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Optimal Contract Design with Unilateral Market Option

By Antonio Nicita and Simone Sepe

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Antonio Nicita
Simone Sepe

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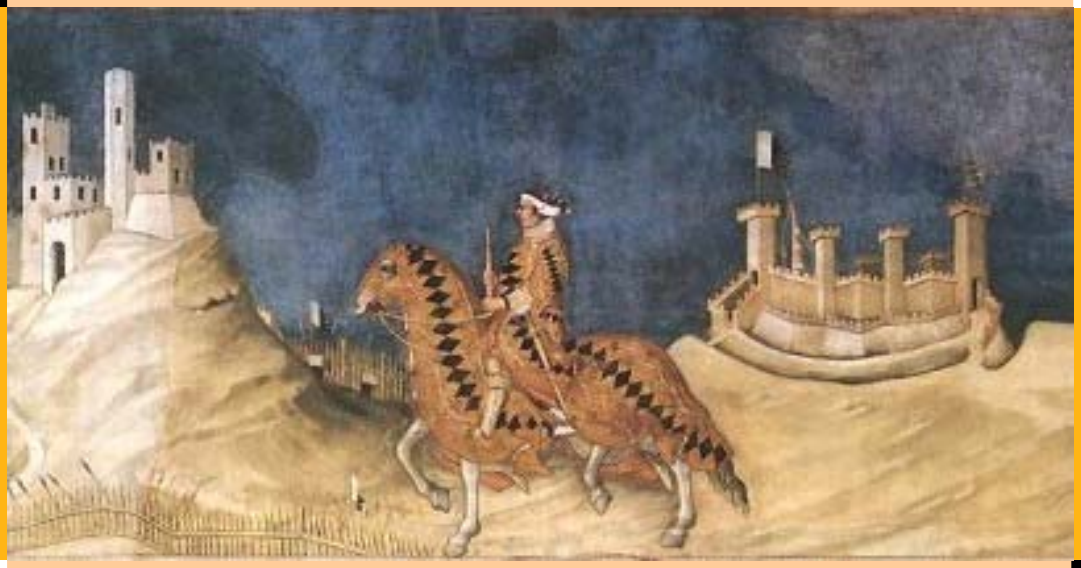

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Abstract - Contrary to previous literature, we show that the assignment of authority decision matters in optimal contract design with bilateral specific self-investments. This is the case when we enlarge the set of the states of nature, to explicitly consider the event that a party's market option turns out to be binding ex-post. We show that, under this setting, simple contracts protected by specific performance remedies may generate hold-up and thus parties' incentives to under-invest. However, investment efficiency is enhanced when authority is assigned to the party with ex-post binding market option. Our results suggest a neglected rationale for vertical integration as a remedy against hold-up.

JEL-Classification: K12, L22, J41, C70.
Keywords: incomplete contracts, outside options, mechanism design

Antonio Nicita, Dept. of Economics University of Siena, nicita@unisi.it

Simone M. Sepe, University of Arizona, J.E. Rogers College of Law, Simone.Sepe@law.arizona.edu

1 Introduction

In this paper we analyze the role of ex-post market options on hold up and incentives to invest, within an incomplete contract framework, sustained by bilateral specific investments and based on optimal contract design.

The literature on the hold-up problem has played a major role in our understanding of the dynamics of institutions. The boundaries of firms and the performance of hybrid governance systems, the role of the allocation of ex-post decision rights (authority) as alternative tools to enhance investment efficiency relative to a bilateral trade, have been deeply analyzed under the lens of the incomplete contracts literature (Williamson (1985, 1996, 2005), Klein, Crawford and Alchian (1978), Grossman and Hart (1986), Hart and Moore (1990) and Hart (1995)). One important result of standard literature is that, under incomplete contracts, 'authority matters', as having ex-post decision rights induces right-holders to optimally invest, while non-owners will under-invest.

Another stream of literature has focused on mechanism design as a way to overcome the hold-up problem through simple contractual mechanisms (Aghion, Dewatripont and Rey (1994), Chung (1991), Rogerson (1992), Edlin and Reichelstein, 1996). The main result reached by this approach is that, in a bilateral relationship sustained by specific self-investments, an implementation mechanism could be designed so as to perfectly align both parties' incentives toward efficient investment levels. An important consequence is that the allocation of ex-post decision rights is irrelevant in order to obtain the first best.

One common feature of the above approaches is the exclusive focus on bilateral trade situations, where the outside market is taken as exogenously given. One limitation of these approches, is that in real world trading exchanges, the degree of specificity and the relevance of hold-up rest pretty much a matter of contract-market interactions, rather than the exogenous result of a 'technological' constraint, as generally depicted in the literature (Spulber, 2002, 2009).

However, as Ishiguro (2009) recently pointed out, the above approaches "have ignored the interactions between the holdup problem in a bilateral trade and the market environments which govern the processes of arriving trading opportunities such as how trading parties find alternative partners when current negotiation fails". The main consequence is that the analysis of how the holdup problem affects and is affected by market competition and trading processes in markets, is still in its infancy (MacLeod and Malcomson, 1993;

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Edlin and Hermalin, 1998; de Meza and Lockwood, 1998; Felli and Roberts, 2002; Chatterjee and Chiu, 2007; Nicita and Sepe, 2010).

