et al. (1995) and Mookerjee and Reichelstein (1997, 2000) have characterized conditions under which decentralizing incentive contracts along a hierarchy entails no efficiency loss with respect to a centralized grand-contracting under incentive constraints. On the contrary, McAfee and McMillan (1995) or Laffont and Martimort (1998) show how agency costs can pile up along a hierarchy once acceptance occurs ex post even if the intermediary has no private information. The nature of the agency costs we identify here is different from theirs.

2 The impossibility of direct communication can be justified by a matching problem if there is a large number of principals and agents while trade is profitable only between two particular types of them. There could a (small) cost of contacting a counterpart while the intermediary knows exactly how to organize efficient matching. The situations we consider could also be characterized by prohibitive costs of direct communication between the principal and the agent even after this matching.
\[ V(s - t) = \frac{1 - e^{-rs-t}}{r}, \] where \( r \) is the constant degree of risk aversion\(^3\) and \( s - t \) is the wealth that the intermediary can pocket for himself.

**Principal:** The principal maximizes his profit \( \Pi = R(q) - s \), where \( R(q) \) (\( R'(\cdot) > 0; R''(\cdot) < 0 \)) is the benefit derived from getting \( q \) units of output. \(|R'(\cdot)| \) is sufficiently large to insure strict concavity of the principal’s objective function in all circumstances. Moreover \( \bar{\theta} + (\nu/1 - \nu) \Delta \theta 1 + (1/1 - \nu) < R'(0) < \theta_a \). This ensures that the principal does not want to induce production by \( \theta_a \) while he always does for other types both under direct and intermediated contracting.

2.3. Contracts

Given the absence of direct communication with the agent, the grand-contract \( GC \) between the principal and the intermediary can only use the intermediary’s report on what he has learned through sub-contracting or what he has directly observed. Given these restrictions, feasible contracts can be understood as simple indirect mechanisms specifying a transfer for any output: \( \{t(q)\} \) for the grand contract and \( \{s(q)\} \) for the sub-contract. The possibility that the intermediary offers contracts composed of lotteries over quantities is ruled out. We suppose for instance that acceptance of the sub-contract requires to commit to a production capacity before the intermediary reports to the principal.

2.4. Benchmarks

The first best outputs satisfy \( R'(q^{fb}(\theta)) = \theta \) for \( \theta \in \{\theta, \bar{\theta}\} \) and \( q^{fb}(\theta_a) = 0 \). Consider now asymmetric information. With direct contracting, the principal observes whether the agent’s type is relevant for production or not. The optimal second best contract entails:

\[
R'(q^{sb}(\bar{\theta})) = \bar{\theta}, \quad R'(q^{sb}(\bar{\theta})) = \bar{\theta} + \frac{\nu}{1 - \nu} \Delta \theta, \quad q^{sb}(\theta_a) = 0
\]

This solution is obtained by having the incentive constraint of \( \bar{\theta} \) and the participation constraint of \( \bar{\theta} \) both binding so that: \( t^{sb}(\bar{\theta}) = \bar{\theta} q^{sb}(\bar{\theta}) + \Delta q^{sb}(\bar{\theta}) \) and \( t^{sb}(\bar{\theta}) = \bar{\theta} q^{sb}(\bar{\theta}) \). Of course \( t^{sb}(\theta_a) = 0 \).

3. Intermediated contracting

The timing of the game unfolds as follows. First, the agent gets private information about his productivity parameter \( \theta \). With probability \( e \), the agent has type \( \theta_a \) and the intermediary learns directly this information. The principal offers a grand-contract to the intermediary. The intermediary accepts or refuses this grand-contract being still not aware of the agent’s type when \( \theta \neq \theta_a \). If the grand-contract has been accepted, the intermediary offers a sub-contract to the agent. The agent accepts or refuses this sub-contract. Production takes place and monetary transfers within the grand-

\(^3\)The incentive constraint of \( \bar{\theta} \) and the participation constraint of \( \theta \) are both slack at the optimum. Using similar arguments, we neglect those two constraints when writing various optimal contracting problems below.
and the sub-contracts are paid. The acceptance of the grand-contract by the intermediary being made after having learned whether the agent's type is relevant or not the intermediary's interim participation constraint must be satisfied by this grand-contract.

