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Optimal Organization

Kouroche Vafaï
Université Paris Descartes, Sorbonne Paris Cité

Abstract

A contract-based model of the endogenous determination of an organization's architecture is considered where a principal has the choice between a two- and a three-level organization. Each organizational architecture is plagued with its own specific form(s) of opportunism. We derive the conditions under which opportunism in a three-level hierarchy becomes so severe as to make this architecture strictly outperformed by a two-level organization.

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Contact: Kouroche Vafaï - kouroche.vafai@libertysurf.fr.
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1 Introduction

What is the optimal architecture of an organization vulnerable to opportunistic activities? This paper aims at providing an answer to this question.

The model of hierarchical organizations studied in the existing literature is built on two narrow premises.[1] The possibility for a principal to directly monitor an agent is precluded. A supervisor is therefore in charge of monitoring. This makes a three-level hierarchy vulnerable to opportunism. The possibility of other forms of opportunism than collusion between the supervisor and the agent is then also precluded by the literature to date.

The existing model of an organization vulnerable to opportunism thus investigates contracting in an agency relationship with an exogenous architecture, namely a principal-supervisor-agent hierarchy, where the supervisor and the agent may collude.[2]

A broader model of hierarchical agency without these two narrow premises has lately been investigated by Vafaï (2004). This author assumes that the principal and the supervisor are equally efficient in monitoring and a principal-supervisor-agent hierarchy is vulnerable to supervisor/agent collusion as well as to abuse of authority.[3] In this richer context, two organizational architectures are available: a two-level principal-agent organization with direct monitoring where the principal monitors himself the output produced by the agent and a three-level principal-supervisor-agent hierarchy where the monitoring task is delegated. It is proved that when both collusion and abuse of authority are possible in a three-level hierarchy, it may be optimal for the principal to adopt a two-level organization.

Contrary to what is implicitly assumed in the existing literature, when a three-level hierarchy is vulnerable to opportunism this organizational architecture may thus become suboptimal. This result shows that the two premises of the standard model are misleading since the presence of opportunism in a three-level hierarchy may entail the optimality of a two-level organization.

Concerning monitoring only two polar cases have therefore been studied in the existing literature: the case where the principal is not able to monitor the agent and the case where the principal and the supervisor have access to the same monitoring technology. Here, we investigate the most plausible case where the principal is able to monitor the agent but, because of a partial lack of time

[1] Tirole (1992) surveys the literature built on these two premises.

[2] Undesired behaviors have also been investigated in other organizational architectures than multi-level agencies with hard information surveyed in Tirole (1992) (e.g., Shleifer and Vishny 1989; Silva, Kahn and Zhu 2007; Bose, Pal and Sappington 2010).

[3] Abuse of authority in three-level hierarchies has first been studied in Vafaï (2002) and has been further investigated in Vafaï (2010).

and/or expertise, not as efficiently as a professional supervisor. Analyzing Vafaï's (2004) model with this more plausible assumption, we prove that a two-level organization may still outperform a three-level hierarchy.

2 The model

Consider an agency relationship where a risk neutral agent (she) chooses between two unobservable effort levels, $e^A \in \{0, 1\}$. Choosing $e^A = 0$ results in $x_L = 0$ being produced while choosing $e^A = 1$ results in producing $x_H > 0$ with probability $\pi \in (0, 1]$ and x_L with probability $1 - \pi$. The agent has a disutility of effort $\gamma > 0$ and receives a monetary transfer w from the principal. Her utility function is thus $U^A(w, e^A) = w - \gamma e^A$.

The only way to obtain hard information (i.e., verifiable, and thus not forgeable) on the output produced by the agent is through monitoring. We make the standard assumption that the monitoring technology is imperfect. The risk neutral principal (he) may undertake the monitoring himself or assign this task to a risk neutral supervisor (he). The person in charge of monitoring chooses between two unobservable monitoring effort levels, $e^M \in \{0, 1\}$. It is assumed that the principal is less efficient in monitoring than a supervisor. If the monitor chooses $e^M = 0$, monitoring reveals nothing. If instead $e^M = 1$, monitoring reveals evidence on the output with probabilities $p \in (0, 1)$ and σp, where $\sigma \in (0, 1)$, respectively in the case where the supervisor is the monitor and in the case where the principal is the monitor. As discussed, only the two polar assumptions $\sigma = 0$ (see Tirole 1992 for a review of the literature based on this assumption) and $\sigma = 1$ (Vafaï 2004) have been studied by the existing literature. These polar assumptions lead to very different environments. Indeed, it is straightforward to see that if $\sigma = 0$ the organization architecture is an exogenous principal-supervisor-agent hierarchy, whereas if $\sigma \neq 0$, as both in Vafaï (2004) and here, the principal has two monitoring - or, equivalently, two architectural - options.