In this paper we make a first step to fill this gap, by studying the impact of a unilateral market option in an incomplete contract sustained by bilateral specific self-investments. In particular, we focus on the 'Chung-ADR' contractual framework (Chung (1991), Aghion, Dewatripont and Rey (1994)), based on specific performance protection as parties' default option in the renegotiation game.

We show that the existence of a market option for one party affects parties' incentives towards efficient investments unless ex-post decision rights are given to the party whose market option is binding. Thus, we argue that, when the states of nature affecting the market environment are taken into account, authority matters. Specifically, we argue that, in the framework we study, authority should be given to the party *less* specific ex-post, a conclusion which reverses some of the lessons derived by both the property rights approach and the mechanism design approach.

Our conclusion may provide new insights towards another rationale – beside traditional ones - for having (quasi)vertical integration under incomplete contracts: vertical integration may derive from the necessity to gain full control of a counterpart's market option. A motivation which is independent of the 'internal' incentives towards hold-up, depending on the realization of (the degree of) market competition. We leave this further explorations to future research.

The paper proceeds as follows. In section 2, we discuss the relevance of the ex-post market environment in an incomplete bilateral trade sustained by specific investments. In section 3, we extend the Chung-ADR, introducing the case of a seller's market option and obtaining our main results. In section 4, we briefly discuss the results and conclude.

2 Motivation

Let ask why should it be relevant to study the interactions between the hold-up problem in a bilateral trade and the market environments where trading parties may find ex-post alternative partners. A first answer relies on the circumstance that, being the degree of specificity determined by the ex-post rate of asset redeployability outside the relationship, this degree could be endogenous rather than exogenous, depending on the evolution of trading opportunities. Thus, for any given investment choice, what is 'specific' at t_0

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may become 'generic' at t_1 and vice-versa, simply because parties' market opportunities may change meanwhile. From one side this mitigates the hold-up problem, as the degree of specificity faced by investors today may be reduced ex-post as the market for specific inputs expands. From the other, hold-up could be well the result of a market shrinkage, independently of the technological nature of the investment made.

Let us report one nice example, among other, where ex-ante non-contractible specific investments on the seller's side turned out to create a new dedicated demand ex-post. Early in 90's Industrial Light & Magic (ILM) was a leading company specialized in motion picture visual effects, among which *Star Wars, Star Trek, Terminator*. Silicon Graphics Inc. was a maker of high-end graphics workstations. Silicon Graphics Inc. signed an agreement with Industrial Light & Magic to use its graphics computers to create the dinosaurs for *Jurassic Park*. As Shapiro and Varian (1999) refer, Silicon Graphics "hoped to showcase its workstations and spur future sales". Since a SGI Crimson system with the three-dimensional file system navigator appeared in the 1993 movie *Jurassic Park*, for eight consecutive years, all films nominated for an Academy Award for Distinguished Achievement in Visual Effects were created on Silicon Graphics computer systems. Thus what was initially a specific investment made by Silicon Graphics, turned out soon to 'create' a market, reducing, in fact, the degree of specificity ex-post.

Shapiro and Varian (1999) report many cases in which initial specific investments in the ICT sector turned out to create a standard or at least to induce additional demand. These authors actually point out that making specific investments toward a 'big' counterpart may generate one side the risk of 'internal' hold-up, but on the other they can also spur sales, when it is possible 'to capture valuable business from others who will pay a premium for your products'. Of course, the opposite it is also true: a generic investment may turn out to become specific, if ex-post the market shrinks or is monopolized. In the *Microsoft II* case in Europe, many software developers alleged that the bundling of Windows Media Player with Windows PC OS would have obliged them to produce only programs specific to Windows PC OS, as the effect Microsoft market foreclosure. Thus, in this case, it was the reduction of market opportunities that affected the degree of asset specificity, rather than the opposite.

Beside the ICT markets, the relevance of market evolution for our understanding of the hold-up problem seem having characterized actually even the well-known and highly debated textbook case referred to the *Fisher Body/General Motors* merger. A full understanding of that case should indeed take into account the huge and unexpected explosion of new demand

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for closed bodies before the merger.

In 1919, Fisher Body signed with General Motors a ten-year term contract for the supply of closed metal auto bodies, containing several provisions aimed at protecting Fisher Body against hold-up by General Motors. A first safeguard was given by a *de facto* exclusivity clause which obliged GM to buy all of its closed metal auto bodies from Fisher. Moreover, the contract defined a pricing formula for auto bodies based on a cost-plus rule according to which the final price was determined by labor and transportation costs plus a mark-up to cover capital costs. Other two contractual clauses (most-favored nation clause and meeting-competition clause) were aimed at preventing Fisher Body from exploiting its contractual power against General Motors. Between 1919 and 1924, however, the market registered a huge and unforeseen change in demand: wooden bodies were rapidly replaced by metal auto bodies, where the Fisher brothers were the market leaders. This exogenous change in the nature of demand for automobile bodies contrasted with the original pricing provisions contracted upon by General Motors and Fisher Bodies that proved to be too high for metal bodies. Fisher Body refused to renegotiate the pricing formula and to satisfy General Motors' request to locate Fisher plants next to its plants, so as to reduce transportation costs at least.

According to Klein, Crawford and Alchian (1978), this refusal to renegotiate constituted a hold-up behavior by FB. Some recent articles[1] have deeply contrasted the traditional explanation of FB/GM vertical integration. According to Coase (2000, 2006), the real story of FB/GM was rather different: (i) what FB acquired in 1926 was the 40 percent share of FB's shares that it did not already own, having acquired 60 percent of FB's shares in 1919; (ii) FB did not locate its plants far away from GM's assembly plants. As a consequence, in Coase's view "there is no evidence that hold-up occurred".

