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Delegation of Authority as an Optimal (In)complete Contract

by

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Delegation of Authority as an Optimal (In)complete Contract

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Abstract

The present paper aims to contribute to the literature on the foundations of incomplete contracts by providing conditions under which simple delegation of authority is the solution to the complete-contracting problem of the parties. We consider a hold-up framework where both parties profit from an investment that raises the value of an asset. Delegation turns out to be optimal if (i) the decision-dependent parts of the payoffs of the parties are linear in the asset value, and (ii) decisions have no investment-independent effect. If overinvestment might be an issue, delegation, however, with restricted competencies is optimal if some additional continuity requirements are met.

Keywords: delegation, decentralization, authority, incomplete contracts, hold-up, property rights.

JEL-Classification: D82, D23, L14, L22.

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1 Introduction

Motivation We study a complete-contracting version of a hold up problem asking under which circumstances a simple institutional arrangement, namely delegation of authority, turns out to be optimal. The literature has paid considerable attention to the question why contracts are often less complex than one might expect, and various authors have provided conditions under which such incompleteness arises as an equilibrium phenomenon. For example, it has been shown that some simple contractual forms that are frequently observed in practice (such as the complete absence of an initial contract, non-contingent contracts, or simple option contracts) might indeed be optimal even if ex-post decisions are contractible ex-ante and message games are feasible.[1] Surprisingly, simple delegation of authority has not received attention in the literature on the foundations of incomplete contracts.

Framework and results The model captures a standard hold up problem (see e.g., Grossman and Hart, 1986). There are two symmetrically informed, risk-neutral parties who want to conduct a joint project. Ex-ante one of the parties may make a preparatory, non-contractible investment to raise the value of an asset (e.g., the investor's human capital, a machine, etc.). The parties use the asset in the course of their project, and both parties profit from an increase in asset value. For example, an investment by an agent in his human capital will frequently increase both his utility and the payoff of the principal. Similarly, it might be the case that A's investment raises the value of a physical asset (such as a machine, a brand name, a customer list, etc.) from which both parties profit. Ex-post, after uncertainty over the state of the world has been lifted, some decisions (for example, regarding the use of the asset) have to be taken. In line with the literature on the foundations of incomplete contracts, we assume that the ex-post decisions, transfer payments, and messages sent between the parties are verifiable by a court. Hence, these variables can be part of an initial contract. As the parties are symmetrically informed they will always renegotiate the initial contract to an ex-post efficient outcome. Consequently, the purpose of the initial contract is to achieve ex-ante

[1] See e.g., Nöldeke and Schmidt (1995, 1998), Edlin and Reichelstein (1996), Che and Hausch (1999), Hart and Moore (1999), Maskin and Tirole (1999), Segal (1999), Edlin and Hermalin (2000), and Segal and Whinston (2002).

efficiency (i.e., to provide investment incentives).

The contribution of the paper is to identify conditions on the basics of the model under which simple delegation of authority over the ex-post decisions is the solution to the complete-contracting problem. In particular, delegation turns out to be optimal if (i) an increase in asset value (brought about by a larger investment) has a linear effect on the decision-dependent parts of the threatpoint payoffs of the parties, and if (ii) decisions have no investment-independent effects. If this condition is satisfied and the parties face an underinvestment problem, it is optimal to agree on a fixed transfer payment (e.g., a fixed wage) and to allow the investing party to choose any decision ex-post. If potential overinvestment is an issue, delegation is still optimal if additionally some continuity requirements are met. However, in this case it might be necessary to tailor competencies in the sense that discretion needs to be contractually restricted to a subset of possible decisions. Intuitively, ex-post a party who has authority will pick decisions that maximize its total payoff. In general, these decisions will, however, fail to maximize the marginal return of investing from an ex-ante perspective. The above condition on the payoff functions of the parties ensures that the ex-post and ex-ante incentives with respect to the choice of decisions are aligned.[2]

Aghion and Tirole (1997) have introduced the distinction between formal and real authority in organizations. Formal authority refers to the (legal) right to take certain decisions. In contrast, a party has real authority if, even though it does not hold formal authority, its recommendations are rubber stamped. In a hold up framework, the allocation of real authority is not an issue because in the end the parties will always agree on ex-post efficient decisions through renegotiations. Hence, in the present paper the question is studied whether it might be optimal to grant one of the parties *formal authority* over decisions. That is, we do not focus on second best decision making by a party with real authority, but study whether the allocation of formal authority might generate optimal investment incentives from an ex-ante perspective.

Related Literature The present paper is related to two strands of the literature. As discussed above, the paper aims to contribute to the literature on the foundations of incomplete contracts. As most of this literature, we consider a hold up model with

[2] Below we provide two examples relating to market entry and project choice to illustrate this condition.

symmetrically informed parties.[3] While in this literature other simple contractual forms have received most of the attention, we focus on delegation as solution to the complete-contracting problem of the parties.

Obviously, the paper is also related to the vast literature on delegation. A first strand of this literature identifies imperfections of the contracting environment under which simple delegation of authority turns out to be *strictly* optimal. For example, it has been shown that this might be the case if there are limits to communication or commitment, if it is costly to process information, if agents might collude, or if contracts are incomplete (see e.g., Aghion and Tirole, 1997; Dessein, 2002, 2004). However, the present paper is more closely related to the second strand of the delegation literature. This part of the literature investigates under which conditions delegation performs just as well as the best message-dependent contract. Previously, such replication results have been derived in adverse selection models and multi-agent moral hazard problems.[4] More recently, various papers have studied settings of partial contracting (see e.g., Aghion and Rey, 1999; Aghion, Dewatripont, and Rey, 2002, 2004) . There, it is assumed that, while decisions are both ex-ante and ex-post unverifiable, control over these decisions is contractible (or at least transferable). Both under complete and incomplete information, simple assignments of authority may turn out to be optimal in such settings. Our model differs from the above papers in that we assume that decisions are both ex-ante and ex-post contractible.

The remainder of the paper is structured as follows. In Section 2 the model is introduced. Section 3 contains the main results. In Section 4 we discuss how our results relate to earlier conditions for the optimality of simple contractual arrangements. This section aims to provide some perspective on the circumstance under which one would expect to observe delegation rather than non-contingent contracts or option contracts as solution to the complete-contracting problem. Section 5 contains concluding remarks.

