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Hold-up and externality: the firm as a nexus of incomplete rights?

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Abstract The Coasean theory of the firm (Coase in Economica 4:386–405, 1937) has flourished with the theory of incomplete contracts. Transaction costs in the form of enforcement costs have been deemed to be the main determinants of the decision to 'make' versus 'buy'. Surprisingly, this stream of literature has almost neglected that transaction costs may also generate incomplete property rights (Coase in J Law Econ 3:1–44, 1960). As firm's activities entail both contractual and property rights, these two domains interfere each other on the decision to carry out a transaction within the firm. When property rights are incomplete, potential externalities may increase the cost of using the price mechanism to procure the assets needed in a given transaction. The resulting 'Coasean firm' would not only centralize incomplete contracts under a unified governance system, but it will also aggregate incomplete property rights under a unified ownership structure.

Keywords Transaction costs · Externalities · Theory of the firm · Property · Incomplete contracts

JEL Classification B15 · B52 · H23 · K11 · K12 · L14 · L22

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1 Introduction

On 15 October 1991, the Royal Swedish Academy of Sciences awarded the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel, to Professor Ronald Coase. The motivation was "for his discovery and clarification of the significance of transaction costs and property rights for the institutional structure and functioning of the economy". According to the motivation, two main fundamental 'stages' of the Coasean research should be recognised: a 'first stage' referred to the*The Nature of the Firm* (Coase 1937) and a 'second stage', referred to *The Problem of Social Cost* (Coase 1960).

The two 'stages' share the general intuition that the ideal-type of perfect competitive markets, usually incorporated in standard microeconomic analysis, neglects the role played by different types of transaction costs in shaping economic choices in the real world economies. In order to provide economic theories with a better understanding of real economic systems, "Coase paved the way for a systematic analysis of institutions in the economic system and their significance".[1] While the two Coasean 'stages' differ in their specific focus (respectively, the explanation of the firm and the internalization of social cost), they both attribute a central role to the notion of transaction costs. As Coase (1988, p. 6) outlines:

> [...] in order to explain why firms exist and what activities they undertake, I found it necessary to introduce a concept which I termed in that article [*the Nature of the Firm*] 'the cost of using the price mechanism', ' the cost of carrying out a transaction by means of an exchange on the open market', or simply, 'marketing costs'. To express the same idea in my article on '*the Problem of Social Cost*', I used the phrase 'the costs of market transactions'. I have described what I had in mind in the following terms: 'in order to carry out a market transaction, it is necessary to discover who it is that one who wishes to deal with, to inform people that one wishes to deal and on what terms, to conduct negotiations leading up to a bargain, to draw up the contract to undertake the inspection needed to make sure that the terms of the contract are being observed, and so on'.

The above long quotation from Coase outlines that a unique framework falls behind the two Coasean 'stages': the role of transaction costs in governing agents' choices and the institutional arrangements needed to overcome them.

In this article, we claim that, despite this common feature being widely recognised (Hodgson 1988), each Coasean 'stage' has generated two parallel, and independent research paths in the economic theorizing about, respectively, firms and externalities, without analyzing the implications deriving from their reciprocal interdependence. Following Coase (1937, 1960), transaction costs have been analyzed as a constraint on efficient contractual agreements over a joint surplus: when the 'use of the price mechanism' is costly, second best arrangements might be reached through vertical integration (in the case of firm) or regulation (in the case of externalities). The main consequence is that 'transactions' have been mainly

[1] From the motivation of the Sveriges Riksbank Prize in Economic Sciences.

investigated through the lens of 'contracts', while the domain of 'property' has been largely neglected (Merrill and Smith 2001). The exclusive emphasis on the contractual side of transaction costs has largely ignored that the same argument used toward 'contractual rights' could be applied to property rights (Alchian 1965, 1998; Demsetz 1967, 1998, 1988; Barzel 2003).

This paradox is fairly even in the *New Institutional Economics* theory of the firm (Williamson 1985; Hart 1995). For instance, Hart and Moore (1990) provide a theory of vertical integration under the framework of incomplete contracts, through the optimal assignment of 'complete' property rights. Similarly, the wide literature on incomplete contracts and governance design has generally been based on the idea that transaction costs affect parties' bargaining over a joint surplus that remains unaffected by the nature and content of proprietary assets (Merrill and Smith 2001, n.d.; Lueck and Miceli 2007; Nicita 2006; Brousseau and Nicita 2010).

One evident weakness of these approaches is that if the source of transaction costs relies on the agents' inability to foresee and verify each possible state of the world in their contract, there is no reason why other institutional settings—as property rights—should be in principle always immune to the same source of transaction costs. According to Coase (1960), reciprocal externalities do emerge when property rights are ex-ante poorly defined and/or weakly enforced, precisely because prohibitive transaction costs are needed to define and enforce every use of those rights.