3.1. Implementable grand-contracts

Let us first characterize the optimal sub-contract for a given grand-contract. For any grand-contract \( GC = \{s(q)\} \), the Revelation Principle applies at the sub-contracting stage. There is no loss of generality in looking for the optimal sub-contract within the class of direct truthful revelation mechanisms of the form \( \{(t; q); (\tilde{t}, \tilde{q}); (t_\infty; q_\infty)\} \) (with obvious notations). Replacing the transfers given by the intermediary by their expressions as functions of output targets and informational rents \( (u = t - \theta q, \tilde{u} = \tilde{t} - \theta \tilde{q} \text{ and } u_\infty = t_\infty - \theta q_\infty) \) yields the following expression of the expected utility of the intermediary when he has to screen the agent's relevant types:

\[
\max_{\{(u,q);(\tilde{t},\tilde{q});(t_\infty,q_\infty)\}} (1 - e) \nu V(s(q) - \theta q - u) + (1 - e)(1 - \nu) V(s(\tilde{q}) - \theta \tilde{q} - \tilde{u}) + e V(s(q_\infty) - \theta q_\infty - u_\infty) \\
\text{subject to } u_\infty \geq 0 \text{ and} \\
u(\theta) \geq u(\tilde{\theta}) + \Delta \theta q(\tilde{\theta})) \\
u(\tilde{\theta}) \geq 0
\]

Because \( \theta_\infty \) does not produce, the downward incentive constraint preventing \( \tilde{\theta} \) to mimic this type are trivially satisfied. On the basis of the agent's report \( \tilde{\theta} \in \{\tilde{\theta}, \tilde{\theta}\} \), the intermediary decides how much the agent produces \( q(\tilde{\theta}) \) within the possible outputs initially suggested by the principal. The agent receives a transfer \( t(\tilde{\theta}) \) and the intermediary keeps the difference \( s(q(\tilde{\theta})) - t(\tilde{\theta}) \). All constraints above are binding at the optimum of the intermediary's programme and we get:

**Proposition 1.** For a given grand-contract \( \{s(q)\} \), the optimal sub-contract implements output targets \( (q, \tilde{q}) \in \mathcal{Q} \) (where \( \mathcal{Q} \) is the list of outputs offered in the grand-contract) which verify the following incentive constraints of intermediation:

\[
s(q(\theta)) - \theta q(\theta) \geq s(q) - \theta q, \text{ for all } q \in \mathcal{Q}; \\
\nu V(s(q) - \theta q - \Delta \theta \tilde{q}) + (1 - \nu) V(s(\tilde{q}) - \theta \tilde{q}) \geq \nu V(s(q) - \theta q - \Delta \theta q) + (1 - \nu) V(s(q) - \theta \tilde{q}), \text{ for all } q \in \mathcal{Q}. 
\]

The efficient (resp. intermediate) agent gets a strictly positive (resp. null) informational rent:

\[
u = \Delta \theta \tilde{q} \text{ (resp. } \tilde{u} = 0)\]

Given the intermediary's best response, we can characterize the constraints put on implementable grand-contracts. There is no loss of generality in restricting attention to grand-contracts which are
direct truthful mechanisms. The essence of this Delegation-Proofness Principle\(^5\) is similar to the standard Revelation Principle: take any grand-contract such that the optimal sub-contract recommends production \(\tilde{q}(\theta)\) (with \(\tilde{q}(\theta) \neq 0\) since the principal would not like to induce production from \(\theta_n\)) and forces the principal to give budget \(s(\tilde{q}(\theta))\). Define now a new grand-contract which is a direct mechanism with output targets \(\{q = \tilde{q}(\theta)\}; \; \tilde{q} = \tilde{q}(\theta), \; q_n = 0\}\) and budgets \(\{s = s(\tilde{q}(\theta)), \; \bar{s} = s(\tilde{q}(\theta)), \; s_n = s(0)\}\). With this direct mechanism, the intermediary truthfully reveals the agent’s type to the principal. Otherwise, \(\tilde{q}(\theta)\) would not have been optimal in the first place.