[3] See Section 4 for a more detailled discussion of this literature.

[4] With respect to the former, see e.g., Melumad, Mookherjee and Reichelstein (1992, 1995), McAfee and McMillan (1995), Mookherjee and Reichelstein (1997, 2001), and Baliga and Sjöström (2001); with respect to the latter, see e.g., Baliga and Sjöström (1998).

2 The Model

We consider a standard holdup model with two risk-neutral, symmetrically informed parties, P and A, who want to conduct a joint project. Party P, the principal, has to rely on A, the agent, who may make a preparatory investment $i \in [0, \bar{i}]$ that increases the value of an asset. For example, A might be able to invest in his human capital to perform better in later tasks. Alternatively, A might possess some special skills that allow him to raise the value of a physical asset. After the investment has been made, the project is carried out. That is, some decisions $d = (d^1, ..., d^n) \in D$ have to be taken, where $D = D^1 \times ... \times D^n \subset \Re^n$. For example, these decisions might relate to the production of a good or the provision of a service. While the investment has to be made by A, we assume that both P and A are, in principle, able to take the decisions. Figure 1 depicts the sequence of events.

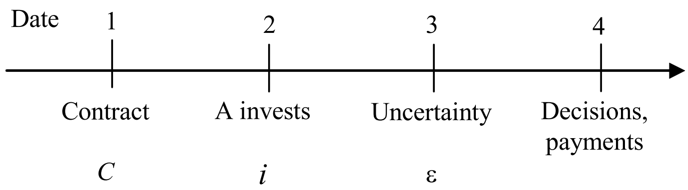

Figure 1: The sequence of events

At *date 1,* the parties sign a contract $\mathcal{C}$. Initial contracts are discussed in more detail below. At *date 2,* A invests $i \in [0, \bar{i}]$ at costs $c(i)$. At *date 3*, uncertainty $\epsilon \in \mathcal{E}$ over the ex-post state of the world (i, ϵ) is resolved, where $\mathcal{E}$ denotes the set of possible random states. A's investment increases the value $a(i, \epsilon)$ of the asset. We assume that c and a are continuously differentiable in i, and $a, a_i > 0$, $a_{ii} < 0$, $c_i > 0$, $c_{ii} \geq 0$.[5] As the ex-post state of the world is now known to both parties, P and A send messages θ^P and θ^A, respectively, about the ex-post state of the world (if the initial contract is message-dependent), where $\theta^P, \theta^A \in \Theta \equiv [0, \bar{i}] \times \mathcal{E}$. Before decisions are taken and payments are made at *date 4*, the parties may possibly renegotiate the initial contract $\mathcal{C}$.

In line with the literature on the hold-up problem we assume that, while all variables are observable to the parties, an initial contract cannot directly condition on the ex-post

[5] Throughout, subscripts denote partial derivatives.

state of the world (i, ϵ). With respect to decisions it is clear that if only control over decisions (but not the decisions themselves) were contractible, some form of delegation of authority would be the only feasible way of generating investment incentives. In order to show that even in a complete-contract setting delegation might emerge as solution to the contracting problem, we, however, assume that (i) the decisions d, (ii) transfer payments between the parties, and (iii) the messages sent at date 3 are verifiable by a court, and hence can be part of an initial contract.[6] The revelation principle allows to restrict attention to direct revelation mechanisms that (i) specify the decisions and an transfer payment from P to A as functions of messages of the parties about the ex-post state of the world, and (ii) under which truthful reporting of the ex-post state by both parties is a Nash equilibrium on and off the equilibrium path.[7] Formally, a contract $\mathcal{C}$ is defined as a mapping $[\ \widehat{d}, \widehat{t}\ ] : \Theta \times \Theta \rightarrow D \times \Re$, where Θ denotes the space of possible ex-post states of the world.

For the moment, considered fixed contract terms $\widehat{d} \in D$ and $\widehat{t} \in \Re$. If renegotiations would fail, the parties would realize their *threatpoint payoffs.* The threatpoint payoffs of P and A depend on the initial contract $\mathcal{C}$. They are given by $\pi^P(\widehat{d}, a(i, \epsilon), \epsilon) - \widehat{t}$ and $\pi^A(\widehat{d}, a(i, \epsilon), \epsilon) + \widehat{t}$, respectively, where π^P and π^A are assumed to be continuously differentiable in i. Hence, as discussed above, the threatpoint payoffs of *both* parties may depend on the value of the asset.[8] As the parties are symmetrically informed, they will, however, always succeed in renegotiating the initial contract and take ex-post efficient decisions at date 4. Thereby, they create an *ex-post surplus* $\phi(i, \epsilon) \equiv \max_{d \in D}\{\pi^P(d, a(i, \epsilon), \epsilon) + \pi^A(d, a(i, \epsilon), \epsilon)\}$, where we assume that $\phi(i, \epsilon)$ is non-negative, continuously differentiable in i, $\phi_i > 0$, and $\phi_{ii} < 0$. P and A share the resulting renegotiation surplus in Nash-bargaining with bargaining powers β and $(1 - \beta)$, respectively, where $\beta \in (0, 1)$. Hence, the *post-renegotiation payoffs* of P and A consist of their threatpoint payoffs and their shares of the renegotiation surplus. They are given by

[6] An extension of the model to the case that some of the decisions are not contractible ex-ante would be straightforward.

[7] Given our assumptions, there will exist ex-ante transfer payments that ensure participation by both parties. As such payments have no effect on investment incentives they are not considered explicitly.

[8] If the investment would affect the threatpoint payoff of only one of the parties, a non-contingent contract specifying fixed decisions and payments would be optimal if some technical assumptions are met (see Section 4 for a more detailed discussion).

$$\Pi^P(\widehat{d}, \widehat{t}, i, \epsilon) \equiv [\, \pi^P(\widehat{d}, a(i,\epsilon), \epsilon) - \widehat{t}\,] + \beta \cdot [\phi(i,\epsilon) - \pi^P(\widehat{d}, a(i,\epsilon), \epsilon) - \pi^A(\widehat{d}, a(i,\epsilon), \epsilon)], \quad (1)$$

and

$$\Pi^A(\widehat{d}, \widehat{t}, i, \epsilon) \equiv [\, \pi^A(\widehat{d}, a(i,\epsilon), \epsilon) + \widehat{t}\,] + (1-\beta) \cdot [\phi(i,\epsilon) - \pi^P(\widehat{d}, a(i,\epsilon), \epsilon) - \pi^A(\widehat{d}, a(i,\epsilon), \epsilon)], \quad (2)$$

respectively.