Comparing thus the two Coasean 'stages' (Coase 1937, 1960) would easily reveal that even property is a (transaction cost-minimizing) institution (Merrill and Smith 2001, 2012) and that when the 'activities' undertaken within a transaction involve incomplete contracts and incomplete property rights, the cost of using the price mechanism affects not only the governance of contracts but also that of property rights. To put it in another way, we suggest that the missing step in the Coasean legacy is a theory of the firm as a transaction cost-minimizing institution with reference both to incomplete contracts and to incomplete property rights.

The resulting picture would be one in which the complementary use of human capital and proprietary assets within the firm is determined, respectively, by hold-up deterrence and externality prevention. An 'externality' could be here defined as the joint claim of 'presumptive' rights holders over rival uses. When some uses of assets in a given transaction are exposed to potential externalities, the cost of 'governing' property rights may increase ex-post. Thus, under given circumstances, it might be more efficient that, in order to prevent ex-post transaction costs due to externalities, all the potential rival uses fall under the same ownership structure. As a consequence, 'expanding' the domain of ownership over uses could be interpreted as a transaction costs minimizing strategy.

Indeed, when property rights are incomplete, in order to minimize the transaction costs associated with bargaining over an externality, one way to prevent potential externalities is to expand the property domain over all those rival uses that contrast with the core activity of the firm.

Here, we have an important result. In a world of both incomplete contracts *and* incomplete property rights, the property rights combined with 'contractual activities' performed within the firm also determine the nexus of property rights owned by the firm (and vice-versa). While in the standard approach to incomplete contracts, the

property and the contractual dimensions have been generally assumed to be independent, we argue that as property rights are incomplete to some extent, both property and contracts affect the dimension of the transactions carried out within the firm.

When incompleteness is also referred to the property domain, the 'Coasean firm' would not only centralize incomplete contracts under a unified governance system, but it will also aggregate incomplete property rights under a unified ownership structure. In this respect, the 'make-or-buy' decision will be affected by, and will in turn affect, the market for property rights.

We believe that the unified framework we propose between the two Coasean 'stages' may enrich our understanding of the institutional nature and the dimension of the firm, as well as the relationship between the firm, the market and the law.

The rest of the paper proceeds as follows. In Sect. 2, we outline the main lessons deriving from the two Coasean 'stages' quoted above. In Sect. 3, we present a simple model of incomplete contracts with weakly defined property rights (externalities). In Sect. 4, we discuss the main implications of a theory of the firm as a nexus of incomplete contracts and incomplete property rights. Section 4 concludes.

2 Two 'stages', one framework

As Ronald Coase (Coase 2005, p. 200) has recently pointed out, in a Walrasian world "exchange takes place without any specification of its institutional setting. We have consumers without humanity, firms without organization, and even exchange without markets". As a consequence for Coase (1988, p. 5), economists' view of human nature is 'of a piece with their treatment of institutions that are central to their work. These institutions are 'the firm' and 'the market', which together make up the institutional structure of the economic system".

An important legacy of the Coasean analysis of economic institutions is that institutional efficiency is not absolute, but it depends on the compared costs associated with existing alternatives. As a consequence, any institutional solution to the problem of managing economic transactions is just a second best solution, far from the optimality features characterizing the ideal type of perfectly competitive equilibria in the Walrasian paradigm.

The minimization of the vast array of transaction costs becomes thus the paradigmatic problem to be solved for the selection of the most appropriate institution. However, since the nature and the dimension of transaction costs are endogenous in nature, also the frontier between economic institutions is 'mobile', bringing to a theory of the architecture of economic institutions as "moving equilibrium": the cost of using market institution generates alternative institutions characterized by some degree of centralized coordination within the firm; however the diseconomies associated with the continuous process of centralization generate, in turn, the upper limit to the process of centralized coordination in firms.

This theory has been developed with reference to boundaries between market and hierarchy on the one side, and between property and externality on the other.

2.1 Markets versus hierarchy

The analysis of the trade-off between market and hierarchy is the most important and pervasive of the trade-offs surrounding the economic theory of institutions. It stemmed from the increasing unhappiness about the assumptions of mainstream Walrasian economic theory and its inability to explain the emergence and the existence of real world institutions.

The pioneering work of Coase (1937) on the nature of the firm started with the precise aim of filling these gaps in economic theory. The question posed by Coase on the existence of the firm as an economic institution is in fact a theme that transcends the specific nature of the firm and regarding any other organization or institution affecting the performance of market transactions.

Coase outlined that in real world markets, two distinct mechanisms of coordination were observable at the same time: coordination through prices and coordination through 'command and control' activities. The explanation given by Coase was based on the notion of the alternative costs in carrying out a market transaction: in Coase's view, if market transactions are also organized through the hierarchical coordination mechanism in firms it should be that there is a cost of using the price mechanism, namely the search costs of discovering new price opportunities, the cost of negotiating and concluding a separate contract for each exchange transaction that takes place on the market, and the cost of adapting ex-post existing contracts to new contingencies when they arise. High transaction costs in the use of the price mechanism induce the emergence of alternative forms of governance—such as the firm—to coordinate market transactions.

