Solving the "Selective Intervention" Puzzle

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1   Introduction

Since Coase's classical article (Coase, 1937), the problem of the integration of different activities in the same firm has been the holy grail of organization theory. Economists have a theory of markets which "prove" that they lead to efficient allocations; most economists also believe that markets are, overall, quite efficient. Yet, as Weitzman (1974) puts it, "the price system does not pass the market test": in market economies, firms choose to bypass the market in order to manage resources through bureaucratic procedures.

   This circumventing of the price system shows itself in two ways. First, firms do not use the price system internally as a way to allocate resources. The second theorem of welfare economics tells us that that, under some, non innocuous, conditions, any efficient allocation can be decentralized through a price system, but firms generally choose to use a command system rather than internal prices.[1] Second, firms often choose to produce inputs in-house rather than to acquire them from another firm, either by developing the capacities for internal production or by purchasing a supplier.

   Understanding the reason for this latter phenomenon seems an inviting path to understanding the role that firms play in the economy. It is not the aim of this article to do a complete literature survey, but I believe that it is fair to say that Williamson (1985) discussed the challenges facing this research program in a way which influenced much of the subsequent literature.

   The aim of this paper is to focus on one of the crucial challenges identified by Williamson: the selective intervention puzzle. Simplifying to the extreme, he asked the following question: it seems that nothing would prevent the owner of a firm from purchasing one of its suppliers and then to tell the managers of what have now become two units of the same firm to behave as if the merger had not taken place. This would prove that, at its worse, vertical integration is never worse than vertical disintegration, which is clearly counterfactual.

   In classical principal-agent theory, as presented in the pioneering contributions of, for instance, Baron and Myerson (1982) and Holmström (1979), the principal offers a contract to the agent, who takes the actions that his self interest dictates. By contrast, in the more recent literature, the principal does not quit the stage once the contract is written: he chooses some actions and makes decisions — in some sense, he becomes one of the agents whose

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[1]Firms do use "transfer prices" to measure the performance of units within the firm. However, these different units are not free to trade at these prices.
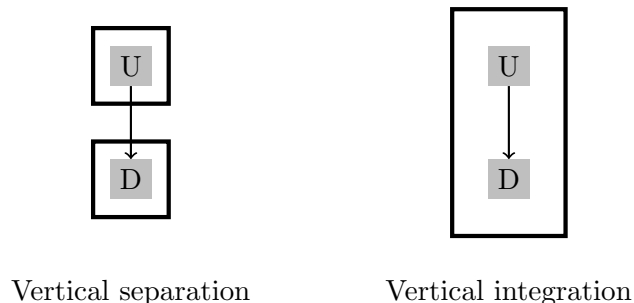
Figure 1: U and D are two different activities. The gray boxes represent the boundaries of the firms. Without vertical integration, activities U and D are run by two different, independent firms. Under vertical integration, they are run by the same firm.

behavior is affected by the terms of the contract. This feature provides a framework through which one can analyze the consequences of different organizational forms and provides for a much richer view of organizations in general and vertical integration in particular. In particular, I will argue that it is the critical feature in all the models that provide solutions to the selective intervention puzzle. Indeed, this is the unifying basis on which the different "solutions" which have been proposed rest, whether they are described in the literature in terms of incomplete contracts, inability to commit to future actions, or influence activities.

2 What is vertical integration?

2.1 Definition

The framework that most economists have used to tackle the problem of vertical integration in presented in figure 1. A downstream activity, D, uses some input provided by an upstream activity, U. We will assume that these two activities are run by two different production units which bear the name of the activity in which they engage. Under "vertical separation", these two units belong to two independent firms — in most of our discussion, we will assume, for simplicity, that these firms are only composed of these units. Under "vertical integration", these two units belong to the same firm. The theory of vertical integration tries to understand when each of these two solutions is more efficient than the other.

It is important to note that in reality all firms are vertically integrated. In restaurants, the food is an input to the activity of serving the customer and the kitchen (U) and the dining room (D) are jointly owned. In the kitchen itself, peeled carrots are an input for the production of stew, and the activity of peeling the carrots (U) is run in the same firm as the cooking of the stew (D), at least for restaurants who do not buy their carrots in plastic bags! In universities, the administration of classrooms (U) is an input to the teaching activities (D) and they are both run by the university. (Of course, the same holds true for horizontal separation - all firms conduct different operations which could conceivably be run in parallel. The same type of theories would apply in this case.)