On the same lines Freeland (2000) has observed that 'the contractual problems that GM and Fisher experienced in 1924 [...] were directly linked to the possibility of the Fisher brothers' departure and had nothing to do with Fisher taking advantage of the cost-plus pricing clause in the existing contract". Freeland (2000) in particular stresses the relevance of "GM's desire to prevent competitors from using Fisher's services" as one of the main factors inducing the complete acquisition of FB: "These fears were magnified in mid-1919, when Fisher obtained its largest order for closed bodies ever from Ford. Fearing that Ford was experimenting with closed bodies on the

[1]Casadeus-Masanell and Spulber (2000), Coase (2000, 2006), Freeland (2000), Nicita and Sepe (2010).

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inexpensive Model T, GM management worried that they were about to fall further behind their primary competitors in an important strategic area". Thus, the empirical test of fact-finding on the General motors/Fisher Body saga, suggests that, in fact, at the origin of the merger there was the circumstance that the degree of specificity of Fisher Body, and mainly of Fisher brothers, decreased over time as the market for closed body cars exploded, enhancing then the market opportunities of the Fisher brothers.

The examples we mentioned above, simply suggest that many real trade situations hardly take place on a dichotomic environment, with either (full) generic or (full) specific investments. As Williamson (2005) finally recognised, asset specificity is a matter of degree as "the key factor in determining whether a large numbers supply condition will evolve into a bilateral exchange relation is the degree to which the transaction in question is supported by durable investments in transaction-specific assets". Spulber (2009) recently argued that what really makes an investment transaction-specific is not defined by the properties of its capital equipment or human capital, rather it depends on the buyer's and seller's ability to change actual trading partners. The way in which actual and potential market opportunities could be explored and taken, clearly affects parties' bargaining power in a contract and thus parties' incentives to invest.

This means, in turn, that, under an incomplete contract, the analysis of the impact of post-contractual market opportunities on parties' incentives, is crucial for a full understanding of the hold-up problem. This particularly holds when assessing the optimality features of the remedies, contractual mechanisms and organizational designs that parties may adopt to deter hold-up and, consequently, under-investment choices.

In this paper we make a first step to fill this gap by investigating the role of the ex-post realization of unilateral market opportunities within the optimal contract design framework defined by Chung (1991) and Aghion, Dewatripont and Rey (1994), which is a degenerated case of the environment analyzed by Edlin and Reichelstein (1996).

The Chung-ADR contractual scheme assumes that one party (say the buyer) is the residual claimant of the relationship and that parties may choose the initial allocation so as to give the other party (the seller) the right incentives to invest. The initial allocation involves a positive level of trade so as to make it costly for the seller to underinvest. Given that the seller is induced to make the efficient investment, the buyer - who is the residual claimant - will also invest efficiently. The first best investment levels will be therefore implemented. This outcome is reached, regardless of the allocation of the ex

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post decision rights.

We depart from the Chung-ADR contractual scheme, by introducing another form of uncertainty, beside that affecting 'internal' gains from trade. Specifically, we explicit the uncertainty over the market environment which affects trading parties' opportunity to find ex-post alternative valuable partners, at the time when renegotiation occurs.

It turns out that such an extension dramatically affects the optimality features of the Chung-ADR contractual scheme. We consider the case in which the fixed claimant party - assumed to be the seller - has an ex-post binding market option. We characterize this as a random contract that a new buyer propose to the seller, asking for a greater quantity than that assured by specific performance.

A first result we obtain is that the existence of an ex-post market option on the seller's side (fixed claimant), induces a failure of the Chung-ADR contractual scheme: the seller will over-invest and the buyer will under-invest. Moreover, there is no contractual mechanism which may induce parties to restore efficient investments, relative to the contract.

This means that, once we remove from the standard contractual framework the assumption that outside markets are exogenously given, there is at least a case where hold-up may still occur, inducing the vulnerable party to under-invest.

A second result we reach is that an appropriate allocation of the ex post decision rights may deter a party's under-investment and mitigate the other party's over-investment, thus increasing overall efficiency. Specifically, we argue that when the party with ex-post binding market option is the fixed claimant party, then it is efficient to revert the allocation of ex-post decision rights.

We then conclude, that under a unilateral market option, it is always efficient to assign the ex-post decision rights to the party for which the market option esists, i.e. to the party less specific ex-post. This is a quite important result, as it reverses one of the main conclusion reached by the mechanism design approach to incomplete contract: 'authority' - i.e. the allocation of ex-post decision rights - matters for efficiency even under an optimal contract design, once we extend our institutional environment in order to take into account contract-market interactions.

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3 The Model

The contractual environment we study involves two parties, a buyer and a seller, assumed to be risk neutral. In order to generate a joint surplus, parties have to make ex-ante specific (self)investments, under an uncertain environment. Since investments are observable but unverifiable, parties can agree ex-ante only on a contractual scheme involving a default option and a renegotiation procedure. The default option implies a specific performance remedy over a pair of quantity and price levels. The renegotiation procedure is shaped as a bargaining game with outside options, alternate offers, and penalities such as to induce parties to reach an immediate equilibrium in the first stage.