The 'authority' exerted by the entrepreneur within hierarchical organizations implies that, within a firm, contracts are reduced in number and the factors of production are coordinated through a relation of power "within certain limits" between the employees and the entrepreneur. Hierarchical organizations reduce also the cost of adaptation in long-term contracts when parties are bounded in their ability to forecast future contingencies and therefore "a firm is likely therefore to emerge in those cases where a very short-term contract would be unsatisfactory". According to Coase,

> the operation of a market costs something and by forming an organization and allowing some authority (an "entrepreneur") to direct the resources, certain marketing costs are saved. The entrepreneur has to carry out his function at less cost, taking into account the fact that he may get factors of production at a lower price than the market transactions which he supersedes, because it is always possible to revert to the open market if he fails to do this (Coase 1937).

On the other side, one should ask "why, if by organizing one can eliminate certain costs and in fact reduce the cost of production, are there any market transactions at all? Why is not all production carried on by one big firm?"

The answer provided by Coase is that as the process of centralization of market transactions through a hierarchical system of governance grows, it generates itself new forms of transaction costs as those necessary to 'command' a richer and more complex amount of production factors. As a consequence "as firm gets larger, there may be

decreasing returns to the entrepreneur function, that is, the costs of organizing additional transactions within the firm may well rise accordingly".

The conclusion reached by Coase is that the 'optimal' division of institutions in the governance of transactions between hierarchies and market will be reached at a point "where the costs of organizing an extra transaction within the firm are equal to the costs involved in carrying out the transaction in the open market". Thus, the dimension of one institution in governing a given transaction depends on the comparative costs of governing the same transaction under an alternative institutional framework. The 'market' will work well as a coordinating institution when the degree of uncertainty and the dimension of search costs are sufficiently low, while 'the firm' will perform better otherwise.

Post-Coasean theories of the firm (Alchian and Demsetz 1972; Jensen and Meckling 1976) stress how by designing appropriate contracts and/or institutions it is possible to mitigate the ex-ante transaction costs associated with asymmetric information which lead to adverse selection and/or moral hazard problems. Here, the trade-off between decentralization and centralization is revisited in terms of the optimal separation between property and direction of the economic resources (Brousseau and Nicita 2010). As long as the entrepreneur needs to recur to external finance, a trade-off emerges between appropriate investors' safeguards and optimal incentives for the managers. According to the principal-agent approach, economic institutions are simply a legal structure shaped by the specific contractual architecture selected. The view of institutions as a 'nexus of contracts' outlines the role of asymmetric information in shaping market transaction costs. However, it does not provide a general theory of institutions alternative to markets. Indeed, as Alchian and Demsetz (1972) outlined, the nature of contracts signed among economic agents within institutions like firms is every respect analogous to that characterizing transactions in the spot market.

The transition from market contracts to 'transactions'—which was originally formulated by Commons (1924)—has been clarified by Nobel Prize Oliver Williamson, the founder of the so-called Transaction Costs Economics, who formulates a theory of economic institutions along the institutional trade-offs depicted by Coase (Williamson 1985, 1996).

Williamson's focus is on the ex-post transaction costs, that is, on the enforcement costs that parties in a contracts have to sustain in order to carry out transactions characterized by incomplete contracts and specific investments:

> transaction costs analysis entails an examination of the comparative costs of planning, adapting, and monitoring task completion under alternative governance structures. [...] The principal dimensions on which transaction cost economics presently relies for purposes of describing transactions are (1) the frequency with which they recur, (2) the degree and type of uncertainty to which they are subject and (3) the condition of asset specificity (Williamson 1979).

According to this framework, Williamson's analysis is mainly devoted at explaining alternative governance structures in terms of the comparative ability in minimizing transaction costs, including in this category not only all the ex-ante

alignment costs (agency costs) but also all the ex-post enforcement costs due to the existence of incomplete contracts and to the risk of hold-up when specific assets are involved.

Williamson explores the case of incomplete contracts with specific investment as the paradigmatic case to be investigated in order to find a rationale for a transaction costs based theory of the firm. When specific assets are involved in incomplete contracts, at least one agent in a contractual relationship might be isolated from ex-post competition on her market side, whereas the owner of specific assets is locked-in by the fact that the degree of asset specificity acts as a 'fundamental transformation' which reduced ex-post the value of employing the assets in alternative uses.

This lock-in effect generates the risk of opportunistic behavior (hold-up) from contractual counterparts, who may want to renegotiate contractual terms in order to earn additional gains, with regard to those contracted ex-ante, due to the ex-post-contractual dependency of specific agents. According to Williamson, it is this feature of market transactions which calls for a governance structure alternative to that provided by market exchange. 'Private orderings' then emerge in order to carry out those transactions characterised by a significant degree of incompleteness and specificity.

In this respect, Williamson's approach goes one step further, relative to Coase, in providing a normative theory of institutions: the analysis of transaction costs not only explains why institutions do emerge but it also suggests how institutions should be managed. The optimal governance system is thus that which economizes on internal transaction costs. Firms, as well as any other economic organization that has a hierarchical governance of 'command and control', constitute a sort of 'internal markets' within which the allocation of resources should follow the same principle of transaction costs minimization that determines the choice between market and hierarchy.