It is also true that no firm is fully integrated. There is always at least some raw machinery or some input that is purchased from other sources. In recent years, improvement in information technology has allowed firms to pursue strategies of vertical separation to an unprecedented degree. (Malone and Laubacher (1998) discuss this phenomenon in an entertaining, and somewhat extreme, way.)

Therefore, the problem which we have to solve is not so much "Is vertical integration good or bad in this or that situation?" but rather "To which degree should the firm be vertically integrated?". This is the question which was asked by Coase. He went on to answer that a firm would integrate activities up to the point at which the marginal benefit of integrating another one would be equal to the cost. Alas, Coase provided very little guidance to the evaluation of these marginal benefits and marginal costs — this is the gap that the subsequent literature has spent much efforts trying to solve.

2.2   Do we already know the solution?

One of the difficulties which we face when we try to theorize the problem of vertical integration is that sometimes the solution seems too obvious. Figure 2 illustrates an example, first proposed by Klein, Crawford, and Alchian (1978), which I like to use in my classes. Oil is extracted in a well, and must be transported to a refinery where it will be transformed into a usable final product. In one case, the well is in the middle of the desert and the oil is transported through a pipeline to the refinery. In the second case, the well in situated on the side of the sea and is transported by boat to the refinery. It seems intuitively clear that vertical integration is more appropriate for the first case than for the second. 90% of my graduate students "get it".

It is not very difficult to go further and to see that the crucial difference between the two panels of figure 2 is the presence of specific capital. When
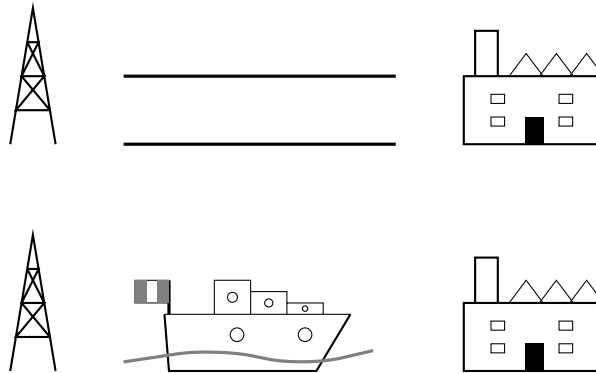
Figure 2: This figure illustrates the consequences of specific capital for vertical integration, following an example of Klein, Crawford, and Alchian (1978).

oil is transported through a pipeline the capital invested in the well, the pipeline and the refinery can only be used in the case of the relationship between the three entities. On the other hand, when oil is transported by boat, the well can easily be used in conjunction with another boat and/or another refinery. Similarly, the boat can be used to transport oil from other wells to other refineries. None of the capital which is invested looses value if the relationship between the three parties is disbanded.

The traditional dialogue then follows: if one can write contracts between separate firms who each manage one of the three activities oil extraction, transportation and refining, why cannot we do just as well as if they are managed by the same firm? And the usual answer follows: because of incomplete contracts.

This is the story that Klein, Crawford, and Alchian tell so well when they discuss the story of Fisher Body: the separation of the production of car bodies from car itself became impossible to maintain as more capital was used and this capital became more specific.

3   The selective intervention puzzle

The discussion of specific capital of Klein, Crawford, and Alchian does answer the question: "what type of inefficiencies of markets create incentives for firms to integrate?". This identifies at least one of the marginal benefits of integration of Coase, but does not help in the identification of its marginal

costs. And yet, firms do not integrate activities without bounds.

For Williamson (1985), the solution was to be found in the changes in incentives that come with vertical integration. He begun by accepting the thesis that vertical integration facilitates the writing of contracts and the use of specific capital, and that, by so doing, it decreases the cost of production. However, he also argued that it decreased the "power" of incentives; the owner of an independent supplier of inputs will be more responsive than the manager of a division that would produce the same inputs. Because the benefits of vertical integration increases with specificity of capital, but the costs in terms of power of incentives do not, we will indeed see more vertical integration with highly specific capital.