The monitor makes a report, r, which belongs to $I = \{x_L, \emptyset, x_H\}$, where $r = \emptyset$ denotes that the monitoring has not been conclusive. Imperfect monitoring opens the door to information concealment. When the monitoring has been conclusive, the monitor has the opportunity to conceal information by claiming that he has not observed the agent's output, that is, by reporting $r = \emptyset$. The monitor incurs a disutility of monitoring effort, $\xi > 0$. The supervisor has then a utility function $U^S(s, e^M) = s - \xi e^M$, where s is the monetary transfer he receives from the principal. The employees' reservation utilities are normalized to zero.

The output x_H is assumed to be large enough for it to be profitable for the principal to engage in production. For his organization to be valuable, the principal must therefore elicit the efforts $e^A = 1$ and $e^M = 1$. We denote by $C^{2L}(\sigma) = C(w(\sigma)) + \xi e^M$ and $C^{3L} = C(w, s)$, respectively, the expected cost of production and monitoring in a two-level principal-agent organization and in a three-level principal-supervisor-agent hierarchy. Given that contracts are contingent on the supervisor's report, the agent's contract is $(w_L, w_\emptyset, w_H)$ and, in case monitoring is delegated, the supervisor's contract is $(s_L, s_\emptyset, s_H)$. Contracts are assumed to be publicly observable, and wages must be non-negative due to the limited liability of employees.

The principal is concerned with the choice of the organization architecture that minimizes the expected cost of inducing the efforts $e^A = 1$ and $e^M = 1$.[4]

2.1. Two-level organization

As explained in Vafaï (2004), since both the agent's production effort and the principal's monitoring effort are unobservable, a two-level organization with direct monitoring is vulnerable to two-sided moral hazard. The principal must use the only available contract, that is, the agent's contract, to both induce monitoring and motivate the agent to work hard. A two-level organization is also vulnerable to information concealment. Indeed, the principal may decide to conceal information - and hence to pay a lower wage (i.e., $w_\emptyset$) than w_H to the agent - whenever monitoring reveals the evidence that x_H has been produced. The agent's contract must thus also motivate the principal to reveal his information. As compared to direct monitoring in Vafaï (2004) where $\sigma = 1$, direct monitoring has an *extra disadvantage* here since the principal is less efficient in monitoring than a supervisor, that is, $\sigma \in (0, 1)$.

The program of the organization with direct monitoring is:

$$\min_{w_L, w_\emptyset, w_H} \quad \sigma p \left[\pi w_H + (1-\pi) w_L\right] + (1-\sigma p) w_\emptyset + \xi$$

subject to the following constraints:

The principal's truth-telling constraint $w_\emptyset \geq w_H$.

The principal's incentive constraint $w_\emptyset \geq \pi w_H + (1-\pi) w_L + \frac{\xi}{\sigma p}$.

The agent's incentive constraint $w_H - w_L \geq \frac{\gamma}{\sigma p \pi}$.

The agent's limited liability constraints $w_L \geq 0$, $w_\emptyset \geq 0$, $w_H \geq 0$.

[4]As in Vafaï (2004), we restrict attention to pure strategies. Allowing for random monitoring, mixed strategies, or random contracts complicates the analysis without altering our results.

We do not consider the agent's participation constraint because it is less restrictive than her incentive constraint.