As ex-post efficiency is achieved through renegotiations, the purpose of the initial contract $\mathcal{C}$ is to generate investment incentives. The initial contract affects A's investment incentives because it influences the threatpoint payoffs of the parties, and hence the distribution of the ex-post surplus. Ex-ante efficiency (i.e., the first-best outcome) is achieved if the optimal contract induces an investment i^* that maximizes the ex-ante expected net surplus of the relationship. Formally, $i^* = argmax_{i \in [0,\bar{i}]} \{E[\phi(i,\epsilon)] - c(i)\}$, where we assume that $i^* > 0$.

3 Delegation of Formal Authority

In this section we present conditions under which delegation of authority to party A turns out to be optimal. In the following, it will be useful to distinguish two cases. First, we study an underinvestment case, where even under the optimal contract A's investment falls short of the first-best investment level i^*. Subsequently, we provide conditions for the optimality of delegation that do not depend on whether the parties face an underinvestment problem or whether overinvestment might be an issue.

Case 1: an underinvestment setting Since A's investment affects the asset value, it has a direct effect on the payoffs of both parties. If the investment has a sufficiently strong positive effect on P, then even under the optimal contract A's investment might fall short of the first-best investment level i^* (see e.g., Che and Hausch, 1999). Intuitively, while A's investment raises his own threatpoint payoff, it also raises P's threatpoint payoff which, in turn, lowers the available renegotiation surplus, and hence reduces A's incentive to invest. In such an underinvestment case, delegation of authority to A is optimal if and only if it leads to an investment level weakly above the equilibrium investment under any other feasible contract.[9] While this is obvious, it is not straightforward to fully characterize conditions *on the basics of the model* that ensure that delegation leads to maximum investment. For example, this is the case because the post-renegotiation payoff of A does not only depend on the threatpoint payoffs of the parties but also on the distribution of bargaining power between them. As a consequence, we do not aim to fully characterize under which conditions delegation is optimal, but present easily interpretable sufficient conditions. These conditions are independent of the distribution of bargaining power and do not impose assumptions on derived entities.

Suppose for the moment that authority is indeed delegated to A (i.e., the initial contract specifies a fixed transfer payment $\widehat{t} \in \Re$, and that A is free to choose any $\widehat{d} \in D$ ex-post). Given that he has authority, ex-post A will pick decisions $\widehat{d}^A(i,\epsilon)$ that maximize his post-renegotiation payoff. Formally,

$$\widehat{d}^A(i,\epsilon) \in \arg\max_{\widehat{d}\in D} \; \Pi^A(\widehat{d},\widehat{t},i,\epsilon), \tag{3}$$

where $\widehat{d}^A(i,\epsilon)$ is assumed to exist for all (i,ϵ), and $\widehat{t} \in \Re$. In general, the decisions $\widehat{d}^A(i,\epsilon)$ that are optimal from an ex-post perspective will, however, fail to maximize A's marginal investment return $E[\Pi_i^A(\widehat{d},i,\epsilon)]$ from an ex-ante perspective.[10] However, ex-post and ex-ante incentives (with respect to the choice of decisions) are aligned if the following condition is met.

Condition 1 *Conditional on ϵ and $\widehat{d}$, (i) the decision-dependent parts of the threatpoint payoffs of the parties are linear in the asset value, and (ii) the decisions have no investment-independent effect. Formally, the threatpoint payoffs can be expressed as*

$$\pi^j(\widehat{d},a(i,\epsilon),\epsilon) \equiv \rho^j(\widehat{d},\epsilon)\cdot a(i,\epsilon) + \gamma^j(a(i,\epsilon),\epsilon),$$

where γ^j is continuously differentiable in i for $j = P, A$.

In the following, we provide two examples to illustrate Condition 1. For simplicity, in both examples we assume that $\gamma^P = \gamma^A \equiv 0$.

[9] Below we provide a condition under which the parties indeed face an underinvestment problem.

[10] Define $\widetilde{d}^A(i,\epsilon) \in \arg\max_{\widehat{d}\in D} \Pi_i^A(\widehat{d},\widehat{t},i,\epsilon)$. In general, it will not be true that $\widetilde{d}^A(i,\epsilon) = \widehat{d}^A(i,\epsilon)$ for all i,ϵ. Note that Proposition 1 below goes through whenever this equality is met in every ex-post state, and Condition 1 below provides a sufficient condition on the *basics* of the model under which this is the case.

Example 1 (market entry) *Suppose a principal* P *has hired an agent* A *to develop a new service or product. On the one hand, the value* $a(i,\epsilon)$ *of the product depends on how much effort* i *the agent exerts. On the other hand, it may also depend on some random events. Ex-post a decision has to be made about whether the parties should or should not enter the market with the newly developed product. If no market entry occurs (i.e., if* $d = 0$*), both parties realize zero payoffs (except for the investment costs, which, however, are already sunk). If it is decided to enter the market (i.e., if* $d = 1$*), assume (for simplicity) that* P *derives a (possibly monetary) return of* $a(i,\epsilon)$*. Moreover, the more successful the product turns out to be, the larger the reputation of being a good innovator that* A *acquires: suppose that (in a given random state) the effect on* A*'s reputation is proportional to the success of the product. That is, assume that* A*'s payoff upon market entry is given by* $\alpha(\epsilon) \cdot a(i,\epsilon)$*, where* $\alpha(\epsilon) > 0$*. To provide an alternative version of this market entry example, one could assume that* P *and* A *are partners in a joint venture contemplating market entry with the product that has been developed by* A*. Let* $a(i,\epsilon)$ *denote the profit per unit sold by either of the partners. Suppose that upon market entry* P *and* A *face stochastic market demands* $p(\epsilon)$ *and* $\alpha(\epsilon)$ *respectively (e.g., suppose that random fractions of consumers arrive at either partner's store), where* $p, \alpha > 0$*. In this case, the payoffs of* P *and* A *are zero if there is no market entry, and they are given by* $p(\epsilon) \cdot a(i,\epsilon)$ *and* $\alpha(\epsilon) \cdot a(i,\epsilon)$*, respectively, otherwise.*