The difficulty is that this phenomenon is not understandable within traditional contract theory. Indeed, it would seem that after vertical integration, the owner of the U firm has more means of controls available to obtain what it wants the D firm to achieve. If this is the case, it can mimic the contract that would be offered in the absence of vertical integration, and hence can never be worse off than under separated ownership. More precisely, the owner of the combined entity of which the U and the D firms are now divisions, could tell the managers of these two divisions "act as you would if you were separate firms". Hence, vertical integration would never make the situation worse. And the owner could always offer some very minor variations on the original contract, which would improve his profits (for instance, sharing the same supplier of stationary, or a parking lot) — this is the selective intervention part. Of course, this is not supposed to be a proof of the fact that the optimal contract after vertical integration is a simple variation on the optimal contract before vertical integration; but it "proves" that vertical integration can never decrease profits and should in nearly all case increase them. This is clearly counterfactual; hence, the term "paradox of selective intervention".

There are two aspects which we can stress when discussing this paradox. One is whether or not selective intervention is indeed possible, that is would it be possible for the owner to intervene only sometimes and only with a light touch. If the answer to this question is negative, then it is not true that vertical integration is always strictly superior to vertical disintegration. This is the aspect on which, for instance, Foss (2005) focuses. This is also the way in which Masten (1999) summarizes Williamson's answer:

> "Williamson's answer to the question 'what limits firm size?'
> lay in the impossibility of selective intervention (1985, chap. 6).
> Unable to use the courts to enforce promise to intervene selec-

tively, management would be drawn to intervening even when joint benefits are not realized. Without effective assurances that owners will not appropriate performance enhancements, the incentives of division managers to innovate, maintain assets, acquire and utilize information, and otherwise invest in the efficient operation of the division are ineluctably compromised. In their place, the firm is forced to substitute weaker, indirect incentives dependent on managerial oversight. The loss of incentive intensity combined with the limited capacity of management to administer additional transactions — which manifest themselves in a variety of bureaucratic inefficiencies — ultimately undermines the efficacy of internal organization and thereby limit firm size."

On the other hand, one could focus on whether is would be possible for the owner even to implement a contract that yield the same outcome than the outcome under vertical disintegration. This is the aspect on which Milgrom and Roberts (1990) focus in the following passage:

"Williamson's treatment of these issues is also based on an incentive argument. He focuses on why 'high-powered', marketlike incentives that replicate residual claimant status are not feasible within a centrally managed organization — that is, he focuses on why selective intervention is not in fact possible."

If we succeed in proving that a contract that replicate the same outcome as vertical disintegration does not exist, then we have showed that Williamson's "proof" that vertical integration is never strictly inferior to market transactions is wrong. (Of course, Williamson presented his proof as a puzzle and did not believe it himself.)

In order to lighten and shorten the discussion, we will not in the sequel always carefully distinguish between these two aspects of the puzzle.

4   Grossman & Hart

4.1   How does the model of Grossman and Hart work?

The widely cited Grossman and Hart (1986) paper was a first formal answer to Williamson's challenge of building a model that would go around the selective intervention paradox. Its features are well known. An agent and a principal contract for the provision of a good. After they come to an agreement, they each must take some action which will affect the profitability

of the project. Once these actions have been taken, they bargain to know whether or not to continue the project. If they do come to an agreement, and continue, they split the profits as predicted in the contract.

The actions that the parties take after having reached an agreement are "non contractible", that is the parties cannot write a contract that in any way influence the action that they are taking. On the other hand, their bargaining position in the subsequent negotiation affects the actions which they are taking. And their bargaining position depends in turn on the allocation of property rights between the principal and the agent. If the principal owns the asset of the downstream firm (*i.e.*, under vertical integration), he controls the use of the asset in case the bargaining does not lead to an agreement. On the other hand, if the agent owns the asset (*i.e.*, in the absence of vertical integration), he controls the use of the asset.