The Coasean institutional trade-offs are thus applied by Williamson also to the internal organization of firms: the specific governance system depends on the structuring of internal transaction costs. At any moment, an efficient adaptation process requires that the direction of resources within a given institution should be attributed to the most valuable and specific factor of production. The allocation of property rights acts as an enforcement device against post-contractual opportunism.

However, as in Coase (1937), Williamson outlines also the risks associated with the process of centralizing economic transactions within a hierarchical institution: bureaucratic failures as well as the emergence of conflicts of interests and self-serving biases may inhibit appropriate forms of ex-post adaptation. Coasean institutional trade-offs are thus enriched in the following terms: from one side, in order to induce appropriate ex-ante efficient investments in specific assets investors should receive appropriate safeguards (i.e., property rights), thus requiring some institutional 'rigidity' in the governance structure; from the other, in order to efficiently adapt to the unforeseen contingencies that arise ex-post, institutions should maintain a significant degree of 'flexibility' in rules and procedure so as to induce at any time the governance change that it is needed to reduce overall transaction costs.

Following this argument, Grossman and Hart (1986) and Hart and Moore (1990) (the 'GHM approach') further explored the rationale underlying the allocation of property rights between and within firms. According to their theories, since property rights represent an appropriate safeguard against hold-up, an efficient assignment of property rights requires to give ownership to those agents whose contribution to the generation of social surplus is the most valuable.

The assignment of property rights to the most valuable agents, however, will decrease non-owners' incentive to invest so that only a second best outcome might be reached in a world of incomplete contract. In this perspective, "the owner of an asset has residual control rights over that asset: the right to decide all usages of the asset in any way not inconsistent with a prior contract, custom or law" (Hart and Moore 1990, p. 3).

In these theories, the economic value of ownership thus stems from the fact that 'property matters as a source of power' as having rights to use a certain scarce asset increase the investor's outside option. This is undoubtedly one of the key contributions offered by this strand of research.

However, the implicit assumption behind this approach is that in a world of incomplete contracts, rights of use are—always—complete. Completeness in property means that any new use of property not previously specified by "contract, custom or law" would always be included ex-post in the owner's bundle of uses. In other words, there is a tension, if not a contradiction, between the economic analysis of contracts and the economic analysis of ownership (Nicita et al. 2007; Nicita 2006). This is particularly relevant, as it is precisely the assignment of 'complete' property rights that mitigates, in the GHM approach, the consequences of the hold-up problem in incomplete contracts. Unsurprisingly, this contradiction could hardly be conciliated within the Coasean framework: on the one hand, institutions, such as firms, are described as being the efficient adaptation to market failure generated by high transaction costs in carrying a given transaction in the open market; on the other hand, the market for property rights and control must work efficiently if firms have to be efficient adaptations to the problem of market failure. Thus, while some 'contractual' rights are difficult to enforce, 'property' rights must be efficiently enforced by a costless public ordering. This dichotic view of the public ordering reaches a rather extreme formulation in the New Property Right approach where some rights (those on human capital investment) cannot be defined exchanged and enforced and other rights (those on physical assets) can be defined enforced and exchanged at zero cost (Nicita and Pagano 2008).

Once the paradigm of 'incompleteness' is assumed, there is no a priori reason why it should cover some rights (on the contractual domain) while excluding some other (on the property domain).

In a more realistic setting, the ownership of a given resource could be incomplete in some respect, being exposed to a potential conflict against rival uses. If incomplete contracts are vulnerable to the risk of hold-up, incomplete property rights are exposed to the risk of externality.

In a world of incomplete rights, hold-up and externality are thus two problems that jointly characterize the Coasean firm. This leads to the 'second' stage', to the *Problem of Social Cost* (Coase 1960).

2.2 Property versus externality

In 1960, Coase developed the theory of institutions outlined in 1937, focusing on the design of economic policy aimed at internalizing externalities in market with high transaction costs: in a world of positive transaction costs the markets may underperform its allocative function and economic resources will be prevented from being employed in their best uses.

Thus with positive transaction costs, the market may need to be replaced by alternative institutions, such as firms but also the State, which have the duty to reallocate economic resources in the most efficient way according to existing transaction costs. Thus, integrating the two main Coasean contributions (1937, 1960) outlines a theory explaining both the emergence and the plurality of institutions in terms of the comparative transaction costs associated with them.

Coasean trade-offs have been further explored by the *principal-agent* literature, investigating the role of asymmetric information in transactions as a market failure requiring centralized institutions and/or public regulation to reduce transaction costs generated by asymmetric information (Alchian and Demsetz 1972; Jensen and Meckling 1976).