A delegation-proof grand-contract consists of a menu \(\{(s, q); (\bar{s}, \tilde{q}); (s_n, 0)\}\) which satisfy the following downwards incentive constraints of intermediation:

\[
s - \theta q \geq \bar{s} - \theta \tilde{q} \tag{5}
\]

\[
\nu V(s - \theta q - \Delta \theta \tilde{q}) + (1 - \nu) V(\bar{s} - \theta \tilde{q}) \geq \nu V(s - \theta q) + (1 - \nu) V(s_n) \tag{6}
\]

We write thereafter \(\nu = \bar{s} - \theta q\) and \(\bar{\nu} = \bar{s} - \theta \tilde{q}\). These quantities are the total gains of the agent–intermediary coalition for relevant types. The downward incentive constraints of intermediation (5) and (6) rewrite then as:\(^6\)

\[
\bar{\nu} \geq \bar{\nu} + \Delta \theta \tilde{q} \tag{7}
\]

\[
\nu V(\nu - \Delta \theta \tilde{q}) + (1 - \nu) V(\bar{\nu}) \geq \nu V(\nu) + (1 - \nu) V(s_n) \tag{8}
\]

The intermediary must also prefer to enter the contract rather than getting an exogenous reservation utility normalized to zero. The following interim participation constraints must be satisfied:

\[
\nu V(\nu - \Delta \theta \tilde{q}) + (1 - \nu) V(\nu) \geq 0 \tag{9}
\]

\[
V(s_n) \geq 0 \tag{10}
\]

To give some intuition for the nature of the agency costs of intermediation, consider the possibility that the principal offers to the intermediary the second best contract derived above, i.e. \(s^{\text{sb}}(\theta) = \theta q^{\text{sb}}(\theta) + \Delta \theta q^{\text{sb}}(\tilde{\theta})\) and \(s^{\text{sb}}(\tilde{\theta}) = \theta q^{\text{sb}}(\tilde{\theta})\). Eq. (5) is then satisfied. If, through sub-contracting, the intermediary learns that the agent is efficient, he reports this information truthfully to the principal. However, to learn this information, the intermediary may offer to the agent a contract which screens the relevant types and is accepted by both of them. Then, \(\tilde{t} = \theta q^{\text{sb}}(\theta)\) and \(t = \theta q^{\text{sb}}(\tilde{\theta}) + \Delta \theta q^{\text{sb}}(\tilde{\theta})\) so that the net rent \(s - t\) kept by the intermediary is always zero and Eq. (9) is satisfied. Unfortunately, the intermediary may also get a strictly positive rent if he offers a contract to the agent stipulating \(\tilde{t} = \theta q^{\text{sb}}(\theta)\). This contract is accepted by \(\theta\) and turned down by \(\tilde{\theta}\). In this latter case, the intermediary reports to the principal that the type is \(\theta_n\), receiving then \(s_n = 0\). But with probability \(\nu\), the intermediary keeps for himself the informational rent that he was supposed to give to the efficient agent to induce truthful revelation.

\(^5\)We refer to Faure-Grimaud et al. (1999a,b) and Martimort (1999) for formal proofs of this principle in related contexts.