This change in the control of the asset affects the outcome of the bargaining, and in turn affects the incentives of the agents to take this or that action in the phase that precedes it. Grossman and Hart identify some conditions under which one or the other mode of allocation of property rights is optimal. It is worthwhile noticing, that, in their model, the only way in which the agents can be given incentives is through the allocation of property rights.[2]

The idea that contracts do not specify completely the set of actions that the agents can take is an old idea in the economic literature. The first paper that I know which explicitly discusses incomplete contract is Simon (1951). Simon argues that the contract between an employer and an employee is necessarily incomplete. Indeed, a complete contract would contain a description of the tasks that the employee has to perform in any foreseeable future circumstance, as well as a formula for determining the salary as a function of these tasks. This is, of course, impossible in practice. Therefore a employment contract simply specifies a set of tasks that the employer-principal has the right to ask from the agent-employee, and leaves him the right to choose any action (or combination of actions) in that set, as he feels warranted. In exchange, the contract fixes a set salary for the employee.

And, of course, as we have discussed above, the fact that the presence of specific capital is an important determinant of the desirability of vertical integration had often been discussed in the literature.

What seems to me to be the most original contribution of the Grossman Hart paper was that they pointed out explicitly that a contract was not

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[2]Hart and Moore (1988) and Hart and Moore (1990) follow basically the same methodology, while expanding the framework to more than two agents and more than one asset.

	"Traditional" contract theory	Grossman and Hart & subsequent authors
❶	Principal offers contract	Principal offers contract
❷	Agent acts	Principal & agent act

Table 1: Comparing the role of the principal in different theories.

simply a technique to control the behavior of one economic agent, but rather organized a game to be played by the different parties. In a standard moral hazard problem, *à la* Holmström (1979), the principal's only role is to offer a contract to the agent, he then withdraws from the scene and the only player in the subsequent game is the agent, who must decide whether or not to accept the contract, and, if he accepts it, must decide how much effort to exert. In a standard adverse selection problem, *à la* Baron and Myerson (1982), the principal simply offers a contract to the agent, and then it is up to the agent to decide, given the payment schedule offered by the contract, how much to produce. The Simon model of employee-employer relationship shares this feature, except for the fact that it is the principal who must choose an action once the contract has been signed.

For Grossman and Hart on the other hand, the contract sets up the rules of a game in which both the principal (in their case firm U) and the agent (firm D) will participate. If we define the principal as the party who proposes the contract, there are one principal and two agents: firm D, but also the "post-contracting" firm U — this is represented in table 1. And the principal must worry about the incentives of both these agents when he chooses the terms of the contract.

Notice that the principal cannot commit not to intervene after the contract is signed. By assumption, there will be states of nature[3] in which the contract does not specify the actions that should be taken;[4] in these circumstances, it will be possible for the owner of the assets to do whatever it pleases with them, but this is inefficient. Hence, there are incentives to renegotiate, and no way ex-ante to renounce this possibility.

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[3]In the formal model that Grossman and Hart present, there is no contract *stricto sensu*, and therefore what actions have to be taken is never specified. However, as the discussion in the paper shows the model is supposed to be a caricature that shows what happens in a reality where not all states of nature are covered by the contract.

[4]I am purposely avoiding discussions of the foundation of incomplete contracts à la Maskin and Tirole (1999), which would take us too far afield.

4.2 Riordan's discussion of Grossman and Hart

The importance of this change in contract theory can perhaps best be understood through an examination of Riordan (1990), which presents an early critique of Grossman and Hart: Riordan disagrees with the definition of vertical integration which they propose. As we have seen above, for Grossman and Hart, vertical integration is defined by the control of the assets of firm U by firm D. They argue that this changes the way in which the second stage renegotiation will take place, by changing the status quo solution, *i.e.,* the power given to the different parties in case the negotiations break down: under vertical integration, the downstream firm will be able to take control of the assets and do whatever it wants with them, while under vertical disintegration, it will the upstream firm which will be control the assets. Riordan argues that it is the right to control the internal management controls of the firm which really defines vertical integration, and not the control of assets.[5] He illustrates his argument through two examples:

A "A firm buys material inputs and contracts for the specific rights to employ labor and capital services in an upstream production process".

B "A firm contracts for output from a supplier but leases to the supplier some specialized asset used in its production".