Example 2 (project choice) *Consider a more general version of Example 1. Similar to Aghion and Tirole (1997), suppose there are* n *possible projects* P *and* A *might pursue. Ex-ante the agent may invest to raise his human capital* $a(i,\epsilon)$*. Again, the parties can decide either to conduct or not to conduct a certain project. If the respective project is not conducted, their payoffs equal zero. Suppose that if project* $k = 1, ..., n$ *goes ahead,* P *and* A *derive payoffs* $p^k(\epsilon) \cdot a(i,\epsilon)$ *and* $\alpha^k(\epsilon) \cdot a(i,\epsilon)$*, respectively, which in every random state are proportional to* A*'s human capital and where* $p^k > 0$*. If more than one project can be pursued at a time, one would have* $d \in \{0,1\}^n$*. Alternatively, if the parties can engage in at most one project (e.g., due to technological constraints), one would have* $d \in \{0, 1, ..., n\}$*. The latter case has been studied by Aghion and Tirole (1997). However, their model differs in that they consider a problem of information acquisition where project choice is not contractible ex-ante because projects are assumed to be indistinguishable at that stage.*

In both of the above examples, even if d is contractible (as assumed in the present paper), simple delegation of authority to A is optimal.[11] In the following, we first provide an intuition for the optimality of delegation and discuss Condition 1 in more detail. We then state and prove our result formally.

Intuitively, if the asset value (i.e., the value of A's human capital or the value of a physical asset) has a linear effect on the payoffs of the parties, A's post-renegotiation payoff can be expressed as the product of the asset value and a term that only depends on decisions and the random state (possibly plus decision-independent terms). That is, Condition 1 implies:

$$\Pi^A(\widehat{d}, \widehat{t}, i, \epsilon) = a(i, \epsilon) \cdot [\text{depends only on } \widehat{d} \text{ and } \epsilon] + [\text{independent of } \widehat{d}] \tag{4}$$

Equation (4) implies that in each ex-post state the decisions that maximize A's total payoff also maximize his marginal investment return. This would in general not be true if decisions also had an investment-independent effect because in this case (4) would contain an additional term that would depend on d but not on i. While the return $\rho^j(\widehat{d}, \epsilon) \cdot a(i, \epsilon)$ from the use of asset may very well be idiosyncratic, a likewise argument would apply if the idiosyncrasy would not enter in a multiplicative way.

Note that the above observation (i.e., equation (4)) does not immediately imply that delegation is optimal: given a message-dependent mechanism, in equilibrium decisions and transfers might depend on the investment level (through the truthfully reported messages); thereby potentially introducing an additional marginal effect of the investment. However, by applying an insight of Maskin and Moore (1999) it is possible to prove the following result.

Proposition 1 *If Condition 1 holds and the parties face an underinvestment problem, delegation of authority to A is optimal. That is, a contract is optimal that specifies a fixed payment* $\widehat{t} \in \Re$ *and prescribes that party A is free to choose any* $\widehat{d} \in D$ *at the ex-post stage.*

Proof. Define $\theta \equiv (i, \epsilon)$, $\widehat{\Pi}^j(\theta^P, \theta^A, \theta) \equiv \Pi^j(\widehat{d}(\theta^P, \theta^A), \widehat{t}(\theta^P, \theta^A), i, \epsilon)$, and $\overline{\Pi}^j(\theta) \equiv \widehat{\Pi}^j(\theta, \theta, \theta)$ for $j = P, A$. An optimal contract $\mathcal{C}^* : \Theta \times \Theta \to D \times \Re$ solves

[11] Note that this would remain to be true if the decisions in the above examples would be allowed to be probabilistic.

$max\,\{E\,[\phi\,(i,\epsilon)] - c(i)\}$ subject to (i) the truth-telling constraints $\overline{\Pi}^P(\theta) \geq \widehat{\Pi}^P(\theta^P,\theta,\theta)$ for all θ,θ^P, and $\overline{\Pi}^A(\theta) \geq \Pi^A(\theta,\theta^A,\theta)$ for all θ,θ^A, and subject to (ii) the constraint that $i \in \arg\max_{\widehat{i}}\,\{E[\overline{\Pi}^A(\widehat{i},\epsilon)] - c(\widehat{i})\}$. Note that the ex-post message game between the parties is constant-sum (i.e., $\widehat{\Pi}^P(\theta^P,\theta^A,\theta) + \widehat{\Pi}^A(\theta^P,\theta^A,\theta) = \phi(\theta)$ for all θ^P,θ^A,θ). This observation in combination with the truth-telling constraints implies $\overline{\Pi}^A(\theta) - \overline{\Pi}^A(\theta') \leq \widehat{\Pi}^A(\theta,\theta',\theta) - \widehat{\Pi}^A(\theta,\theta',\theta')$ for all $\theta,\theta' \in \Theta$ (see e.g., Maskin and Moore, 1999). Hence, for any $\theta = (i,\epsilon)$ and $\theta' = (i',\epsilon)$, where $i' > i$, we have

$$
\begin{aligned}
&\tfrac{\delta\overline{\Pi}^A(\theta)}{\delta i} \equiv \limsup_{i'\to i} \tfrac{\overline{\Pi}^A(\theta)-\overline{\Pi}^A(\theta')}{i-i'}\\
&\leq (1-\beta)\cdot\phi_i(i,\epsilon) + \limsup_{i'\to i}\{\beta\cdot\pi_i^A(\widehat{d}(\theta,\theta'),a(i,\epsilon),\epsilon) - (1-\beta)\cdot\pi_i^P(\widehat{d}(\theta,\theta'),a(i,\epsilon),\epsilon)\}\\
&= (1-\beta)\cdot\phi_i(i,\epsilon) + [\beta\cdot\gamma_i^A(a(i,\epsilon),\epsilon) - (1-\beta)\cdot\gamma_i^P(a(i,\epsilon),\epsilon)]\\
&\quad + \limsup_{i'\to i}\{a_i(i,\epsilon)\cdot[\beta\cdot\rho^A(\widehat{d}(\theta,\theta'),\epsilon) - (1-\beta)\cdot\rho^P(\widehat{d}(\theta,\theta'),\epsilon)]\},\\
&\leq (1-\beta)\cdot\phi_i(i,\epsilon) + [\beta\cdot\gamma_i^A(a(i,\epsilon),\epsilon) - (1-\beta)\cdot\gamma_i^P(a(i,\epsilon),\epsilon)]\\
&\quad + a_i(i,\epsilon)\cdot[\beta\cdot\rho^A(\widehat{d}^A(i,\epsilon),\epsilon) - (1-\beta)\cdot\rho^P(\widehat{d}^A(i,\epsilon),\epsilon)],
\end{aligned}
\tag{5}
$$

where the second inequality follows from (3) and Condition 1. As the parties face an underinvestment problem, it is optimal to maximize A' investment incentives. Given the above inequality, this is achieved by specifying in the ex-ante contract that A receives some fixed payment $\widehat{t} \in \Re$ and that he is free to choose any $\widehat{d} \in D$ ex-post. ■

In the appendix Proposition 1 is extended to the case of multi-dimensional effort provision by A.