As a consequence, in the renegotiation game, the proponent has all the bargaining power over the renegotiation surplus and the respondent has the right either to accept, or to enforce the specific performance, or to go to the next round, where she will be the proponent. As the random variable is revealed, affecting the buyer's value and the seller's cost, parties may renegotiate on agreed upon terms whenever it is ex-post efficient.

3.1 Basic Framework

Our basic framework refers to the Chung-ADR contractual scheme. Two agents, the buyer (B), and the seller (S) sign an incomplete contract over a bilateral trading relationship, which defines parties' default options and a renegotiation procedure. Ex-ante maximization of joint surplus requires parties to make bilateral specific self-investments, equal to $i \in I \subseteq R^+$ for the buyer and , $j \in J \subseteq R^+$ for the seller. Investment decisions occur at t_1 in an uncertain environment, as the value and cost functions, respectively, of the buyer and the seller, are only known ex-post. At t_2, after the investments are made, uncertainty is solved by the realization of a random variable $\theta_1 \in \Theta_1 \subseteq \mathbb{R}^n$, where Θ_1 is a compact set describing all the contingencies related to the 'contract'.

Contractual timeline is as following: parties meet at t_0 and sign a simple contract Γ which defines default options and the renegotiation game; bilateral investment are chosen at t_1, whereas the realization of a θ_C occurs at t_2 ; trade occurs only once and takes place no sooner than t_3, with $t_3 > t_2 > t_1 > t_0$. After t_2 and before t_3 renegotiation may take place.

The simple contract Γ is a pair $(q,t)_{\theta_1 \in \Theta_1}$, of quantity $q \in [0, q^{max}]$ and transfer $t \in \mathbb{R}^+$, with $\Gamma \in [0, q^{max}] \times [\mathbb{R}^+]$. The information structure is

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mutual knowledge. In particular, investments (i, j) are observable but non-contractible; parties know the distribution of θ_1, $F(\theta_1)$, and its support Θ_1. Thus, the contract Γ cannot directly specify investment targets, nor can it make trade contractually contingent upon the realization of the random variable θ_1. The gross monetary benefit to the buyer is given by $v(q,\theta_1, i)$, whereas the gross monetary cost to the seller is given by $c(q,\theta_1, j)$, where $v(.)$ and $-c(.)$ are concave and twice differentiable in all arguments, with $v(.) > c(.)$, $\forall\theta_1 \in \Theta_1$. That means that trade is always desirable.

Parties investment cost functions are $h_B(i)$ for the buyer and $h_S(j)$ for the seller, which are assumed to be convex. Von Neumann-Morgenstern utilities-for the buyer and the seller are given, respectively, by:

$$U_B(\Gamma, i,\theta_1) = v(q,\theta_1, i) - tq - h_B(i) \tag{1}$$

$$U_S(\Gamma, j,\theta_1) = tq - c(q,\theta_1, j) - h_S(j) \tag{2}$$

As it is standard to assume in the related literature, $v_{qi} > 0$, $c_{qj} < 0$, $v(0, \theta_1, i) = 0$, $c(0, \theta_1, j) = 0$, and Inada conditions hold.

Following the Chung-ADR contractual scheme, we assume that parties can design a 'specific performance' contractual mechanism which specifies the 'default option', $\overline{\Gamma}(\overline{q}, \overline{t})$, that parties can individually enforce at the renegotiation stage. Once θ_1 is realized at t_2, a renegotiation game, RG, starts: in stage 1, one party, say the buyer, can make an offer (q, t) to the seller; in stage 2, the seller either accepts the offer, inducing a trade to take place at these terms, or rejects it. When the offer is rejected, either the default contract $\overline{\Gamma}$ is enforced or another bargaining round starts, in which the proponent and the respondent switch their roles. At each round of the renegotiaton game, parties incur in a loss given by the depreciation of the collaterals, offered as 'contractual hostages' (Aghion, Dewatripont and Rey, 1994).

An important result of such literature is that this mechanism implements the first best. Let us define $r(\overline{\Gamma}, RG)$ the contractual scheme which includes the default contract $\overline{\Gamma}(\overline{q}, \overline{t})$, and a renegotiation game RG which gives the buyer all bargaining power (α=1), $\alpha \in [0, 1]$. The buyer thus has the ex-post decision rights over the renegotiation game and can make a take-it-or-leave-it offer to the seller; the seller has the right to accept it, either to reject and obtain the specific performance, or to go for the next renegotiation round, when she will be the proponent, and so on. A straighforward application of the Nash bargaining solution with alternate offers and outside options to this game (Osborne and Rubinstein, 1990), implies that an equilibrium will be reached immediately at the first stage, with the respondent (the seller) obtaining his outside option (the agreed upon default option $\overline{\Gamma}(\overline{q}, \overline{t})$)

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and the proponent (the buyer) being the residual claimant over the entire renegotiation surplus.

Proposition 1

Under the contractual scheme $r(\overline{\Gamma}, RG)$ *the equilibrium pair investments are the first best levels* $(i^e, j^e) = (i^*, j^*)$.

For a formal proof see Chung (1991), Aghion, Dewatripont and Rey (1994). The intuition for the proof works as follows. We are interested in showing that, given the ex-post final allocation $[(q(i, j, \theta_1), t(i, j, \theta_1)]$ at t_3, the efficient Nash equilibrium investments (i^e, j^e) are those which maximize the buyer's and the seller's utilities, i.e. (i^*, j^*).