Defining $\overline{\pi} = \gamma/(\gamma + \xi)$, we then have:

Proposition 1. *The design of a two-level organization is such that: (1) For* $\pi \leq \overline{\pi}$, $(w_L, w_\emptyset, w_H) = (0, \frac{\gamma}{\sigma p \pi}, \frac{\gamma}{\sigma p \pi})$ *and* $C_1^{2L}(\sigma) = \frac{[1-\sigma p(1-\pi)]\gamma}{\sigma p \pi} + \xi$. *(2) For* $\pi > \overline{\pi}$, $(w_L, w_\emptyset, w_H) = (0, \frac{\gamma+\xi}{\sigma p}, \frac{\gamma}{\sigma p \pi})$ *and* $C_2^{2L}(\sigma) = \frac{\gamma+\xi}{\sigma p}$.

The proof of this proposition is that of Proposition 1 in Vafaï (2004) where p is replaced with σp. It is interesting to present the results of Proposition 1 in terms of agency costs and rents. Since the (expected) *agency cost* incurred by an organization is the sum of the (expected) *rents* extracted by its employees, there are two ways to obtain these rents.

In a two-level organization, the rent extracted by the agent - or, identically, the agency cost incurred by the organization - is the difference between either the agent's expected utilities associated with the organization's second-best and first-best environment, respectively $EU_{SB}^A(w, e^A)$ and $EU_{FB}^A(w, e^A)$, or the organization's second-best and first-best expected cost of production and monitoring - or, equivalently, of inducing the agent to choose $e = 1$. As it is easy to verify, $EU_{FB}^A(w, e^A) = 0$ (the agent is kept at her reservation utility level), and the first-best expected cost of production and monitoring - that is, the expected cost of production and monitoring of both a two-tier organization and a three-tier hierarchy with no information asymmetries and no opportunistic monitoring - is $C_{FB} = \gamma + \xi$. Therefore, the rent extracted by the agent in a two-tier organization when $\pi \leq \overline{\pi}$ is either $EU_{SB}^A(w, e^A) - EU_{FB}^A(w, e^A) = \sigma p\, [\pi w_H + (1-\pi) w_L] + (1 - \sigma p) w_\emptyset - \gamma - 0$, that is, $\frac{(1-\sigma p)\gamma}{\sigma p \pi}$ for the optimal contract $(w_L, w_\emptyset, w_H) = (0, \frac{\gamma}{\sigma p \pi}, \frac{\gamma}{\sigma p \pi})$, or, equivalently, $C_1^{2L}(\sigma) - C_{FB} = \frac{[1-\sigma p(1-\pi)]\gamma}{\sigma p \pi} + \xi - (\gamma + \xi)$, that is, $\frac{(1-\sigma p)\gamma}{\sigma p \pi}$ for the same optimal contract. Similarly, the rent extracted by the agent when $\pi > \overline{\pi}$ is either $EU_{SB}^A(w, e^A) - EU_{FB}^A(w, e^A)$, that is, $\frac{(1-\sigma p)(\gamma+\xi)}{\sigma p}$ for the optimal contract $(w_L, w_\emptyset, w_H) = (0, \frac{\gamma+\xi}{\sigma p}, \frac{\gamma}{\sigma p \pi})$, or, equivalently, $C_2^{2L}(\sigma) - C_{FB} = \frac{\gamma+\xi}{\sigma p} - (\gamma + \xi)$, that is, $\frac{(1-\sigma p)(\gamma+\xi)}{\sigma p}$ for the same optimal contract. The agent thus always receives a rent in a two-level organization.

2.2. Three-level hierarchy

Unlike in a two-level organization, there are two available contracts in a three-level hierarchy to regulate incentives, namely the agent's and the supervisor's contracts. A three-level hierarchy has thus an advantage over a two-level organization in regulating incentives. Opportunism in the form of information concealment may however be more costly to deal with in a three-level hierarchy. Indeed, information may then be concealed through collusion or abuse of authority. Whenever the monitoring reveals evidence that the agent has produced x_L, the supervisor may decide to collude with the agent and, in exchange for a bribe, report $r = \emptyset$. The agent then receives a higher wage (i.e., $w_\emptyset$) than w_L. The supervisor may also decide to abuse his authority by asking the agent a tribute to reveal the information he has obtained whenever the monitoring reveals evidence that $x = x_H$. We make the standard assumption that there are transaction costs associated with the unofficial transfers (i.e., a bribe or a tribute) made to the supervisor. If z euros are transferred to the supervisor, he receives only kz euros, where $k \in (0,1)$. Coping with these opportunistic activities creates additional costs in a three-level hierarchy.