A few remarks might be useful. First, Proposition 1 describes a setting where an initial delegation-contract, which grants A authority, is optimal. Now, if all decisions relate to the use of the asset it would be equivalent for the parties to just assign ownership of the asset to A because this would lead to the same investment incentives. In this sense, Proposition 1 provides conditions under which the ad-hoc restriction to simple assignments of ownership made by the property-rights theory of the firm (see e.g., Grossman and Hart, 1986; Hart and Moore, 1990; Hart, 1995) is innocuous.[12] Second, note that for Proposition 1 to hold, the net expected payoff of A does not need to be concave in the investment, which will in general not be the case given that the investment has a direct

[12] On this issue, see e.g., Che and Hausch (1999), Maskin and Tirole (1999), Roider (2004).

effect on both parties. Third, Condition 1 implies that, while the incentive-maximizing decisions $\widehat{d}^A(i,\epsilon)$ may depend on the random state ϵ, they do not vary with the level of A's investment.[13] Finally, Proposition 1 focuses on an underinvestment problem. Naturally, the question arises under which conditions such an underinvestment setting indeed arises: if Condition 1 holds and A has authority over decisions, he will select an investment level $\widetilde{i}$ defined by

$$\widetilde{i} \in \arg\max_{i\in[0,\bar{i}]}\{E[\Pi^A(\widehat{d}^A(i,\epsilon),i,\epsilon)] - c(i)\}. \tag{6}$$

It turns out that overinvestment (i.e., $\widetilde{i} > i^*$) might be an issue if $\gamma_i^P \geq 0$ and if A's preferred decisions are unfavorable for P in the sense that they would cause his threatpoint payoff to be negative. In such a case, additional investment by A would reduce P's threatpoint payoff even further, thereby possibly providing A with private investment returns above social investment returns. If, on the other hand, $\rho^P(\widehat{d},\epsilon) \geq 0$ for all $\widehat{d}$ and ϵ, then A's investment falls short of the efficient investment level i^*. Intuitively, if for any ex-post decision A's investment has a positive effect on P's threatpoint payoff, A's return from investing is below the social return in any ex-post state.

Lemma 1 *If $\rho^P \geq 0$ and $\gamma_i^P \geq 0$, the parties face an underinvestment problem.*

Proof. A's investment falls short of the efficient investment level if $\Pi_i^A(\widehat{d}^A(i,\epsilon),\widehat{t},i,\epsilon) \leq \phi_i(i,\epsilon)$ for all i and ϵ. Define $d^*(i,\epsilon) \in \arg\max_{d\in D}\{\pi^P(d,a(i,\epsilon),\epsilon) + \pi^A(d,a(i,\epsilon),\epsilon)\}$. Condition 1 implies that, for a given ϵ, $\widehat{d}^A(i,\epsilon)$ and $d^*(i,\epsilon)$ do not vary in i. Hence, substituting for $\Pi_i^A(\widehat{d}^A(i,\epsilon),\widehat{t},i,\epsilon)$ and $\phi_i(i,\epsilon)$, and noting that $\gamma_i^P(a(i,\epsilon),\epsilon) \geq 0$ for all i and ϵ, reveals that a sufficient condition for underinvestment is given by $\beta \cdot \{[\rho^A(\widehat{d}^A(i,\epsilon),\epsilon) + \rho^P(\widehat{d}^A(i,\epsilon),\epsilon)] - [\rho^A(d^*(i,\epsilon),\epsilon) + \rho^P(d^*(i,\epsilon),\epsilon)]\} \leq \rho^P(\widehat{d}^A(i,\epsilon),\epsilon)$ for all i and ϵ. The definition of $d^*(i,\epsilon)$ implies that the left-hand side of this inequality is non-positive. Hence, the above inequality is satisfied for all (i,ϵ) because $\rho^j(\widehat{d},\epsilon) \geq 0$ by assumption. ■

Case 2: settings where overinvestment might be an issue In the following, we provide (slightly stronger) conditions for the optimality of delegation that do, however, not rely on the parties facing an underinvestment problem. Given Condition 1, A has

[13] In this sense, Condition 1 is a polar case to a condition introduced by Segal and Whinston (2002, Condition $H^{\pm}$) who require that, for a given i, the incentive-maximizing decisions do not vary across random states ϵ (for a more detailled discussion, see again Section 4).

maximal investment incentives if he has authority. If potential overinvestment is an issue, A's investment incentives can be reduced by restricting his freedom of choice (i.e., by specifying in the initial contract that not D but only some subset $D^* \subseteq D$ constitutes the set of decisions from which A may select ex-post): if A is only allowed to choose from D^*, the incentive-maximizing decisions $\widehat{d}^A(i,\epsilon)$ might not be feasible resulting in lower returns from investing. Hence, by carefully choosing D^* it might be possible to provide A with first-best investment incentives. This is indeed the case if some additional (arguably mild) requirements are met.

Condition 2 *Decisions are continuous and have a continuous effect, and null-decisions exist. Formally, (i)* $D \equiv [0, \overline{d}^1] \times ... \times [0, \overline{d}^n]$, *(ii)* $\rho^j(\widehat{d}, \epsilon)$ *is continuous in* $\widehat{d}$, *and (iii)* $\rho^j((0, ..., 0), \epsilon) = 0$ *for all* ϵ *and* $j = P, A$.