Let us consider first the seller's problem. Define the investment equilibrium j^e as:

$$j^e = argmax_j \int_{\Theta_1} \left[t^d q^d - c(q^d, \theta_1, j)\right] dF(\theta_1) - h_S(j) = j^* \tag{3}$$

where (q^d, t^d) are the default values agreed upon by parties at t_0. By the implicit function theorem it is possible to express j^e as a continuous function of q, obviously with $dj^e/dq^d > 0$. Since $j(0) = 0$ and $j(q^{max}) > j^*$, the intermediate value theorem assures that there exists a value $\overline{q}$ such that $j^e(\overline{q}) = j^*$.

Defining U_S the seller's ex-ante reservation utility, it is possible to find a transfer $\overline{t}$ such that $\overline{t}\overline{q} - c(\overline{q}, \theta, j^*) - h_S(j*) = \overline{U}_S$. Thus the default contract $\overline{\Gamma}(\overline{q}, \overline{t})$ assures that the seller will select the efficient specific investment. Choosing a proper initial quantity will ensure that the seller mantains the right ex ante incentives to invest, solving thus one side of the hold-up problem.

The other side is solved by the assumption made on the renegotiation game, which allocates all the bargaining power to the buyer. The buyer's problem then becomes:

$$Max_\Gamma \left[v(q, \theta_1, i) - tq - h_B(i)\right] \tag{4}$$

s.t. $tq - c(q, \theta_1, j) - h_S(j) \geq \overline{t}\overline{q} - c(\overline{q}, \theta_1, j) - h_S(j) = \overline{U}_S$

Then the value i^e that solves (3) is such that $i^e = i*$.

In other terms the buyer is the residual claimant over the renegotiation surplus RS, which is defined as follows:

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$$RS(\overline{q},\theta_1, i, j) = v(q^*, \theta_1, i) - c(q^*, \theta_1, j) - [v(\overline{q},\theta_1, i) - c(\overline{q},\theta_1, j)] \quad (5)$$

Given RS, the buyer's utility could also be written in the following way:

$$U_B(\overline{\Gamma}, \theta_1, i) = v(\overline{q},\theta_1, i) - \overline{t}\overline{q} + \alpha RS(\overline{q},\theta_1, i, j) - h_B(i). \quad (6)$$

where $\alpha \in [0, 1]$ is the buyer's bargaining power. In the Chung-ADR framework, being $\alpha = 1$, the buyers is residual claimant in the compact set Θ_1.

Since the structure is symmetric, the same argument applies to the inverted case where the seller acts as a residual claimant. An interesting feature of the Chung-ADR contractual scheme, is the *irrelevance result* concerning the allocation of ex-post decision rights as a condition to induce efficient investments: it does not matter who has the authority, it is only necessary that one side is residual claimant whereas the respondent has a binding default option in the renegotiation game.

3.2 Contractual Design with Unilateral Market Option

The Chung-ADR framework is generally focused on the analysis of the impact of uncertainty on contractual gains from trade, i.e. on parties' internal gains from contracting with the counterpart. It is generally assumed that such uncertainty never entails parties opportunities outside the contract. Here we remove this assumption, so as to include in the states of nature, also the changes occured in parties' market opportunities, after investments are made.

We are then interested in analyzing how the introduction of ex-post market opportunities in the Chung-ADR framework, affects the optimal contract design and thus parties' incentives to select efficient investment levels.

Let us assume that, in the above framework, where the seller is the fixed claimant party and the buyer is the residual claimant one, a market option exists for the seller.

We define the seller's market option as a new market opportunity revealed at t_2, after investments are made. The seller's market option depends on the realization of a random variable $\theta_2 \in \Theta_2 \subseteq \mathbb{R}^m$, which completely describes all the possible market opportunities for the seller, after investments are made. For simplicity's sake we assume that $Cov(\theta_1, \theta_2) = 0$.

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One way to figure out the case of the seller's market option is another buyer asking ex-post for a quantity $q(\theta_2) > \overline{q}$ at a price $t(\theta_2)$. Given the specific performance rule, which allows the buyer to enforce at any time the default contract $\overline{\Gamma}$, the residual quantity that the seller could switch to third parties in the market is given by $q(\theta_2) - \overline{q}$. Thus the seller's market opportunity $\widetilde{X}_S$ generates a random contract $\Gamma(\theta_1, \theta_2)$.

As a consequence, a market option for the seller does exist if and only if: (i) the market opportunities require a quantity exceeding the default level $\theta_2 : q(\theta_2) > \overline{q}$, and (ii) the market transfer, $t(\theta_2)$ is such that the extra net utility of the seller due to her market opportunity is greater than zero. In other words, since the seller has a granted default option, the market option should allow her to gain a pair (q, t) which generates an extra rent relative to the contract. The information structure over θ_2 is common knowledge, parties know the distribution of θ_2, $F(\theta_2)$, and its support Θ_2.

Let us define the value of the market opportunity as following.