He argues that in case **A**, Grossman and Hart would say that there is no vertical integration because the upstream firm owns its capital, whereas, according to his definition there is vertical integration, as firm D manages all the assets which are used in the production process. On the other hand, in case **B**, the situation is reversed: there is vertical integration for Grossman and Hart, but not for Riordan.

The analysis of the consequences of vertical integration are radically different with Riordan's definition than with Grossman and Hart's. In particular, Riordan's provides a straightforward explanation of the reasons why vertical integration lowers the power of incentives. After vertical integration, firm U cannot commit to give very large rewards to firm D for exceptional performance: because it controls its management control system, it would manipulate the measurement of performance rather than pay what is promised. Hence, the access to better information comes at a cost: the inability to commit.

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[5]A similar point is made by (Milgrom and Roberts, 1990, p. 72): "... the crucial distinguishing characteristic of a firm is not the pattern of asset ownership but the substitution of centralized authority for the relatively unfettered negotiations that characterize market transactions."

For our purposes, the important point is to notice that Riordan is, certainly implicitly, applying the same methodology as Grossman and Hart. After the contract is signed, the principal still can take some actions — in his case, manipulate the accounts of firm U when he has the power to do so. In the very simple model that he uses, he does this anytime he owes anything to his subordinate.

The solution to the selective intervention puzzle is very simple in this case. Under vertical integration, firm D cannot obtain that firm U does the same thing than without vertical integration because its own actions will be different. We can only represent this fact through models where a) the principal takes an action after the contract is signed and b) these actions are different with and without vertical integration. From a modeling point of view, point b) can be implemented in two different ways. The first, and technically easiest, is to simply assume, as Riordan does, that vertical integration opens up the possibility of actions that would not be possible otherwise. The other, which was used by Grossman and Hart is to assume that vertical integration changes the incentives of firm U, and therefore the relative costs of obtaining different actions from its management is different (in particular, the same contract will yield different outcomes). Trading off these different costs will lead to different outcomes.

5 Other literature

5.1 No commitment, renegotiation and the like

Of course, models where the principal "stays on the scene" after the signature of the contract are now standard fare. For instance, renegotiation proofness implies that the principal can propose and/or accept a new contract after the original contract has been signed. Similarly, the literature on repeated contracting without commitment assumes that the principal is able to offer a new contract after the first one has been executed. (For textbook discussions of these issues see Bolton and Dewatripont (2005), Laffont and Martimort (2001) or Salanie (2005).) Personally, as far as I remember, I understood the issue for the first time from Khalil (1997), who studies a standard Baron-Myerson with auditing, but assumes that the principal cannot commit to a probability of audit. The contract simply gives him the right to audit. Then, the principal becomes a player in the game defined by the contract, and he must be provided the right incentives to audit often enough. Khalil shows that this changes fundamentally the structure of the optimal mechanism: there is overproduction, rather than underproduction, in the "bad" state of

nature. Having to give incentives to the principal changes fundamentally the problem of designing the optimal contract.[6]

5.2 Subsequent work on vertical integration

I would like to finish this discussion by briefly reviewing two other families of vertical integration models and showing that they use the same strategy to solve the selective intervention puzzle. This is far from a survey of the vertical integration literature and is just aimed at stressing the main point of this paper: the solution to the selective intervention puzzle lies in the change of the description of the role of the principal.

5.2.1 Relational contracts

In recent years, a number of authors have used "relational contracts" to explore the reasons for vertical integration, and its limits (Baker, Gibbons, and Murphy, 2002; Levin, 2003). This literature presents a dynamic extension of the Grossman-Hart-Moore framework where the principal and the agent have limited commitment power to long run contracts; one of its aims is to understand better the relationship between explicit, legally enforceable, contracts and implicit, non legally enforceable, contracts. Indeed, most contractual relationships are based on a mixture on these two types of contracts. You have a legally enforceable contract with your employer: he must pay you and you must show up for work. But there are also, in general, many non legally enforceable aspects of these contracts: "if you work hard, we will be flexible about the dates at which you can go on vacation". The relational contract literature tries to understand how these two types of contract interact with each other. Because it assumes that the parties sign a new contract in each period, the principal never "leaves the scene". The first period contract must take into account what his future strategy will be, and this implies, as in Grossman and Hart that the incentives schemes are fundamentally different with or without vertical integration.