Part (iii) of Condition 2 states that if no decisions are taken (i.e., if the status quo is maintained), the decision-dependent parts of the threatpoint payoffs are zero. Jointly, Conditions 1 and 2 ensure that if potential overinvestment is an issue, some form of restricted delegation leads to the first-best outcome. To illustrate this, suppose that allowing A to choose from D would lead to overinvestment. First, Conditions 1 and 2 imply that there exists a truncated choice set $D^* \subseteq D$ such that (given that A is allowed to choose any $\widehat{d} \in D^*$ ex-post), i^* satisfies the first-order condition of A's ex-ante maximization problem. Second, as discussed above, given that the asset value affects the threatpoint payoffs of both parties, the post-renegotiation payoff of A is in general not concave in his investment (even if a and ϕ are well-behaved). However, if he has authority, A's post-renegotiation payoff turns out to be concave if null-decisions exist and $\gamma^j(a(i,\epsilon),\epsilon) \equiv \widetilde{\gamma}^j(\epsilon)$ $\forall \epsilon$ holds for $j = P, A$: in this case the first term in square brackets in (4) is non-negative, and the second term in square brackets is strictly concave in i.

Proposition 2 *If Conditions 1 and 2 hold, and* $\gamma^j(a(i,\epsilon),\epsilon) \equiv \widetilde{\gamma}^j(\epsilon)$ *for all* ϵ *and* $j = P, A$, *delegation of authority to* A *is optimal, but it might be necessary to restrict competencies. That is, a contract of the following form is optimal: the parties agree on a fixed payment* $\widehat{t} \in \Re$ *and prescribe that party* A *is free to choose any* $\widehat{d} \in D^*$ *at the ex-post stage, where* $D^* \subseteq D$.

Proof. If $\widetilde{i} < i^*$, Proposition 1 implies that unrestricted delegation of authority (i.e., $D^* = D$) is optimal. Next, consider the case $\widetilde{i} \geq i^*$. Define a truncated decision space $D(\omega) \equiv [0, \overline{d}^1 - \omega^1] \times ... \times [0, \overline{d}^n - \omega^n]$, where $\omega^l \in [0, \overline{d}^l]$ $\forall l \in \{1, ..., n\}$. In analogy to (3), define

$$\widetilde{\rho}^A(\epsilon, \omega) \equiv \max_{\widehat{d} \in D(\omega)} \{\beta \cdot \rho^A(\widehat{d}, \epsilon) - (1 - \beta) \cdot \rho^P(\widehat{d}, \epsilon)\}. \tag{7}$$

Conditions 1 and 2 ensure that solutions to (7) exists for all ϵ and ω. Condition 2 implies $\widetilde{\rho}^A(\epsilon, \omega) \geq 0$ $\forall \epsilon, \omega$. This observation together with the concavity of $E[\phi(i, \epsilon)]$ implies $E[(1 - \beta) \cdot \phi_{ii}(i, \epsilon) + a_{ii}(i, \epsilon) \cdot \widetilde{\rho}^A(\epsilon, \omega)] < 0$ $\forall i, \omega$. Hence, it follows from $\widetilde{i} \geq i^*$ that $E[a_i(i^*, \epsilon) \cdot \widetilde{\rho}^A(\epsilon, \omega^0)] \geq E[\beta \cdot \phi_i(i^*, \epsilon)] > 0$, where $\omega^0 \equiv (0, ..., 0)$. Now, define $\overline{\omega} \equiv (\overline{d}^1, ..., \overline{d}^n)$. Condition 2 implies $\widetilde{\rho}^A(\epsilon, \overline{\omega}) = 0$, and hence $E[a_i(i^*, \epsilon) \cdot \widetilde{\rho}^A(\epsilon, \overline{\omega})] = 0$. Moreover, as ρ^A and ρ^P are continuous in $\widehat{d}$, it follows from Berge's theorem of the maximum that the value function $\widetilde{\rho}^A(\epsilon, \omega)$ is continuous in ω. Hence, the Intermediate Value Theorem implies that there exists an ω^* such that $E[(1 - \beta) \cdot \phi_i(i^*, \epsilon) + a_i(i^*, \epsilon) \cdot \widetilde{\rho}^A(\epsilon, \omega^*)] = E[\phi_i(i^*, \epsilon)]$. Consequently, if party A is free to choose from the set $D(\omega^*)$ ex-post, he finds it optimal to invest $i = i^*$ ex-ante. ■

As the proof of Proposition 2 shows, one simple way to optimally restrict competencies is to rule out extreme choices. That is, a choice set of the form $D^* = [0, \overline{d}^1 - \omega^1] \times ... \times [0, \overline{d}^n - \omega^n]$, where $\omega^1, ..., \omega^n \geq 0$, is optimal.[14]

To summarize, we provide two sets of conditions on the basics of the model under which simple delegation of authority is the solution to the complete-contracting problem of the parties. First, if the parties face an underinvestment problem and Condition 1 holds, unrestricted delegation of authority to A is optimal because it maximizes A's incentives to invest. Second, if overinvestment might be an issue, delegation is nevertheless optimal if, in addition to Condition 1, decisions are continuous and have a continuous effect, and null-decisions exist. In this second case it might be optimal to restrict competencies by allowing A to choose from only a subset of the feasible decisions. In the next section, we relate our results (and in particular Condition 1) to earlier findings on the optimality of simple contractual forms.

[14] While in the present model restricting competencies serves to reduce investment incentives, Szalay (2004) shows that such partial delegation may foster incentives to acquire relevant information. Partial forms of delegation may also emerge if a principal can only commit to a decision rule, but not to monetary transfers (e.g., Holmstrom, 1984; Melumad and Shibano, 1991; Armstrong, 1994).

4 Non-Contingent Contracts, Option Contracts, and Delegation: An Overview

In this section we discuss the literature on the foundations of incomplete contracts in more detail. Various authors have provided conditions on the payoff functions of the parties under which simple contracts (such as the complete lack of a contract, non-contingent contracts, or options) turn out to be optimal.[15] In order to provide some perspective under which circumstances non-contingent contracts, option contracts, or delegation of authority are optimal, in the following it is discussed how Condition 1 relates to these earlier results.