Lemma 1

The seller's market option identifies the seller's extra net utility exceeding the parties' default option. It is given by:

$$\widetilde{X}_S = \text{Max}\left\{0; \left[t(\theta_2)\left[q(\theta_2) - \overline{q}\right] - \left[c(q(\theta_2), \theta_1, j\right] - c(\overline{q}, \theta_1, j)\right]\right\} \qquad (7)$$

Proof

It is strightforward to see that, given the seller's default option, $X_S(\overline{q}, \theta_1, \theta_1, j)$ could never be lower than zero, i.e. it could never transfer to the seller a net utility lower than the one the seller would have obtained by serving the original buyer. Any value exceeding the default option (the seller would have obtained within the contract and has to paid to the buyer in case of contractual switch) constitutes the extra net utility generated by a sale of a quantity $[q(\theta_2) - \overline{q}]$ at a price $t(q_2)$.

□

We are interested in analyzing how the result of Proposition 1 is affected by the introduction of the seller's ex-post market opportunity into the Chung-ADR contractual scheme. Under the new framework the buyer's utility and seller's utility become, respectively:

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$$U_B(\overline{\Gamma}, \theta_1, \theta_2, i) = v(\overline{q},\theta_1, i) - \overline{t}\overline{q} + \alpha RS(\overline{q},\theta_1, i, j) - h_B(i) \tag{8}$$

$$U_S(\overline{\Gamma}, \theta_1, \theta_2, j) = \overline{t}\overline{q} - c(\overline{q},\theta_1, j) + X_S(\overline{q},\theta_1, \theta_2, j) - h_S(j) \tag{9}$$

where α is defined as follows.

Lemma 2

Given $X_S(\overline{q},\theta_1, \theta_2, j)$, under (8) and (9), the buyer's bargaining power becomes $\alpha = Max\left\{0, \left[RS(q,\theta_1, i, j) - \widetilde{X}_S\right] / RS(q,\theta_1, i, j)\right\}$.

Proof

It is straighforward to see that: (i) $X_S(\overline{q},\theta_1, \theta_2, j)$ being the new seller' outside option, defined as in (7), is greater than the seller's default option, thus reducing the buyer surplus when it is greater than zero; (ii) when $RS(q,\theta_1, i, j) = \widetilde{X}_S$, the dimension of the seller's outside option is such to allow the seller to extract all the renegotiation surplus, thus $\alpha = 0$; should the seller decide to stay in the contract he will obtain a greater quantity at a lower price than the one agreed upon (hold-up); (iii) when $RS(q,\theta_1, i, j) < \widetilde{X}_S$ the seller will prefer to sell the quantity $[q(\theta_2) - \overline{q}]$ at a price $t(q_2)$ to 'the market', the specific peformance rule assures that the buyer will obtain the default option; thus the buyer's bargaining power could never be negative, and $\alpha \in [0, 1]$.

□

Then we have the following proposition.

Proposition 2

Under any contractual mechanism $r(\overline{\Gamma}, RG)$, when a market option for the fixed claimant party exists: (i) the fixed claimant will over-invest relative to the contract; (ii) the residual claimant will under-invest relative to the contract; and therefore (iii) the pair of efficient investments will never be a Nash equilibrium.

Proof.

The proof is developed in three parts, considering the case of the seller being the fixed claimant party and consequently the buyer as the residual claimant.

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We will show first, the seller's over-investment and then the buyer's under-investment. Finally we will show an impossibility result for any simple contract r to induce efficient bilateral investments when a market option for the seller exists.

a) *Seller's over-investment*

To show why the seller will over-invest relative to the contractual mechanism r, when a market option for the seller exists, recall first the benchmark case with the seller's investment equilibrium without market option. Recall that from (3) we have:

$$j^e \equiv argmax_j \int_{\Theta_1} \overline{t}\overline{q} - c(\overline{q},\theta_1, j)dF(\theta_1) - h_S(j) = j*.$$

When a market option exists, the above equation becomes:

$$\widehat{j}^e \equiv argmax_j \int_{\Theta_1}\int_{\Theta_2} \left[\overline{t}\overline{q} - c(\overline{q},\theta_1, j) + x_S(\overline{q},\theta_1,\theta_2, j)\right] dF(\theta_1)dF(\theta_2) - h_S(j) \tag{10}$$

Expanding $\widetilde{X_S}$, and integrating over q the market option in differential form, the above equation becomes:

$$\widehat{j}^e \equiv argmax_j \int_{\Theta_1}\int_{\Theta_2} \left[\overline{t}\overline{q} - c(\overline{q},\theta_1, j) + \left\{\int_{\overline{q}}^{q(\theta_2)} t(\theta_2) - c_q(y,\theta_1, j)dy\right\}_{I:X_S\geq 0}\right] dF(\theta_2)dF(\theta_1) - h_S(j) \tag{11}$$

By optimality of j^* and since $\widetilde{X_S}$ is not equal to zero $wp1$ then $\widehat{j}^e \neq j^*$. In particular, $\widetilde{X_S}$ is strictly positive in the set A:

$$A = \left\{\Theta_1 \times \Theta_2 : (q(\theta_2) > \overline{q}) \wedge \left(\int_{\overline{q}}^{q(\theta_2)} \left[t(\theta_2) - c_q(y,\theta_1, j)\right] dy > 0\right)\right\} \tag{12}$$

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Since, (i) $-c_q(y,\theta_1,j)$ is increasing in j by assumption, and (ii) $\mu A > 0$ by construction, then $\widehat{j}^e > j^*$. Thus the result of seller's over-investment is proven.