The *Coase Theorem*, as Stigler first named it, has been traditionally interpreted (Cooter 1987) as a theory of the superiority of free market exchange over state regulatory intervention for handling externalities. As Coase (1988) has later pointed out, his 1960 article has been widely cited and discussed only with reference to the first part of the analysis (concerning a world with zero transaction costs), "neglecting other aspects of the analysis" as those regarding "the fundamental role which transaction costs do, and should, play in the fashioning of the institutions which make up the economic system".

The *Coase Theorem*, which thus covers only a part of a more general argument, could be formulated in the following way: "if transaction costs were assumed to be zero and the rights of the various parties well defined, the allocation of resources would be the same" independently of the initial allocation of rights. The consequence of this assertion is that "how the rights will be used depends on who owns the rights and the contractual arrangements into which the owner has entered. If these arrangements are the result of market transactions, they will tend to lead to the rights being used in the way which is the most valued, but only after deducting the costs involved in making these transactions. Transaction costs therefore play a crucial role in determining how the rights will be used". The mere existence of an externality (which in Coase's terms is simply defined as 'harmful effects') therefore "does not imply that there is a prima facie case for governmental intervention (taxation or regulation)". Sometimes, "if with governmental intervention the losses also exceed the gains from eliminating 'externality' it is obviously desirable that it should remain". It could happen that when externalities occur, "the only reason individuals and private organizations do not eliminate them is that the gain from doing so would be offset by what would be lost (including the cost of making the arrangements necessary to bring about this result)".

It comes out that the Coasean boundary between market decentralized exchange and governmental intervention (and, more generally, the choice among alternative

economic institutions) should be essentially referred to the dimension of transaction costs and to the potential distortions attributable to public centralized intervention. As some authors have noticed (Cooter 1987; Allen 1991, 2000; Usher 1998), under the Coasean framework, the notion of transaction costs could be expanded so as to include quite every potential source of market failure in allowing efficient bargaining over an externality, thus including not only all kind of ex-post transaction costs incurred in the exchange of given rights, but also all the ex-ante transaction costs incurred in the definition of rights and/or in contracting over the initial allocation of rights (Allen 1991, 2000). Cheung (1983), for instance, has argued that in the absence of transaction costs "the assumption of private property rights can be dropped without in the least negating the Coase Theorem".

Moreover, if one accepts the idea the property rights are well defined, then the only motivation for having a Pareto-relevant externality to persist over time should be found in parties' inability to reach any efficient ex-post trade. In this respect, the problem of internalizing externalities, in Coase's view, seems to be mainly associated with the problem of minimization of the ex-post transaction costs to be carried out in order to proceed toward an efficient market exchange of well defined property rights.

However, the original Coasean intuition outlined two separate assumptions for the Coase theorem to work: (1) zero transaction costs and (2) well-defined property rights. In turn, the latter question involves the following ones: who is entitled to define rights in the first instance? How is she selected? How are rights maintained and enforced over time?

If property rights are not well defined, then externalities in the form of reciprocal claims over rival uses do inevitably emerge, even in a world of zero ex-post transaction costs. In this case, externalities would be generated by ex-ante transaction costs to be carried out in order to define complete property rights.

As a consequence, the relationship between externalities and property in the Coase theorem turns out to be ambiguous as it seems to depend on the nature of transactions costs.

When the costs of defining ex-ante a system of complete property rights are prohibitive, then externalities do emerge as reciprocal claims over rival uses. When property rights are well defined, but ex-post transaction costs over the exchange of those rights are prohibitive, then the externality is depicted as the social waste of having a sub-optimal Paretian allocation (in this respect, the notion of externality would coincide with that of an inefficient market configuration).

Now, while it is reasonable to admit, according to Buchanan and Stubblebine (1962), that the process of internalizing a Pareto-relevant externality is always a Pareto improvement, it is controversial to say that any time we have a Pareto-relevant exchange we are solving a pre-existent externality.

Some confusion between these two distinct situations may be misleading for the joint analysis of both externalities and transaction costs. Indeed, some potential Pareto improvements could be inhibited in the market by relevant transaction costs, but the resulting status quo would not be 'an externality'.

Let us consider the following example. If Mr.*A* values the assets owned by Mr. *B* more than *B* does, but transaction costs reduce the expected benefits of Mr. *A* to a

point that Mr. *A* gives up, could then the missed Pareto-relevant exchange be depicted as an externality? At the same time, if *A* takes without consent the assets from Mr. *B*, it is clear that the negative effect for Mr. *B* is not 'an externality': it is 'a taking'. On the other side, if Mr. *A*'s use of the river in his land, which traverses also Mr. *B*'s property, is inhibiting a rival use of the river by Mr. *B* and if those rival uses were not clearly defined in either Mr. *A*'s or in Mr. *B*'s bundle of property rights, then an externality is certainly occurring.

It should not come as a surprise that the Coase theorem has been mainly studied under the lens of ex-post transaction costs, with the consequence of neglecting to investigate the role of ex-ante transaction costs in affecting the definition of property rights. The main consequence is that very few scholars have analyzed the role of transaction costs in generating 'incomplete property rights'.