\(^6\)It is easy to show that those constraints are the only relevant ones at the optimum of the principal’s problem. Proof available upon request.
3.2. The optimal grand-contract

Taking into account the expression of the informational rent of the agent as a function of outputs and replacing into the principal’s objective function, the optimal grand-contract solves therefore the following problem:

$$\max_{\{(s,q); (\tilde{s}; q); (s_u)\}} e(n(R(q) - \theta q - v) + (1 - v)(R(\tilde{q}) - \tilde{\theta} q - \tilde{v}) - (1 - e)s_u$$

subject to (7), (8), (9) and (10)

Proposition 2. The optimal grand-contract entails:

- The incentive constraints of intermediation for $\theta$ and $\tilde{\theta}$, i.e. (7) and (8), and the participation constraint (10) are all binding. The other constraints and, in particular, the intermediary’s participation constraint with relevant types (9) are slack at the optimum.
- $\theta$, does not produce anything while the efficient agent $\theta$ produces an output $q^*(\theta)$ equal to its first best value: $q^*(\theta) = q^{eb}$.\(\quad\)
- The inefficient agent’s output is distorted downwards with respect to its second best value:

$$R'(q^*(\theta)) = \tilde{\theta} + \frac{\nu}{1 - \nu} \left( 1 + \frac{1}{e^{\Delta\theta q^*(\theta)} - \nu} \right) \Delta \theta \geq \tilde{\theta} + \frac{\nu}{1 - \nu} \Delta \theta \quad (11)$$

and we have $q^*(\theta) \leq q^{eb}(\tilde{\theta}) < q^{eb}(\theta)$ with the first inequality being an equality only in the limiting case $r = \infty$.

Intermediated contracting creates further distortions with respect to direct contracting.

3.2.1. Origins of the agency costs of intermediation

These agency costs come from the tension between two intermediation constraints (7) and (8). First, at the intermediate level, the incentive problem when $\theta = \theta$ is similar to that at the bottom level. To satisfy (7), the principal must leave some rents to the efficient agent–intermediary coalition, but, quite interestingly, no extra rent compared to the case with direct contracting. Offering $\bar{s} = \theta q + \Delta \theta \bar{q}$ and $\tilde{s} = \theta \bar{q}$ is enough to ensure incentive compatibility and to satisfy the intermediary’s interim participation constraint (9). But necessarily, the principal has to offer $\bar{s}$ exceeding the sole production cost $\theta q$. This opens the possibility of a second incentive problem captured by (8). Granting a budget $\bar{s}$ in excess of the direct production cost creates the temptation for the intermediary to make a profit by taking the risk of inducing only the efficient agent to produce. This strategy is risky because this subcontract is turned down when type is $\tilde{\theta}$. With (7) binding and $s_u = 0$, (8) becomes:

$$V(\tilde{u}) \geq \nu V(s - \theta q) = \nu V(\bar{u} + \Delta \theta \bar{q})$$

This constraint clearly illustrates the trade-off faced by the intermediary: he can induce both relevant types to produce and this guarantees him an ex post utility of $\bar{u}$ for sure or he can take the gamble to have only the efficient agent to produce. This gives him a higher payoff with probability $\nu$ and zero otherwise. To curb the intermediary’s opportunistic behavior, the principal must increase above zero the sure wealth he gives up, $\bar{u}$, to satisfy (12). This lower bound on $\bar{u}$ writes as:
3.2.2. Properties of the agency cost of intermediation

The agency cost of intermediation is an increasing function of the efficient agent’s informational rent \( \Delta \theta \bar{q} \). Again, from (12), we remark that the attractiveness of the gamble increases with \( \Delta \theta \bar{q} \) since not inducing production by a \( \bar{\theta} \) type allows the intermediary not to pay the informational rent of an efficient agent. The larger the output, the larger the rent and the more attractive this risky strategy. This effect explains why the equilibrium output levels are downward distorted compared to the standard second best solutions. Not only the informational rent of an efficient agent is reduced but also the intermediary is less tempted to behave opportunistically. In fact, the relationship between the rents the intermediary can extract for himself and the efficient agent’s informational rent can be further illustrated by taking a second order Taylor expansion of the right-hand-side of (13) for small levels of rents \( \bar{u} \):

\[
\bar{v} \approx \frac{1}{r} \log \left( \frac{1 - \nu e^{-r \Delta \theta \bar{q}}}{1 - \nu} \right)
\]