The program of a three-level hierarchy is thus:

$$\min_{w_L, w_\emptyset, w_H, s_L, s_\emptyset, s_H} \quad p\left[\pi(w_H + s_H) + (1-\pi)(w_L + s_L)\right] + (1-p)(w_\emptyset + s_\emptyset)$$

subject to the following constraints:

The agent's incentive constraint $w_\emptyset - w_L \geq \frac{\gamma}{p\pi}$.

The supervisor's incentive constraint $\pi\left[s_H + k(w_H - w_\emptyset)\right] + (1-\pi)s_L - s_\emptyset \geq \frac{\xi}{p}$.

The supervisor/agent no-collusion constraint $s_L \geq s_\emptyset + k(w_\emptyset - w_L)$.

The abuse of authority management constraint $w_H - w_\emptyset \geq 0$.

The employees' limited liability constraints $w_L \geq 0$, $w_\emptyset \geq 0$, $w_H \geq 0$, $s_L \geq 0$, $s_\emptyset \geq 0$, $s_H \geq 0$.

Because it is less restrictive than his incentive constraint, the supervisor's participation constraint is disregarded.

Defining $\widehat{\pi} = \frac{k\gamma}{k\gamma + \xi}$, we then have the following proposition which is Proposition 4 in Vafaï (2004):

Proposition 2. *The design of a three-level hierarchy is such that: (1) For* $\pi \leq \widehat{\pi}$, $(w_L, w_\emptyset, w_H) = (0, \frac{\gamma}{p\pi}, \frac{\gamma}{p\pi})$, $(s_L, s_\emptyset, s_H) = (\frac{k\gamma}{p\pi}, 0, 0)$, *and* $C_1^{3L} = \frac{[1-p(1-k)(1-\pi)]\gamma}{p\pi}$. *(2) For* $\pi > \widehat{\pi}$, $(w_L, w_\emptyset, w_H) = (0, \frac{\gamma}{p\pi}, \frac{\gamma}{p\pi})$, $s_L = \frac{\xi}{p(1-\pi)} - \frac{\pi s_H}{1-\pi}$, $s_\emptyset = 0$, $s_H \in \left[0, \frac{\pi\xi - (1-\pi)k\gamma}{p\pi^2}\right]$, *and* $C_2^{3L} = C_1^{2L}(1) = \frac{[1-p(1-\pi)]\gamma}{p\pi} + \xi$.

As in the previous subsection, we also present the results of Proposition 2 in terms of agency costs and rents. In a three-level hierarchy, the rent extracted by the agent is $EU_{SB}^A(w, e^A) -$

$EU_{FB}^A(w, e^A) = p[\pi[w_H - (w_H - w_\emptyset)] + (1-\pi)w_L] + (1-p)w_\emptyset - \gamma - 0$, that is, $\frac{(1-p)\gamma}{p\pi}$ for the optimal contract $(w_L, w_\emptyset, w_H) = (0, \frac{\gamma}{p\pi}, \frac{\gamma}{p\pi})$.