Comparing the two Coasean stages implies, then, integrating two theories in one framework: the governance of incomplete contracting and the governance of incomplete property. While these two theories have been developed under two parallel and independent paths, we propose to integrate them in a unique framework. The next section outlines a simple model of incomplete contracts with incomplete property rights.

3 Hold-up and externality under a unified Coasean framework

In this section, we consider a standard model of hold-up in incomplete contracts where parties' specific investments are combined with productive assets.[2] We first consider the standard case with complete property rights and then will outline the case where assets are exposed to externality. We will show that parties' incentives to invest crucially depend on both authority assignment and the degree of completeness of property rights.

Let us assume a set of assets $A = (a_1, a_2)$, a set of contractual agents $M = (B, S)$, and a set of external agents $N = (K, L)$ using assets $X = (x_1, x_2)$. Let us focus fist on the bilateral relationship between *S* and *B*.

S (the seller), in combination with asset a_2, produces a single unit of a widget z which is acquired as an input by *B* (the buyer) at the price *P* or by a third party at a price *p*, with $P > p$, determined according to parties' contractual power.[3]

Let us assume that prior to trading, both *B* and *S* make a specific self-investment that enhances respectively the marginal revenue for *B* and reduces the marginal cost of production for *S*. The buyer, *B*, will combine her specific investment with asset a_1. The marginal return to the investments depends on whether or not trade occurs between *B* and *S*.

Investments are made at $t = 0$, and the widget is supplied at $t = 1$, that is, there is uncertainty about the type of the widget which *B* will require in $t = 1$. Let us

[2] The formalization is an extension from Hart (1995).

[3] Symmetrically, *B* can purchase the widget, either from *S* (specific-relationship), or from the spot market. In combination with own a_1, *B* uses this widget z to produce an output x that is sold on the output market.

define B's relationship-specific investment at $t = 0$ by $i - a$ non-negative number representing the level and cost of the investment; $R(i)$ denotes B's revenue with the trade and P is the agreed widget price.

If trade does not occur, B buys a 'non-specific' widget from an outside for price p and B's revenue is denoted by $r(i)$. In the same way, e represents the Seller's level and cost of investment, $C(e)$ the production cost with the trade and $c(e)$ the production cost outside the trade.

Under this setting, the capital letters represent the specific variables, while the lower case letters the non-specific (or market) ones.

When S trades with B, the net total surplus generated W is given by:

$$W = R(i|a_1) - P + P - C(e|a_2) - (i + e) = R(i|a_1) - C(e|a_2) - (i + e)$$

When S or B trade with third parties, the net total surplus w is given by

$$w = r(i|a_{21}) - p + p - c(e|a_2) - (i + e) = r(i|a_1) - c(e|a_2) - (i + e).$$

Let us assume[4] that there are always gains, namely a surplus, from trade between S and B[5], that is: $W > w > 0$.

Proposition 1 *When contracts are complete and rights over assets A are well-defined, efficient trade between S and B will always occur, with S and B choosing respectively the investment levels e* and i* that maximize W and satisfy the first order conditions:*

$$R'(i*; a_1) = 1 \tag{1}$$

$$\|C'(e*; a_2)\| = -1 \tag{2}$$

leading to an equilibrium on the Pareto frontier, determined according to parties' ex-ante contractual power.

Proof In a world with complete contracts and complete rights, the investment levels i and e, considering the net present value of the trading relationship W, are given by the first order conditions:

$$\frac{\partial R(i; a_1)}{\partial i} - 1 = R'(i*; a_1) - 1 = 0 \left\| \frac{\partial C(e; a_2)}{\partial e} \right\| - 1 = \|C'(e; a_2)\| - 1 = 0$$

Therefore, the optimal value i^* and e^* is given by (1) and (2).

Let us now turn to the case where contracts are incomplete, while property rights over A are complete.

In this case, a well-known result is that parties will choose their investments non-cooperatively, leading to equilibrium into the second best area and the Pareto frontier is not achieved. □

[4] Other three important assumptions are:
1. the parties are risk-neutral;
2. the parties have unlimited amounts of initial wealth;
3. the interest rate is zero.

[5] This condition shows the idea that investments i and e are relation-specific.

Proposition 2 *When contracts are incomplete, parties will underinvest.*

Proof We can calculate the quasi-rent (QR) of the investments in a world with contractual incompleteness:

$$QR^B = R(i) - P - [r(i) - p] > 0$$
$$QR^S = P - C(e) - [p - c(e)] > 0$$

By ex-post Nash bargaining, we obtain the net ex-post payoffs (where $a \in (0,1)$ is the buyer's bargaining power):

$$\begin{aligned} \prod^B - i &= r - p + a[R - C - (r - c)] - i \\ &= -p - aC + ac + aR + (1 - a)r - i \end{aligned} \tag{3}$$

$$\begin{aligned} \prod^S - e &= p - c + (1 - a)[R - C - (r - c)] - e \\ &= p - ac + (1 - a)R - (1 - a)C - (1 - a)r - e \end{aligned} \tag{4}$$

Differentiating (3) with respect to i and (4) with respect to e yields the following necessary and sufficient conditions:

$$aR'(i) + (1 - a)r'(i) = 1 \tag{5}$$
$$(1 - a)\|C'(e)\| + a\|c'(e)\| = 1$$

These first order conditions lead to a Pareto inferior equilibrium with respect to complete contractual conditions.

