

Termination Clauses in Partnerships*

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Abstract

We show that when designing a partnership agreement partner firms may prefer not to specify how to allocate the commonly owned assets should there be an early termination of the contract. By not including such a clause, firms induce litigation before a Court with positive probability. Firms create this ex-post inefficiency in order to increase the levels of non-contractible investments, i.e., increase the ex-ante efficiency. The absence of an asset allocation clause works as a “discipline device” that mitigates the hold-up problem within the partnership. In our set-up, no other contract but that without an asset allocation clause can credibly create an ex-post inefficiency.

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1 Introduction

Strategic alliances, in the form of joint ventures (JVs) or looser modes of cooperation, are an increasingly common solution in response to the need to reduce start-up costs, share risks, enter new markets or develop new technologies. According to Dyer et al. (2001) the top 500 global businesses have an average of 60 major strategic alliances each. During the nineties, the number of alliances grew at an annual rate of over 25% in the leading industrial nations and about 20% of the revenue of the largest US and European corporations comes from partnerships (see Contractor and Lorange, 2002 and Harbison et al., 2000).

Even though the potential advantages of partnering are well known, the track record for joint ventures is not a glowing one. Instability is a commonly recognized problem affecting strategic alliances and the average life span of a JV is as little as four years (seven years for other studies) with a failure rate ranging between 50 and 70%.¹ Because of these prospects, partners should be aware of the difficulties they may encounter when managing an alliance and of the possibility of its early termination, when setting up a new relation. According to some commentators, partners should approach JVs as Hollywood marriages; they should plan their termination strategy from the very beginning by specifying in the initial agreement “what happens to assets, customers and existing contracts in the (likely) event of a break-up”.² Indeed, as is well documented in business literature, a non-amicable termination of an alliance may result in very long negotiations, large expenses and bitter legal battles.³

Surprisingly, JV participants devote relatively little attention to predicting what happens in case of termination of the alliance. A PricewaterhouseCoopers (2000) survey shows that less than half of the firms entering an alliance have a formal exit strategy. Similarly, several authors have observed that, of the many aspects of alliance management, planning its termination ranks among the most ignored by partners.⁴ Obviously, there are probably various reasons for such a lack of attention. Just as a pre-nuptial agreement, discussing a termination clause when forming the alliance might sour the deal; it might reveal a lack of trust among partners. Also difficulties in working out all the possible contingencies that might occur and designing what parties should do in these cases may justify the absence of a termination clause in a JV contract. A possible alternative explanation for such an absence can be envisaged in the case of Concert. When negotiating the terms of their joint venture (called Concert), British Telecommunications and AT&T explicitly decided not to include a termination clause. By not determining the rules for separation, partners wanted to demonstrate their commitment into the relationship.⁵ The model we present develops formally this idea.

We consider two firms setting up a joint venture to pursue a project.⁶ The project can

¹These figures are taken from Gonzalez (2001) and Inpken and Ross (2001).

²“Joint Ventures: Getting out Without Being Hurt” by A. Maitland, Financial Times 10th October 2002.

³This point has been raised in many of the papers we are quoting in this Introduction; see, for instance, Gonzalez (2001).

⁴We refer, among many others, to Roussel (2001) and Chi and Seth (2002).

⁵“Joint Ventures: Getting out Without Being Hurt”, Financial Times 10th October 2002.

⁶In this paper we focus on the strategic effects of contract clauses when parties have decided to start

succeed or fail with probabilities which depend on the investment levels chosen by partners. In case the project fails, firms terminate the partnership and decide upon the allocation of the assets belonging to the JV. If the JV-contract is silent about asset allocation, partners bargain just after terminating the partnership about the assets ownership and the related payments. If they are unable to reach an agreement then the case comes up before a Court, which takes the final decision about assets allocation. Litigation is costly due to the related legal expenses. We show that litigating with positive probability is an equilibrium strategy for partners.⁷ They could avoid litigation before the Court by simply including an asset allocation clause in their JV-contract. However, they benefit from not including this clause, under reasonable conditions. By not including it, firms worsen their own prospects in the event of failure of the project: not only do they not succeed in pursuing it but they also waste resources litigating. But this induces them to increase their investments in order to lower the probability of failure, thus mitigating the hold-up problem when investments are non-contractible.

Litigation before the Court occurs with positive probability because of asymmetric information. Following the argument put forward by several authors,⁸ we assume that partners are asymmetrically informed about the private value of assets. Namely, if the partnership fails, we assume that assets are (more) valuable for one firm which knows its exact private value, while the other knows only that its own valuation is lower. The attempt of the former firm to appropriate a larger part of the assets value during the bargaining stage induces the latter to reject an amicable settlement with positive probability so that firms resort to a costly outside option, the Court, in order to take a decision.