5.2.2 Influence activities

In a number of papers, Paul Milgrom and John Roberts have stressed the fact that vertical integration opens the path to "influence activities" (see Milgrom and Roberts, 1988; Meyer, Milgrom, and Roberts, 1992). A good summary is provided by Milgrom and Roberts (1990):

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[6]It also makes the problem much harder to solve, as the revelation principle (Myerson, 1981) does not hold.

> "Influence costs arise first because individuals and groups within the organization expend time, effort and ingenuity in attempting to affect others' decisions to their benefit and secondly because inefficient decisions result either directly from these influence activities or, less directly, from attempts to prevent or control them."

Milgrom and Roberts explain that one would think that it would be easy to avoid influence activities: "simply have decision makers ignore attempts at influence." However, the policy of ignoring attempts at influence is not feasible:

> "*Ex post*,when relevant information is available and those at lower levels have already taken actions that cannot be reversed, there will be interventions that are now organizationally desirable and that the center will thus want to take."

It is therefore because the principal cannot remove himself from the game that influence activities prevent selective intervention. The aim of the present paper has been to show that this is the case of *all* the solutions to the selective intervention paradox.

5.3   Benevolent principal

Some of the literature has stressed the fact that the intervention of the principal in the second stage of the contract creates problems because he is not benevolent. For instance, in the quote on page 5, Masten (1999) states "Without effective assurances that owners will not appropriate performance enhancements...". Similarly, Milgrom and Roberts (1990) state that "two kinds of cost generally accompany increases in discretionary centralized activity" that, according to them, necessarily accompany vertical integration; "the first kind arises because those with discretionary authority may misuse it directly, on their own initiative". However, the fact that the new owner of the integrated firm is benevolent would not, by itself, be sufficient to make the selective intervention puzzle irrelevant.

For instance, in Cremer (1995), I develop a model which tries to explain why cutting off the flow of information to the principal, as vertical disintegration would do, can provide for more powerful incentives. In this model, in the first period, the agent can signal his quality through his effort, as both increase the likelihood of a good outcome. When the principal has a direct source of information on the quality of the agent, he will be able to know that

the agent is of high quality even when the outcome is bad, and this decreases the incentives for high effort. The solution to the selective intervention puzzle in this case is the fact that the optimal contract under vertical disintegration is not renegotiation proof in the second period — indeed renegotiation can only take place if it does not hurt the agent. It is not caused by his use of discretionary authority in a way which is detrimental to the interest of the agent. The only thing that really matters is that the principal acts after the contract is signed.

We find the same type of phenomenon in the theory of mixed oligopoly (see Cremer, Marchand, and Thisse, 1990). From a social welfare point of view, a mixed oligopoly, where some firms are state owned firms, can be worse than a purely private oligopoly if the state owned firm cannot commit itself ex-ante to a production policy. In this case again, it is not misaligned incentives but the impossibility to commit which is at the root of the problems.

6   Concluding remarks

The aim of this paper has been to discuss the way in which the economic literature has solved Williamson's selective intervention puzzle. I have shown that the common thread to all the solutions is the fact that the principal "stays in the game" after the contract is signed, and cannot commit himself to a policy which would make the world similar to the world in which there would be no vertical integration. On this basis, solutions that stress incompleteness of contracts, the change in the allocation of authority, the change in the amount of information available to the principal, all provide solutions that are theoretically consistent, and, furthermore, often not incompatible with each other. Determining which solution provides a better guide to applied analysis requires an examination of other features of the model.

There is another paradox, inspired by Coase (1960) (the Coase of the "problem of social cost"), which I find useful to illuminate the difficulties of developing a theory of vertical integration. Assume firms U and D realize that they could gain by merging; they could also obtain the same gains by signing a contract that commits them to act as if they had merged. We would deduce that mergers can never be beneficial — a sort of reverse selective intervention puzzle. The same analysis as was done in the current paper would show that the same solution holds: it is not possible to provide the same incentives in the two cases, and to study this phenomenon, we need a solution a model that keeps the principal in the game after the contract is

signed.

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