The most general conditions under which parties can optimally restrict themselves to *non-contingent contracts* (i.e., contracts where the specified decisions and payments do not depend on messages sent by the parties) have been provided by Segal and Whinston (2002). To illustrate their result, consider a setting where $D = [0, \overline{d}]$, and π_i^A, π_{id}^A, π_i^P, $\pi_{id}^P > 0$. In this case, it follows from equation (2) that the marginal effect of a change in $\widehat{d}$ on A' investment return is given by

$$\Pi_{id}^A(\widehat{d}, \widehat{t}, i, \epsilon) = \beta \cdot \pi_{id}^A(\widehat{d}, a(i, \epsilon), \epsilon) - (1 - \beta) \cdot \pi_{id}^P(\widehat{d}, a(i, \epsilon), \epsilon). \tag{8}$$

The investment is said to have a *mainly selfish* effect if $\Pi_{id}^A(\widehat{d}, \widehat{t}, i, \epsilon) \geq 0$, and it is said to have a *mainly cooperative* effect otherwise. Segal and Whinston (2002) show that non-contingent contracts are optimal if (i) it does not depend on the realization of uncertainty ϵ whether the investment has a mainly selfish or mainly cooperative effect on the investing party, and if (ii) some additional requirements are met (see their Condition $H^{\pm}$ and Proposition 4).[16] For example, their result applies if the investment is purely selfish, i.e., if $\pi_i^A > \pi_i^P \equiv 0$ (a case considered by Edlin and Reichelstein, 1996), or if the investment is purely cooperative, i.e., if $\pi_i^P > \pi_i^A \equiv 0$ (a case considered by Che and

[15] In a hold-up setting, the complete lack of an initial contract may also be optimal if the trading environment is sufficiently complex (see e.g., Hart and Moore, 1999; Segal, 1999). Considering alternative models, various authors have shown that the incompleteness of contracts might arise due to strategic ambiguity, contracting costs, and signaling or screening problems.

[16] More generally, Segal and Whinston (2002) prove their result for the case that the decisions that minimize (respectively maximize) the investment returns of a party do not depend on the realization of ϵ.

Hausch, 1999).[17] However, Segal and Whinston's Condition $H^{\pm}$ will frequently fail to hold if the investment has a direct effect on both parties. In such hybrid cases, the sign of $\Pi^A_{id}(\widehat{d}, \widehat{t}, i, \epsilon)$ depends on (i) the distribution of bargaining power, (ii) the impact of the investment on π^A and π^P, and (iii) the realization of the random state ϵ. Hence, in particular if the parties are relatively symmetric (i.e., if β is close to 0.5, and π^A_{id} and π^P_{id} are of similar size), it is likely that it depends on ϵ whether the effect of the investment is mainly selfish or mainly cooperative.

To summarize, in the case of symmetric parties non-contingent contracts will often fail to be optimal. This observation suggests a classification as illustrated in Figure 2.

	Proposition 1 (resp. 2) holds	Proposition 1 (resp. 2) does not hold
Symmetric parties	delegation	
Asymmetric parties	delegation and non-contingent contracts	non-contingent contracts

Figure 2: Non-contingent contracts versus delegation of authority

In the case of asymmetric parties, non-contingent contracts are likely to be optimal, but if additionally Propositions 1 or 2 hold (in particular if the asset value has a linear effect on the payoffs of the parties), delegation of authority is likely to be optimal as well.

On the other hand, if the parties are relatively symmetric, the above discussion suggests that the parties cannot restrict themselves to non-contingent contracts, in which case an optimal contract is necessarily message-dependent. While in such cases so far relatively little is known with respect to the form of optimal *simple* contracts, there do exist some interesting results with respect to the optimality of *option contracts*, i.e., contracts where the contractually specified decisions and payments only depend on the messages sent by *one* of the parties (see e.g., Segal and Whinston, 2002, Proposition 8). However,

[17] As the present paper, Che and Hausch (1999) allow for investments to have direct effects on both parties. However, their focus is on providing conditions under which the complete absence of an initial contract is optimal. They show that this is the case if the effect of A's investment on P is large.

such option contracts might still take a rather complicated form.[18] We provide conditions under which the parties can optimally restrict themselves to the even simpler institutional arrangement of delegation of authority. Hence, perhaps surprisingly, delegation might be more likely to be observed when parties are relatively symmetric.

Finally, it might be instructive to compare Condition 1 with a result of Edlin and Reichelstein (1996). They show that non-contingent contracts might induce efficient *two-sided investments*. While two-sided investments are beyond the scope of the present paper, a discussion of their payoff condition is useful because our Condition 1 takes a similar form. Edlin and Reichelstein (1996) assume that the threatpoint payoffs of the parties can be expressed as

$$\pi^j(i^j, \widehat{d}, \epsilon) = \widehat{\pi}^j(i^j) \cdot \widehat{d} + \widetilde{\pi}^j(\widehat{d}, \epsilon) + \overline{\pi}^j(i^j, \epsilon), \tag{9}$$

for $j = 1, 2$, where i^j denotes party j's investment and where $\widehat{d} \in [0, \overline{d}]$ denotes a variable trade quantity.[19] Given that we consider a one-sided investment, a comparison of Condition 1 with (9) is not straightforward, but a few points are noteworthy. While (9) and Condition 1 have in common that investments and decisions (respectively functions thereof) only interact multiplicatively, there are some important differences. First, while (9) requires that the threatpoint payoff of each party depends only on its own investment (i.e., investments are purely selfish), in the present model both threatpoint payoffs depend on the asset value. Second, in contrast to Condition 1, (9) allows for an investment-independent effect $\widetilde{\pi}^j(\widehat{d}, \epsilon)$ of decisions. As a consequence, neither of the two conditions is a special case of the other.

[18] It has been shown that in settings where parties invest *sequentially*, it might suffice to restrict oneself to *dichotomous* option contracts that allow for a choice between just two decision-payment pairs (see e.g., Nöldeke and Schmidt, 1998; Edlin and Hermalin, 2000). For the one-sided investment case Schweizer (2000) has shown that dichotomous options are optimal if for any decision the net expected post-renegotiation payoff of the investing party is a strictly single-peaked function of the investment, and if some additional assumptions are met.

[19] Segal and Whinston (2002) extend Edlin and Reichelstein's (1996) result: they show that in the two-sided investment case non-contingent contracts are optimal if (i) their Condition $H^{\pm}$ (see above) is satisfied, (ii) the decision-dependent parts of the post-renegotiation payoffs of the parties depend on investments only through a one-dimensional aggregate measure, and (iii) some additional assumptions are met.