Review of the Relevant Literature

There are different strands of economic literature that are related to our paper. A relatively recent series of studies stemming from the paper by Cramton, Gibbons and Klemperer (1987) focuses on partnership dissolution. There are two main issues tackled: i) under what conditions is there efficient partnership dissolution (i.e. dissolve it when it is efficient to do so and assign the assets to the partner that evaluates them the most)?⁹ ii) what are the relative merits of commonly used dissolution clauses such as the so-called Texas-shootout?¹⁰ Our paper departs from this literature quite substantially. We consider the relationship between investment and termination decisions, while the literature on partnership dissolution focuses

a partnership, in particular the effect of asset allocation clauses on the partners' behavior. We will not analyse in details why parties want to form a partnership, neither the reason why partners decide to form a partnership instead of choosing different organizational forms.

⁷In principle, bargaining might be costly because of various reasons: the time spent by partners haggling over the terms of the agreement or the payments to experts/arbitrators needed for evaluating the assets. In the model, we focus on this second aspect.

⁸See for instance Chi and Seth (2002).

⁹See Fiesler, Kittsteiner and Moldovanu (2003) and McAfee (1992).

¹⁰In the Texas-shootout one partner announces a price and the counterpart chooses whether to be the buyer or the seller of the assets at such a price. See Brooks et al. (2009) and De Frutos and Kittsteiner (2008) for recent contributions on this topic.

exclusively on the latter decision.¹¹ Said differently, we study the effect of different termination procedures more on the ex-ante efficiency and less on the ex-post efficiency. Ex-post inefficiency (in our paper, litigation before the Court) generated by the absence of a termination clause might be beneficial in order to improve ex-ante efficiency (in our paper, to induce larger investments). The idea that there is a trade-off between ex-ante and ex-post efficiency is similar to the one presented in quite different contexts by Bordignon and Brusco (2001), and Gerardi and Yariv (2008). In the former paper, the authors show that the lack of exit rules in federal constitutions can be a commitment device; high costs of secessions (secessions are possible only by “independence wars”) increase the stability of the federation, and therefore the ex-ante benefits of joining it. Gerardi and Yariv (2008) present a mechanism design model with a principal and a committee of agents/experts who collect some (privately costly) information regarding a pay-off relevant variable. The design problem rests on the determination of the size of the committee and on a rule for aggregating agents’ information in order to come up with a decision. The authors show that an imperfect aggregation of the available information (an ex-post inefficiency) is useful in order to stimulate more agents to collect information in the first place (increased ex-ante efficiency).

The problem of how economic institutions and contracts should be designed in order to provide correct investment incentives to parties has been extensively studied by the hold-up literature. In a typical hold-up model, two parties involved in a transaction are required to make some relationship-specific investment and contract incompleteness forces them to rely on ex-post bargaining. The crucial difference between our paper and most of this literature relates to the informational structure at the bargaining stage; the vast majority of these papers assumes that bargaining takes place in a context of symmetric information and therefore yields to outcomes that are ex-post efficient. We show that, in a context where other solutions of the hold-up problem are not effective,¹² the presence of asymmetric information increases the investment incentives of firms. The study of hold-up problems with asymmetric information at the bargaining stage is relatively recent. Lau (2008) analyzes the role of asymmetric information in a standard buyer-seller relationship where only the former party makes trade-specific investments. She shows that the joint profits of the two parties increase with the probability that buyer and seller are asymmetrically informed about the investment chosen by the former party. An increase in the probability that parties are asymmetrically informed enhances the rents of the buyer thus increasing her/his investment

¹¹Li and Wolfstetter (2004) represent a relevant exception. They consider both partners’ contributions and possible termination of the JV. The fundamental difference between Li and Wolfstetter (2004) and our paper is related to the assumption about the contractibility of partners’ contributions. While we assume that they are not contractible, Li and Wolfstetter assume that they are so that no hold-up problem arises.

¹²This is the case of, for instance, option contracts where one (or both) partners are given the possibility to buy the asset at some pre-determined strike-price. Option contracts mitigate the hold-up problem when the investment of only one of the parties is non-contractible (Lerner and Malmendier, 2009) or when firms take their investment decision sequentially (Nöldeke and Schmidt, 1998). In our framework these contracts are not useful to solve the hold-up problem since we consider a case where: the hold-up problem is two-sided, partners invest simultaneously and the relevance of their investments to the success of the partnership is the same.

incentives. This incentive effect dominates the negative effect due to failure to trade because of asymmetry of information. In a similar setting, Gul (2001) shows that if the investment of the buyer is unobservable and the time between offers is small, then the hold-up problem disappears. In these papers, asymmetric information lessens the hold-up since it decreases the seller's ability to expropriate the efficient investment made ex-ante by the buyer, at the bargaining stage. In our paper, which deals with two-sided hold-up problems, asymmetric information at the bargaining stage and the possibility of resorting to an outside option induce an ex-post inefficiency which turns out to be ex-ante beneficial.