An important result in the literature of incomplete contracts [the so-called GHM approach, due to Grossman and Hart (1986) and Hart and Moore (1990)] shows the relevance of property rights assignment with respect to the degree of underinvestment in an incomplete contract framework.

According to this approach, the ownership of assets matters because it is assumed that it increases investors' ex-post outside options after investments are made. □

Proposition 3 (GHM) *When contracts are incomplete and assets' ownership increases investors' ex-post outside options after investments are made, the assignment of property rights is monotonic in parties' investment.*

Proof The result derives immediately from the assumption made:

$$R'(i;A) > r'(i;a_1,a_2) \geq r'(i;a_1) \geq r'(i;\varnothing)\ \forall i : 0 < i < \infty \text{ for } B$$
$$\|C'(e;A)\| > \|c'(e;a_1,a_2)\| \geq \|c'(e;a_2)\| \geq \|c'(e;\varnothing)\| \forall e : 0 < e < \infty \text{ for } S.$$

The agent investment level will increase (decrease) as the number of property rights in the set A, under his ownership, increases (decreases).

The intuition here is that ownership is a source of power since it assigns to the owner the residual right to control over non-contractible uses, even when trade occurs with third parties. The allocation of ownership over assets determines the returns to investments. As a consequence, ownership determines parties' incentives to choose the degree of specific investments. Property matters in this framework, but

the assignment of ownerhsip over assets only leads to second best outcomes, as non-owner's incentives to make relationship-specific investments is reduced. In order to reach the highest second best outcome, property rights should be assigned to those agents whose investment maximizes joint surplus.

One essential ingredient of the above result is that property rights are complete, that is, that the private value of assets in A is not exposed to externality. If property rights are weakly defined, a rival use over assets included in A could be claimed by other agents N, 'external' to the contractual relationship.

Let us assume, in the above framework, that after investments are made, an externality does emerge as rival uses over $A = (a_1, a_2)$, are claimed, respectively, by external agents K and L using assets $X = (x_1, x_2)$. In particular, let us assume that agent K's use of his own asset x_1 is rival with B's use of asset a_1, and that agent L's use of her own asset x_2 conflicts with agent S's use of a_2.

An externality does emerge when assets A and B are jointly used by agents A, B, K, L.

Let us also assume that Coasean bargaining over externalities may involve two levels of transaction costs to be borne by agents M: g for a_1, and h for a_2, with $g > h > 0$. It is assumed that g and h are the prices agents M have to pay, respectively, ex-post in order to exclude rival uses.

We thus have the following proposition. □

Proposition 4 *Assume that both contracts and assets are incomplete, and that an externality occurs over assets' ownership, after investments are made with transaction costs to be borne by agents M: g for a_1, and h for a_2, with $g > h > 0$. Assume also that asset owenership increases investors' ex-post outside options after investments are made. Then the assignment of property rights is monotonic in parties' investment only when the level of transaction costs to be borne by agents M to internalize the externality for each asset, are lower than the corresponding parties' outside options.*

Proof With transaction costs equal to g for a_1, and h for a_2, with $g > h > 0$, parties' payoffs become:

$$\begin{aligned} R'(i;A,X) - (g+h) &> r'(i;a_1,a_2;,x_1,x_2) - (g+h) \geq r'(i;a_1,x_1) - g \\ &\geq r'(i;\varnothing)\ \forall i : 0 < i < \infty \text{ for } B \text{ and} \\ \|C'(e;A,X)\| - (g+h) &> \|c'(e;a_1,a_2,x_1,x_2)\| - (g+h) \geq \|c'(e;a_2,x_2)\| - h \\ &\geq \|c'(e;\varnothing)\| \forall e : 0 < e < \infty \text{ for } S. \end{aligned}$$

It is easy to see that:

1. When $(g+h) \geq R'(i;A,X)$ or when $\|(g+h) \geq C'(e;A,X)\|$ externalities outweigh the gains from trade even under complete contracts, consequently, by anticipating this outcome parties will under-invest;
2. When $r'(i;a_1,a_2,x_1,x_2) - (g+h) \leq 0$ or when $\|c'(e;a_1,a_2,x_1,x_2)\| - (g+h) \leq 0$, the assignment of authority over both assets in incomplete contracts will not induce second best outcomes, as there are no gains from trade, once the externality is anticipated;

3. When $r'(i;a_1,x_1) - g < r'(i;\varnothing)$ or when $\|c'(e;a_2,x_2)\| - h < \|c'(e;\varnothing)\|$, the ex-post externality, when anticipated, will induce underinvestment. □

Proposition 4 simply shows how introducing externalities (i.e., joint claims over rival uses in incomplete property rights) in the standard incomplete contract framework may underpin the efficiency features of vertical integration.