Similarly, the rent extracted by the supervisor when $\pi \leq \widehat{\pi}$ (resp. $\pi > \widehat{\pi}$) is $EU_{SB}^S(w, e^A) - EU_{FB}^S(w, e^A) = p[\pi[s_H + k(w_H - w_\emptyset)] + (1-\pi)s_L] + (1-p)s_\emptyset - \xi - 0$, that is, $\frac{(1-\pi)k\gamma}{\pi} - \xi$ (resp. 0) for the optimal contract $(s_L, s_\emptyset, s_H) = (\frac{k\gamma}{p\pi}, 0, 0)$ (resp. $s_L = \frac{\xi}{p(1-\pi)} - \frac{\pi s_H}{1-\pi}$, $s_\emptyset = 0$, and $s_H \in \left[0, \frac{\pi\xi-(1-\pi)k\gamma}{p\pi^2}\right]$). The sum of the rents extracted by the agent and the supervisor in a three-tier hierarchy when $\pi \leq \widehat{\pi}$ (resp. $\pi > \widehat{\pi}$) is thus $\frac{(1-p)\gamma}{p\pi} + \frac{(1-\pi)k\gamma}{\pi} - \xi$ or, identically, $\frac{[1-p[1-(1-\pi)k]]\gamma}{p\pi} - \xi$ (resp. $\frac{(1-p)\gamma}{p\pi}$). As reminded above, this sum is also the (expected) agency cost incurred by the organization. Indeed, when $\pi \leq \widehat{\pi}$ (resp. $\pi > \widehat{\pi}$) the (expected) agency cost incurred by a three-tier hierarchy is $C_1^{3L} - C_{FB} = \frac{[1-p(1-k)(1-\pi)]\gamma}{p\pi} - (\gamma + \xi) = \frac{[1-p[1-(1-\pi)k]]\gamma}{p\pi} - \xi$ (resp. $C_2^{3L} - C_{FB} = \frac{[1-p(1-\pi)]\gamma}{p\pi} + \xi - (\gamma + \xi) = \frac{(1-p)\gamma}{p\pi}$). In a three-tier hierarchy, the agent systematically receives a rent while the supervisor receives a rent only when $\pi \leq \widehat{\pi}$.

2.3. Optimal Organization

When opportunism in the form of information concealment becomes more expensive to cope with under delegated monitoring than information concealment by the principal under direct monitoring, *the optimal organizational architecture trades-off the advantage of direct monitoring in regulating information against the advantages of delegated monitoring in regulating incentives and in better monitoring the agent.*

To derive the optimal organizational architecture, or equivalently, the optimal monitoring policy, the expected costs of direct monitoring and delegated monitoring have to be compared. Define $\overline{\sigma} = \frac{1}{1+pk}$ and $\overleftrightarrow{\pi} = \frac{[(1+pk)\sigma-1]\gamma}{p\sigma(k\gamma+\xi)}$. The following theorem presents the results of this costs comparison.

Theorem. *(1) If $\sigma \in (0, \overline{\sigma}]$, a three-level hierarchy strictly outperforms a two-level organization. (2) If $\sigma \in (\overline{\sigma}, 1)$ and $\pi < \overleftrightarrow{\pi}$, a two-level organization strictly outperforms a three-level hierarchy. In all other cases with $\sigma \in (\overline{\sigma}, 1)$ the converse is true. (3) (Vafaï 2004) If $\sigma = 1$ and (i) $\pi < \widehat{\pi}$, a two-level organization strictly outperforms a three-level hierarchy; (ii) $\pi \in [\widehat{\pi}, \overline{\pi}]$, the two architectures are equally effective; (iii) $\pi > \overline{\pi}$, a three-level hierarchy strictly outperforms a two-level organization.*

Proof. The costs comparison regions are those derived in Vafaï's (2004) proof of Theorem 3. As there, the only region where a two-level organization may strictly outperform a three-level hierarchy is $\pi < \widehat{\pi}$. Indeed, given that $C_1^{2L}(\sigma) > C_1^{2L}(\sigma = 1) = \frac{[1-p(1-\pi)]\gamma}{p\pi} + \xi$ and $C_2^{2L}(\sigma) > C_2^{2L}(\sigma = 1) = \frac{\gamma+\xi}{p}$, a three-level hierarchy is strictly preferable in the other regions. We thus have to compare $C_1^{2L}(\sigma)$ to C_1^{3L}. We have $C_1^{2L}(\sigma) < C_1^{3L} \Leftrightarrow \pi > \overleftrightarrow{\pi}$. Since $\overleftrightarrow{\pi} < \widehat{\pi} \Leftrightarrow \sigma < 1$ and $\overleftrightarrow{\pi} > 0 \Leftrightarrow \sigma > \overline{\sigma}$, a two-level organization strictly outperforms a three-level hierarchy if $\sigma \in (\overline{\sigma}, 1)$ and $\pi < \overleftrightarrow{\pi}$.