b) *Buyer's under-investment*

Let us now show why the buyer will under-invest under r when a market option for the seller exists. Recall the definition of the renegotiation surplus, RS, in (4). While in the Chung-ADR scheme α is assumed to be equal to 1, being determined by the renegotiation procedure and independent of investments, default contract and random variable, here $\alpha(\overline{q},\theta_1,\theta_2,i,j)\in[0,1]$ is defined as $\alpha = [RS(q,\theta_1,i,j) - X_S]/RS(q,\theta_1,i,j)$. Also, recall the definition of the set A in (13). The buyers' equilibrium investment is given by:

$$\widehat{i} \equiv argmax_i = \int_{\Theta_1}\int_{\Theta_2} [v(\overline{q},\theta_1,i) - \overline{t}\overline{q} + \alpha\,(\overline{q},\theta_1,\theta_2,i,j)\,RS]\,dF(\theta_2)dF(\theta_1) - h_B(i) \leq i* \quad (13)$$

Since $i^*$is $argmax$ where $\alpha = 1$ w.p.1 , here the buyer is *state contingent residual claimant*. Indeed in the set A, with $\mu A > 0$, $\alpha < 1$ always applies. As a result, the buyer will under-invest, with $\widehat{i}^e < i^*$.

c) *The impossibility result*

We are now ready to prove the final part of Proposition 2, showing that, under any r when a market option for the seller exists, there is no equilibrium pair with bilateral efficient investment levels. It is sufficient to osberve that, in our framework, the seller and the buyer mantain opposite incentives towards the preferred level of the default value $\overline{q}$ which induces efficient investments.

As to the seller, in order to induce her to select j^* when a market option exists , parties should define a default quantity $\widehat{q} < \overline{q}$ such that the $argmax_j$ of equation (12) is j^*. The existence of a level $\widehat{q} < \overline{q} : \hat{j}^e(\widehat{q}) = j^*$ is assured by the implicit function theorem. Thus to induce an investment level j^* on the seller's side, parties should decrease the default quantity in the contractual scheme r, from $\overline{q}$ to $\widehat{q}$. However, on the other side, having such $\widehat{q}$ does increase the probability of having a binding seller's market option, as the

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range of values $q(\theta_2) - \widehat{q}$ is greater than $q(\theta_2) - \overline{q}$, which further exacerbates the buyer's incentives to under-invest.

As to the buyer, the only way for inducing the buyer to efficiently invest, would be imposing a default quantity in the contract which reduces to zero the probability of having a binding seller's market option and to restore a maximal buyer bargaining power, $\alpha = 1$, i.e. to fix the default option at its highest level, $\overline{q} = q^{max}$, which by Inada conditions is not sustainable as, in the most favourable case, it generates no gains from trade.

□

An important result we introduce at this point refers to the intuition that, under r, when a market option exists for a fixed claimant party, by inverting the assignment of 'authority' in the previous contractual framework, we may reduce distortion in investments. Thus, we conclude that, in our framework, contrary to the Chung-ADR conclusion, authority matters for optimal contract design.

Proposition 3

Under any contractual mechanism $r(\overline{\Gamma}, RG)$, when a market option exists for one party, the assignment of ex-post decision rights to that party enhances investment efficiency relative to the contract.
In particular, (i) the fixed claimant party will invest optimally; (ii) the residual claimant (with market option) will over-invest, relative to the contract; however (iii) the residual claimant's over-investment will be less severe than in the alternative allocation of ex-post decision rights.

Proof.

To prove proposition 3, we first consider the case analyzed in Proposition 2, where the seller is the fixed claimant with market option and the buyer is the residual claimant, and then compare those outcomes with the ones obtainable through an inversion of the allocation of ex-post decision rights.

(i). It is easy to see that, when the buyer becomes fixed claimant, he will efficiently invest, as specific performance protection assures that no hold-up may occur due to renegotiation, under a seller's market option. Then, as in Proposition 1, it is possible to choose $\overline{q} : i^e(\overline{q}) = i^*$. Thus, compared to proposition 2, in this case, shifting the 'authority' would realign the buyer's incentives towards efficient investments.

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(ii). As to the seller, now being the residual claimant party with bargaining power equal to 1, her investment equilibrium will be given by:

$$\widehat{j}^{e} \equiv \int_{\Theta_1}\int_{\Theta_2} \left[\overline{t}\overline{q} - c(\overline{q},\theta_1,j) + RS(\overline{q},\theta_1,i,j) + \left\{\int_{\overline{q}}^{q(\theta_2)} t(\theta_2) - c_q(y,\theta_1,j)dy\right\}_{I:\widetilde{X}_S\geq 0}\right] dF(\theta_2)dF(\theta_1) - h_S(j) \tag{14}$$

Since j^* is $argmax$ of $\int_{\Theta_1}\int_{\Theta_2}\left[\overline{t}\overline{q} - c(\overline{q},\theta_1,j) + RS(\overline{q},\theta_1,i,j)\right] dF(\theta_2)dF(\theta_1) - h_S(j)$, given that the seller's bargaining power is equal to 1 and $-c_q(.)$ is increasing in j, optimality for the seller implies $\hat{j}^e > j^*$, i.e. a seller's over-investment.