The simple formalization above may suggest that when the level of transaction costs over externalities are low enough—so that $r'(i;a_1,a_2,x_1,x_2) - (g+h) \leq 0$ or $\|c'(e;a_1,a_2,x_1,x_2)\| - (g+h) \leq 0$—in order to preserve the value of specific investments within the transaction, parties might be induce to prevent externalities by expanding the 'dimension' of their property rights.

In other words, parties may want to prevent externalities by acquiring at $t = 0$, that is, before investments are made, all the possible assets B from the use of which an externality may occur ex-post. Consequently, when property rights are incomplete, in order to obtain the standard second best outcomes of the GHM approach, parties will be induced to include in the transaction the range of property rights from which a costly externality may emerge.

This implies that, under incomplete property rights, the joint surplus in an incomplete contract will also depend on the scope of the property rights embedded in the transaction.

The main lesson we can derive from our simple formalization is that when both contracts and property rights are incomplete to some extent, the 'centralization' of assets within the firm should be coupled with the 'aggregation' of all the relevant assets needed in order to prevent externalities. This outcome reveals a neglected function of the firm, under incomplete property rights: it acts as an 'aggregator' of property rights in order to centralize under a unified ownership all the potential rival uses that may interfere with the firm's core activities.

4 Conclusions: the Coasean firm as a nexus of incomplete rights?

Comparing the two 'stages' of the Coasean theory of transaction costs shows that a 'Coasean firm' would not only centralize incomplete contracts under a unified governance system, but it will also aggregate incomplete property rights under a unified ownership structure.

Surprisingly, while the literature on contracts is replete with all sorts of references to the reasons why the latter should be regarded as incomplete, scant attention has generally been paid to the circumstance that even property rights may not be fully definable ex-ante.

Indeed, whenever property is invoked, it tends to take the appearance of a fully defined object whose primary characteristics is that of securing full control over resources, thus promoting stability of expectations and incentives' alignment. Ownership is always assumed to be ex-post complete, irrespective of the ex-ante problems of definition (of rights over each possible use).

Introducing the notion of incomplete property in the Coase theorem has important consequences for the theory of the firm, as it combines the risk of hold-up with the risk of externality. This highlights the complementarity relationship between the process of 'public' definition of rights and duties and the role of the market in promoting efficient allocation of rights.

Under an incomplete property framework, the Coase theorem could be reformulated as follows: *if an externality occurs over undefined uses, and if ex-post transaction costs are zero, the (re)definition of rights over rival uses will always lead to ex-post efficient allocation of newly defined rights*.

In this respect, if the ex-ante transaction costs to define rights are zero, and ex-post transaction costs to exchange rights are negligible, then the market mechanism by itself will lead resources to the most efficient use of rights. However, when ex-ante transaction costs are relevant, the market may perform well only if a system of rights definition is implemented.

There are at least two ways of (re)defining property rights. The first is the unification of property's bundles through market exchange ('property rights aggregation'). The second is to publicly define new rights, through a process of bundling and unbundling of rival uses from which the externalities emerge ('definition of partitioned property rights'). As a consequence, in the latter case, market performance in allowing ex-post efficient allocation goes hand in hand with society's ability to define property rights.

However, property incompleteness may also suggest that decisions to vertically integrate may derive not only from the analysis of compared transaction costs of *make* versus *buy*, as in Coase (1937), but also on the dimension and on the direction of ex-post transaction costs to be incurred in order to properly define a right over a rival uses between 'neighboring' property rights.

In other words, the owner of the firm can be induced to 'buy' all the assets over which someone else's use may produce an externality, when those rights are undefined. The nature of the firm thus is also affected by the degree of completeness of property, in the sense that integrating rival uses under the same ownership minimizes the potential for externalities. Thus the optimal dimension of property may depend, not only on the ex-post transaction costs of enforcement as in the Williamsonian framework, but also on the ex-ante and the ex-post transaction costs of definition of rights. The above argument implies that, with incomplete property, transactions could be plagued by the emergence of externalities in a world of complete contracts. This suggests that the efficient allocation of property rights may also be affected not only by owners' ability to efficiently use their core rights, but also by their ability to cope with externalities when they arise.

In Williamson (1985, 1996), for instance, the emergence of private orderings characterized by the 'forbearance' role of the manager who maintains the authority over firm's assets is instrumental to the overcoming, for a given transaction, of the inefficiencies related to the incompleteness of contracts. However, since externalities may raise the need of publicly (re)defining property, the role of 'forbearence' may extend also to the process of presumptive rights' definition in private orderings among corporate constituents.

This paper surely raises more questions than it solves. In particular, we suspect that making explicit the intrinsically incomplete nature of property may have deep consequences for the theory of efficient allocation of property and of the optimal dimension of economic organizations.

We propose some preliminary thoughts on this issue, although a comprehensive understanding of it is outside the scope of this paper. Similarly, issues of governance deserve much more attention than is presently the case. Hopefully, future work might address these deficiencies.

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