(13)

This equation highlights also that the intermediary’s rent is concave in the agent’s rent, \( \bar{u} \). The intermediary can appropriate for himself some of this stake but at a decreasing rate. Moreover, it clearly shows the role of \( r \): the more risk averse the intermediary is, the more decreasing this rate is.\(^7\)

Here the incentive conflict arises from the possibility that the intermediary chooses a risky action, i.e. a sub-contract which does not induce production by \( \bar{\theta} \). Preventing him from doing so is easier when he is risk averse as other things equal, the intermediary is less tempted to do so. In fact, an upper bound of the agency costs of intermediated contracting is obtained when \( r \) is equal to zero.

3.2.3. Robustness of the results

Although the information structure considered is particular, most of the properties aforementioned are robust to alternative settings. Suppose for instance that the intermediary does not observe \( \theta \), but that he is protected by a limited liability constraint: \( s - t \geq 0 \). Solving the adverse selection with the agent who can now be of three types does not necessitate any additional informational rents as a \( \bar{\theta} \) cannot claim that its production cost is lower without having to produce at a loss and better types do not want to mimic this type as if they do, no production takes place. The intermediary’s subcontracting problem is the same as the one above. The solution characterized in Proposition 2 satisfies limited liability (with only \( s_m = 0 \) binding) and so the optimal contract would remain unchanged. Finally, still with the intermediary not observing anything about the agent but now without limited liability and only ex ante participation constraint of the intermediary, we would still obtain a solution very similar to the one characterized here. The output distortion for \( \bar{q} \) would be defined as in (11) but the the ratio in the term into brackets would be multiplied by a factor \( \alpha(\bar{q}) \) between 0 and 1, resulting in a lower output distortion.

\(^7\)The concavity of the agency cost in the inefficient agent’s output could introduce a non-concavity in the principal’s objective function. However, this does not happen when \( |R'(\cdot)| \) is sufficiently large.
Appendix. Proof of Proposition 2

- First, observe that the principal’s objective function is decreasing in \( v, \overline{v} \) and \( s_m \). Hence, some of the constraints in the principal’s objective function are binding.
- It is immediate that \( s_m = 0 \).
- Eq. (7) is binding at the optimum of the principal’s problem. Otherwise one could reduce \( v \) and increase \( \overline{v} \) in a way which leaves the expected utility of the intermediary unchanged. This would relax the incentive constraint (7) and intermediation constraint (8). Because the intermediary is risk averse it would allow the principal to save on the expected rents given up.
- Eq. (8) is more stringent than the interim participation (9). Indeed, as \( \overline{v} = \overline{v} + \Delta \theta \overline{q} \). When (7) is binding, (8) can be rewritten as: \( V(\overline{v}) \geq \nu V(\overline{v} + \Delta \theta \overline{q}) \) which implies \( \overline{v} \geq 0 \). Then (8) constraint is binding.
- Inserting the values \( \overline{v} = \Delta \theta \overline{q} + (1/r) \ln(1 - ve^{-r\Delta \theta \overline{q}/1 - \nu}) \) and \( \overline{\theta} = (1/r) \ln(1 - ve^{-r\Delta \theta \overline{q}/1 - \nu}) \) into the principal’s objective function and optimizing with respect to \( q \) and \( \overline{q} \) yields \( q' = q^* \) and \( \overline{q}' \) given by (11).
- We check that the intermediate type does not want to report he is efficient when (7) is binding. This holds when: \( V(\overline{v}) \geq V(v - \Delta \theta \overline{q}) \), i.e. \( \overline{v} \geq v - \Delta \theta \overline{q} \). But the latter inequality holds since (7) is binding and \( q'(\overline{v}) < q'(\overline{v}) \).

References