Finally, our paper is also related to the stream of literature which takes into consideration strategic reasons for contract incompleteness. Non-contingent contracts as a signaling/screening device are analyzed in Aghion and Bolton (1987), Diamond (1993), Hermalin (2002), and Spier (1992). Bernheim and Whinston (1998) show that contracts that contain some "gaps" may help in establishing the appropriate incentives for parties. In a context where certain actions are observable by parties but not verifiable by Courts, incomplete contracts that expand the set of discretionary choices/strategies may be used in order to induce parties to coordinate on Pareto superior equilibria.

Outline of the Paper

In Section 2, we describe the set-up of the model and we develop the benchmark. In Section 3, we derive the main results of the paper focussing on a comparison between two specific types of contracts: the Texas-shootout and one without an asset allocation (the one we wish to analyze). In particular we derive under which condition the latter is preferable to the former. Section 4 is devoted to showing that the results of Section 3 hold also when considering more general settings and alternative contracts. Finally, in the concluding Section 5 we relate the results shown in the paper to some of the stylized evidence on strategic alliances. All the proofs that are not essential for an understanding of the main arguments of the paper are presented in the Appendix.

2 The Model

Two firms, firm 1 and 2, form a partnership to pursue a joint project. The project is a risky activity with two possible outcomes: good, i.e. the project is successful, or bad, i.e. the project fails. The good outcome occurs with probability $p(k_1, k_2) \in [0, 1]$ while the bad one occurs with complementary probability; $k_i \geq 0$ represents the investment level chosen by partner $i = 1, 2$ and $c_i(k_1, k_2)$ is the corresponding private cost. At an intermediate stage of the project, after the investment levels have been chosen, firms observe a signal of the future outcome, $\theta \in \{\theta_G, \theta_B\}$, where θ_j stands for the signal of outcome $j = \text{Good}$ or Bad , and decide whether to continue or to terminate the partnership. Continuation generates a monetary value $v_G = v > 0$ if the project is successful and $v_B < 0$ in case the project fails. For the sake of simplicity, in what follows we assume that θ is a perfect signal of the future outcome. Moreover, we assume that v_G and v_B are sufficiently large in absolute terms and

that parties agree to continue the partnership when θ_G is observed and to terminate it when $\theta = \theta_B$.¹³

The firms' collaboration generates some intermediate results which are incorporated in an indivisible asset A . If firms choose to continue the partnership then the asset is devoted to the joint project. If firms decide for an early termination, then A can be acquired by one of them and used for its own business; we let φ_i denote the private value that accrues to firm $i = 1, 2$ when it employs the asset in its own business. We assume that, independent of the realization of the outcome or the investment levels, with probability $\frac{1}{2}$ the asset has a larger private value for firm 1 and, with complementary probability, for firm 2. For the sake of simplicity, we assume that: either $\varphi_1 = 0$ and $\varphi_2 > 0$ or $\varphi_1 > 0$ and $\varphi_2 = 0$.¹⁴ Moreover, we assume that, when positive, φ_i can take two different values: φ^H, φ^L with $\varphi^H > \varphi^L > 0$; each of these two realizations occurs with probability $\frac{1}{2}$, independent of the outcome and of the investment levels. In what follows we let $E[\varphi] \equiv \frac{\varphi^H + \varphi^L}{2}$.

Information structure and timing

We assume that the signal θ and the investment levels k_i , $i = 1, 2$, are observed by both firms even though they are not verifiable. The only source of asymmetric information between the two partners relies on the private value of the asset. They both know their own private value, and, having collaborated on the project, they are able to disentangle which firm values the asset the most. Hence, the firm for which the asset has no value knows that A has a positive value for its partner but it ignores whether the value is φ^H or φ^L .

The timing of the game is as follows

At **time** $t = 0$ partners sign the partnership contract. The contract specifies the shares, $s_i \in [0, 1]$ and $s_j = (1 - s_i)$, of the monetary revenues v that partners are entitled to. Moreover, the contract can include an asset allocation clause: a price, or a procedure that firms have to comply in order to allocate the asset in case the partnership is terminated. After agreeing on the terms of the contract, partners simultaneously choose the investment levels.