5 Conclusion

The present paper aims to contribute to two strands of the literature. First, in the literature on delegation it has been shown that delegation might perform just as well as the best message-dependent mechanism. The present paper differs from this strand of the literature by providing such a replication result in a symmetric information environment where all ex-post decisions are contractible ex-ante. Second, the literature on the foundations of incomplete contracts has identified circumstances under which simple contractual arrangements (such as non-contingent contracts, options, or the complete lack of an initial contract) are a solution to the complete-contracting problem. The present paper differs from this literature by its focus on delegation.

We provide two sets of conditions on the *basics* of the model under which simple delegation of authority is the solution to the complete-contracting problem. First, delegation is optimal if (i) the decision-dependent parts of the payoffs of the parties are linear in the asset value, (ii) the decisions have no investment-independent effect, and (iii) the parties face an underinvestment problem. Second, if overinvestment might be an issue, delegation is optimal if (a) a slightly stronger version of Condition 1 holds, (b) the ex-post decisions are continuous and have a continuous effect, and (c) null-decisions exist. While in the former case unrestricted competencies are desirable, in the latter case it may be optimal to tailor A' competencies contractually.

Appendix

Extension: Multi-Dimensional Effort Provision. Frequently, an agent will engage in various preparatory activities. If effort components are strategic complements, Proposition 1 can be extended to the case of multi-dimensional effort provision. Under slight abuse of notation, suppose that A chooses a k-dimensional effort vector $i \equiv (\iota^1, ..., \iota^k)$, $k \geq 1$, from a compact subset of $\Re^k$. For simplicity, assume that investment costs are linear, i.e., $c(i) = \iota^1 + ... + \iota^k$. Now, suppose that authority over ex-post decisions is delegated to A and he receives a fixed payment $\widehat{t} \in \Re$. In this case, define $\iota^l(\iota^{-l})$ as the l^{th} effort component that A will choose ex-ante for a given ι^{-l}. Formally, $\iota^l(\iota^{-l}) \in \arg\max_{\iota^l} \{\Pi^A(\widehat{d}^A(i,\epsilon), \widehat{t}, i, \epsilon) - \iota^l\}$, for $l = 1,..,n$. If Condition 1 holds, null-decisions exist, and $\gamma^j(a(i,\epsilon),\epsilon) \equiv \widetilde{\gamma}^j(\epsilon)$ for all i, ϵ and $j = P, A$, then $\iota^l(\iota^{-l})$ and the equilibrium investment vector $\widetilde{i}$ are unique. If, in addition, the investment components are strategic complements, delegation is indeed desirable because, for each investment component, it is optimal to maximize A's incentives. Figure 3 below serves to illustrate Proposition 3.

Proposition 3 *Suppose A provides multi-dimensional effort and the parties face an underinvestment problem. If Conditions 1, 2(iii), $\gamma^j(a(i,\epsilon),\epsilon) \equiv \widetilde{\gamma}^j(\epsilon)$ $\forall i, \epsilon$, and $a_{\iota^l \iota^m}, \phi_{\iota^l \iota^m} > 0$ hold for all $l \neq m$ and $j = P, A$, delegation of authority over ex-post decisions to A is optimal. That is, a contract is optimal that specifies some fixed payment $\widehat{t} \in \Re$ and prescribes that party A is free to choose any $\widehat{d} \in D$ at the ex-post stage.*

Proof. Condition 2(iii) implies that $\beta \cdot \rho^A(\widehat{d}^A(i,\epsilon),\epsilon) - (1-\beta) \cdot \rho^P(\widehat{d}^A(i,\epsilon),\epsilon) \geq 0$ $\forall i, \epsilon$. Hence, for all l, $\iota^l(\iota^{-l})$ is unique and non-decreasing in ι^{-l}. Moreover, given delegation, the equilibrium investment vector $\widetilde{i} = (\widetilde{\iota}^l, \widetilde{\iota}^{-l})$ is unique (where $\widetilde{i}$ is implicitly defined by $\iota^l(\widetilde{\iota}^{-l}) = \widetilde{\iota}^l$ for all l). Similar to the proof of Proposition 1, it follows from Condition 1 that under any arbitrary contract $\mathcal{C}$ it holds that

$$\frac{\delta \overline{\Pi}^A(\theta)}{\delta \iota^l} \leq (1-\beta) \cdot \phi_{\iota^l}(i,\epsilon) + a_{\iota^l}(i,\epsilon) \cdot [\beta \cdot \rho^A(\widehat{d}^A(i,\epsilon),\epsilon) - (1-\beta) \cdot \rho^P(\widehat{d}^A(i,\epsilon),\epsilon)] \ \forall i, \epsilon. \quad (10)$$

Hence, for a given ι^{-l}, the l-th investment component chosen when authority is delegated to A is weakly larger than the ι^l chosen under any other contract $\mathcal{C}$. Define $\Omega \equiv \{i \mid$

$\iota^l \le \iota^l(\iota^{-l})$ for all $l\}$. The above inequality together with the fact that the functions ι^l are non-decreasing in their arguments implies that (a) any investment equilibrium $\widehat{i}(\mathcal{C})$ under an arbitrary contract $\mathcal{C}$ is in the set Ω (i.e., $\widehat{i}(\mathcal{C}) \in \Omega \ \forall \mathcal{C}$), and (b) $\widehat{i}^l(\mathcal{C}) \le \widetilde{\iota}^l \le \iota^{*l}$ $\forall \mathcal{C}, l$. Hence, delegation of authority to A, which leads to $\widetilde{i}$, is optimal. ■

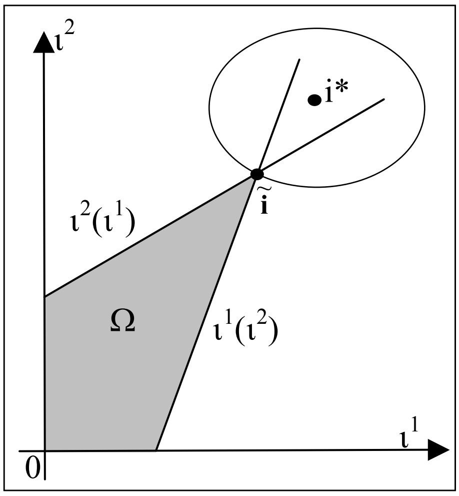

Figure 3: Delegation and multi-dimensional effort provision: an example where $i \equiv (\iota^1, \iota^2)$.

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