Case (2) of the theorem extends Vafaï's (2004) main result (i.e., case (3) of the theorem) by revealing that opportunism in a three-level hierarchy with a superior monitoring technology may be so severe as to make this organizational architecture strictly outperformed by a two-level organization. A three-level hierarchy has then an irreversible disadvantage in coping with information concealment (opportunism). Therefore, even with a less efficient monitoring technology, a two-level principal-agent organization may still be the optimal organization architecture. Nonetheless, as shown in case (1) of the Theorem, there is a monitoring efficiency limit $\overline{\sigma}$ above which the optimal organization is a three-level hierarchy. In other words, if a three-level hierarchy has a sufficiently large advantage in monitoring as compared with a two-level organization, then the principal will choose indirect monitoring.

It is important to note that choosing between direct and delegated monitoring amounts to both choosing the size of the organization (i.e., the number of hierarchical tiers and the number of employees) and deciding whether to integrate or separate ownership and control. Unlike the existing literature on the optimal organization size (e.g., Rosen 1982, Keren and Levhari 1989) that investigates environments where organizations are unexposed to supervisory opportunism and where inefficiencies are cumulative across hierarchical levels and the form of these inefficiencies is exogenously given, we consider an environment where all organizational architectures must deal with the threat of opportunism generated by monitoring and where the form as well as the impact of potential informational inefficiencies depend on the organization's architecture, and we determine the conditions under which the threat of opportunism sets a limit to the size of an organization.

Since the seminal work of Jensen and Meckling (1976) on the agency costs of the separation of ownership and control, this separation is mostly associated with supervisory opportunism.[5] Our analysis has notably proven that the integration of ownership and control may also generate opportunistic monitoring under the form of information concealment by the principal, and that despite the fact that the separation of ownership and control exposes an organization to more forms

[5] As noted in the introduction, the focus of the agency literature to date has been supervisory opportunism under the form of collusion between a supervisor and an agent.

of opportunistic activity generated by monitoring than integration, separation may outperform integration. These results thus show that the issue of ownership and control is more complex that suggested by most of the literature based on the work of Jensen and Meckling.

Finally, let us present some important comparative statics. One has $\frac{\delta\overline{\sigma}}{\delta p} < 0$ and $\frac{\delta\overline{\sigma}}{\delta k} < 0$. The explanation for the former partial derivative is straightforward. The latter partial derivative can be explained in the following way. The larger k (i.e., low transaction costs associated with the unofficial transfers) the easier opportunistic activities, and thus the more expensive it is to cope with opportunism. This means that in the region $\pi < \widehat{\pi}$ where direct monitoring may strictly dominate delegated monitoring, the expected cost of production and monitoring C_1^{3L} of a three-level hierarchy increases with k. In other words, the value of delegation, and therefore the threshold $\overline{\sigma}$ above which direct monitoring becomes optimal, decreases with k.

References

Bose, A., D. Pal and D.E.M. Sappington (2010) "Equal pay for unequal work: limiting sabotage in teams" *Journal of Economics and Management Strategy* 19, 25-53.

Jensen, M.J. and W.R. Meckling (1976) "Theory of the firm: managerial behavior, agency cost, and ownership structure" *Journal of Financial Economics* 3, 305-360.

Keren, M. and D. Levhari (1989) "Decentralization, aggregation, control loss and costs in a hierarchical model of the firm" *Journal of Economic Behavior and Organization* 11, 213-236.

Rosen, S. (1982) "Authority, control, and the distribution of earnings" *Bell Journal of Economics* 13, 311-323.

Shleifer, A. and R. Vishny (1989) "Management entrenchment: the case of manager-specific investments" *Journal of Financial Economics* 25, 123-139.

Silva, E.C.D, C.M. Kahn and X. Zhu (2007) "Crime and punishment and corruption: who needs "untouchables" ?" *Journal of Public Economic Theory* 9, 69-87.

Tirole, J. (1992) "Collusion and the theory of organizations" in *Advances in economic theory, Vol. 2* by J.-J. Laffont, Ed., Cambridge University Press: Cambridge, 151-206.

Vafaï, K. (2002) "Preventing abuse of authority in hierarchies" *International Journal of Industrial Organization* 20, 1143-1166.

Vafaï, K. (2004) "Delegation and opportunism" *Journal of Institutional and Theoretical Economics* 160, 498-521.

Vafaï, K. (2010) "Opportunism in organizations" *Journal of Law, Economics, and Organization* 26, 158-181.