At **time** $t = 1$, firms observe the signal θ , and the private values of the asset, as explained above; afterwards, they decide whether to continue or to terminate the partnership. In case of termination, A is allocated in accordance with the contract, or, through bargaining if the contract does not include an asset allocation clause. If bargaining fails, parties resort to going to Court, which then verifies the value of the asset and decides to which firm to allocate

¹³With these assumptions we rule out the possibility of inefficient continuation (continue the partnership when θ_B is observed) and inefficient termination (terminate the partnership when θ_G is observed) of the partnership. As we checked in a previous version of the paper, allowing for the possibility of such inefficient continuation/termination decisions does not alter our results and makes the analysis more cumbersome; see Comino et al. (2006).

¹⁴Note that the assumption that the asset A is worthless for one of the two partners, implies that its market value is nought.

A , the compensation for the other partner, and how to split the overall legal expenses $2F$ (we will be more detailed on the Court rules in Section 3.2). We assume that the Court can verify (estimate) the private values of A and the monetary value of the project, but it cannot verify the levels of investment. We interpret the legal expenses $2F$ as the cost of estimating the asset value by means of independent experts employed by the Court.

At **time** $t = 2$ the monetary or private values are realized.

Throughout the paper we will assume that the following conditions are met:

- (A1) $v > \varphi^H$ and $\varphi^L > 2F > 0$;
- (A2) $\varphi^H - \varphi^L \geq 2F$.

The first inequality in (A1) implies that it is efficient to continue the partnership when $\theta = \theta_G$ while the second implies that firms are better-off going to Court to allocate the asset rather than disposing of it when they do not reach an agreement in the bargaining stage. Condition (A2) requires the two possible positive private values of the asset to be significantly different, and guarantees that partners have substantially asymmetric information.

In order to derive a closed-form solution for the model, in the benchmark and Section 3 we employ specific functional forms for the probability and cost functions. Namely, we assume that $p(k_1, k_2) = \min\{\eta \cdot (k_1 + k_2), 1\}$ and $c_i(k_1, k_2) = \frac{\gamma k_i^2}{2}$ for $i = 1, 2$. Moreover we assume that parameters γ and η are such that the chosen investment levels induce $0 < p(k_1, k_2) < 1$.¹⁵

2.1 Benchmark

Before solving the model we define the first best solution. Efficiency has to be ensured ex-post, at $t = 1$, once the signal and the private values of the asset are realized, as well as ex-ante, at $t = 0$, when investments are to be made. From condition (A1), it follows that ex-post decisions are efficient if and only if:

- (1) the partnership is continued, in case $\theta = \theta_G$;
- (2) the partnership is terminated and the asset is assigned to the firm with the largest private value, in case $\theta = \theta_B$.

Ex-ante efficiency is obtained when investments are chosen in order to maximize the joint expected pay-off of the two firms:

$$\max_{\{k_1, k_2\}} \eta \cdot (k_1 + k_2) v + (1 - \eta \cdot (k_1 + k_2)) E[\varphi] - \frac{\gamma k_1^2}{2} - \frac{\gamma k_2^2}{2}.$$

Simple calculations yield the following first best investment levels: $k_1^{FB} = k_2^{FB} = \frac{(v - E[\varphi])\eta}{\gamma}$.

¹⁵Relaxing this condition complicates the presentation of the results substantially without adding any interesting new insight.

3 Results

Let us now turn to the case where firms act non-cooperatively. Our aim is to demonstrate that firms might find it beneficial to select a contract that does not specify an asset allocation clause. For the sake of simplicity, in this section we compare such contract with another one which includes a particular procedure to allocate the asset, a Texas-shootout clause; we focus on this clause because of its simplicity, and its virtues in allocating assets efficiently, as advocated by practitioners and academic researchers.¹⁶ However, any other contract inducing ex-post efficiency is equivalent, to our goals, to the Texas-shootout. In this section we assume that in case of termination once the asset has been assigned to one of the parties, resale to the partner is not possible. In the following section we discuss how our arguments extend to more general settings, considering in particular also the possibility of resale.

3.1 Contracts with a Texas-shootout Clause

Consider a contract that, in case of termination of the partnership, stipulates that the asset is allocated by means of a Texas-shootout: a partner (the proposer) proposes a price, and the other (the receiver) decides whether to be the buyer or the seller of the asset at such a price. Formally, the contract, besides s_i and s_j , specifies a probability $\chi \in [0, 1]$ according to which firm i is selected as the proposer of the Texas-shootout, once the partnership is terminated.