(iii). To obtain the result that seller's over-investment is mitigated when she is the residual claimant compared to the case when she acts as a fixed claimant (as in Proposition 2), let us recall first the definition of the set A in (13). Consider that $\widetilde{X}_S > 0$ in the set B, where B is defined as:

$$B : \left\{\Theta_1 \times \Theta_2 : (q(\theta_2) > \text{Max}\{\overline{q}, q\}\ ) \wedge \left(\int_{Max\{\overline{q},q\}}^{q(\theta_2)} (t(\theta_2) - c_q(y,\theta_1,j))\, dy\right)\right\} \tag{15}$$

However, since A is reducing in q, we have that $\mu B \leq \mu A$ (or $B \subseteq A$). This means that the states of nature in which there is a realization of the seller's market opportunity are less likely, which, in turn, mitigate the seller's over-investment level.

□

4 Discussion and Conclusions

Proposition 2 shows how the two main results obtained by optimal contract design (the so-called Chung-ADR framework) - i.e. (i) bilateral efficient investments and (ii) irrelevance of authority assignments - do not hold anymore once we extend the complexity of the institutional environment faced by contractual parties, so as to include potential contract-market interactions.

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We interpret this outcome as the consequence of shifting towards a more realistic framework, the trade relationship analyzed. Besides the extreme case of full asset specificity under a constant bilateral monopoly, there are many intermediate cases in which the degree of specificity ultimately depends on the evolution of the outside market. Apparently, established theories of hold-up say nothing about these intermediate cases, where however the risk of hold-up still exists and it is related to the contract-market interactions.

An interesting result we obtained in Proposition 2 is for instance the fact that the party with outside opportunity may even over-invest even when she has full contractual protection and no authority, while in the literature having full contractual protection induces efficient investment, whereas having no authority leads to under-investment.

The economic rationale for such a behavior has been clearly outlined by Shapiro and Varian (1999) and Spulber (2002, 2009), according to whom the ex-ante most vulnerable party in an incomplete contract may even over-invest to find new opportunities, signing multi-party contracts, precisely as a way to 'signal' her ability to the market or to reduce counterpart's post-contractual opportunism.

Moreover we show that a potential hold-up, and thus actual under-investment, may occur even under an optimal contract design when the party with specific performance has a market option. This confirms that hold-up and the degree of asset specificity is a matter at the intersection between the technological nature of the investment made and parties' potential outside options.

The result we reach in proposition 3, outlines not only that 'authority matters', but also provides an economic rationale for the *direction* of authority assignment. Under unilateral market option, it is always efficient to assign ex-post decision rights to party less specific ex-post, because specific performance will assure efficient investments by counterpart.

This conclusion is relevant, in our view, for at least two reasons:

1. it reverses, under the new framework considered, the main results reached by the property rights school (Hart, 1995) and by the mechanism design literature;

2. it shows that having authority could not be enough to deter hold-up when the counterparts has a market option, and that having the right to specific performance may provide extra-incentives, so as to induce over-investment.

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As a consequence, the efficiency of contractual remedies should not be evaluued *per se*, as if they occurred in a competitive *vacuum*, rather it should be analyzed relative to the contract-market interactions. What the *Fisher Body/General motors* story really tells us, is that the degree of co-specificity changed as the market for the Fisher brothers' human capital exploded. This was actually the source of potential hold-up by Fisher Body.

However the direction of the merger was probably wrong. According to our analysis economic efficiency would have required to assign ex-post decision rights to the Fisher brothers rather than to General Motors, as Fisher brothers had the human capital most demanded in the outside market. In fact, one of the puzzling facts of the story is the circumstance that the Fisher brothers continued to work for GM at the top executive level: Lawrence as vice president and director; William as G.M. consulting executive; Alfred as aircraft director; Edward as vice president, director of G.M. and general manager of the Fisher Body division. Freeland (2000), noticing that GM was even willing to continue to pay Fisher brothers' gambling debts, defined thus the merger as "a case of hold-up through merger".

What Freeland (2000) suggests is in fact that the merger was motivated by the GM's need to control the Fisher Body market option. Going back to Proposition 3, this means that our result can provide insights towards another explanation of vertical (quasi)integration, beside the standard one: a party may be willing ot vertically integrate a counterpart when it is costly, in terms of transaction costs, to design a contractual framework which internalizes market externalities.

The circumstance that even the textbook case of hold-up reveals a strong role for contract-market interaction in explaining hold-up (Nicita and Sepe, 2010), suggests that a progress in this direction would allow to fully investigate the complex dynamics between contractual governance and market competition.

Our analysis is just a first step in this direction. A possible extension should explore the case of bilateral market options and the role of authority assignment in that case. Further analysis would require to consider, for instance, the trade-off between contractual mechanism which induce efficient investments relative to the contract, but decrease incentive to 'create' new markets; the case when both parties may have a market option; and the case when information about market options is private information. In the first case, we refer to the idea that over-investment by the party with market option - as in Proposition 2 and 3 - could be efficient from a welfare point of view, when it creates new markets even when, looking exclusively to the contract surplus, it appears to be a quasi-rent dissipation. In the second case, when both

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parties have a market option, the simple contract we refer to, could be just a short term safeguard for parties waiting for better outside opportunities. In the third case, when there is private information about the counterpart's outside opportunities, the renegotiation game should need to include a complex mechanism of information revelation, as parties may cheat or bluff about their real market opportunities ex-post.

In general, as the uncertainty over the market environment becomes relevant, the contractual governance structure matters and one reason towards vertical integration could be found, rather than in the protection of actual specific investments, in the need to control an uncertain counterpart's market option, i.e. the countepart's degree of ex-post specificity.

We believe that much more analysis is needed to investigate the consequences of relaxing several of the assumptions which characterize the standard hold-up models. This is left to future research.

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