The following lemma shows that in our setting the Texas-shootout ensures an efficient allocation of the asset.

Lemma 1 *When the contract specifies a Texas-shootout, the asset is efficiently allocated.*

Proof. Without loss of generality, let us call 1 the firm for which the asset has positive value. Suppose that firm 1 is selected to act as the proposer of the Texas-shootout; firm 2 finds it optimal to sell A at any non-negative price, then firm 1 proposes a price 0 and buys the asset. Consider now the case where firm 2 acts as the proposer; type φ^i (with $i = H, L$) of firm 1 is willing to buy the asset at any price smaller than or equal to $\frac{\varphi^i}{2}$ and to sell it otherwise. Hence, to offer any price different from $\frac{\varphi^H}{2}$ and $\frac{\varphi^L}{2}$ is a dominated strategy for firm 2. If it offers $\frac{\varphi^H}{2}$, it obtains zero in expected terms since type φ^H buys the asset while type φ^L sells it. By offering $\frac{\varphi^L}{2}$ firm 2 obtains $\frac{\varphi^L}{2}$ with certainty. Therefore, in equilibrium firm 2 proposes a price equal to $\frac{\varphi^L}{2}$ and firm 1 buys the asset whatever its type is. ■

With a Texas-shootout the asset is efficiently allocated to the firm with the highest evaluation independent of the probability χ specified in the contract. As it is shown in the proof of the lemma, a firm obtains a larger share of the gains from trade when it acts as proposer; clearly, changes in χ alter the expected gains from trade of the two firms.

¹⁶See De Frutos and Kittsteiner (2008).

Consider now the investment decision. Firm i chooses k_i to maximize the following expression:

$$\eta(k_1 + k_2) s_i v + \frac{1}{2}(1 - \eta(k_1 + k_2)) \left(\chi E[\varphi] + (1 - \chi) \left(E[\varphi] - \frac{\varphi^L}{2} \right) + \chi \frac{\varphi^L}{2} \right) - \frac{\gamma}{2} k_i^2 \quad (1)$$

With probability $\eta \cdot (k_1 + k_2)$ the project is successful and firm i obtains the share s_i of the monetary revenues v . When the project fails, then with probability $\frac{1}{2}$ the asset is valuable for firm i . In this case, with probability χ firm i acts as the proposer of the shootout clause, and therefore it obtains the asset at a zero price; with probability $(1 - \chi)$ the other party sets the price and firm i obtains the asset at price $\frac{\varphi^L}{2}$; similarly with $\frac{1}{2}$ probability the asset has no value for firm i and it receives the payment $\frac{\varphi^L}{2}$ for selling the asset only in the case it acts as the proposer.

We are now in the position to derive the second best contract in the class of contracts that include a Texas-shootout clause; namely, the contract that induces partners to choose the levels of investment that maximize their joint pay-off under the incentive compatibility constraint.

Proposition 1 *The second best contract with a Texas-shootout clause provides that $s_1 = s_2 = \frac{1}{2}$ and $\chi = \frac{1}{2}$. The equilibrium investment levels chosen by partners under such a contract are $k_1^{TS} = k_2^{TS} = \frac{(v - E[\varphi])\eta}{2\gamma}$.*

The above result can be easily understood. At $t = 0$ firms maximize the same expected profit function and their cost functions are convex. Therefore, it is optimal to share revenues equally in both states of nature, and this can be achieved by setting $s_1 = s_2 = \frac{1}{2}$ and $\chi = \frac{1}{2}$. By comparing the equilibrium investment levels with the efficient ones, it is possible to verify that there is underinvestment.

3.2 Contracts without an Asset Allocation Clause

Consider now a contract that is silent about the terms under which A is allocated. When partnership is terminated, no firm has full ownership over the asset, and, therefore, no firm is entitled to use it. The allocation of the asset has to be bargained ex-post; if firms fail to reach an amicable agreement they have the option of resorting to Court in order to allocate A .

In what follows we focus on a particular bargaining protocol. In Section 4 we discuss how our results generalize to alternative protocols.

Bargaining over Asset Ownership

We assume that the bargaining over asset ownership takes the form of a take-it-or-leave-it offer made by the firm with the highest evaluation for the asset. Let 1 be such firm and ε be the cost of making a proposal, with ε positive but arbitrarily small. Firm 1 proposes a price π at which it is willing to buy A ; firm 2 can either:

- accept the proposal, and in this case the asset is transferred to firm 1 at price π ;
- reject the proposal, and in this case firms resort to Court in order to allocate the asset. We assume that the Court verifies the value φ^j of the asset (i.e. firm 1's value), $j = L, H$, and decides the following. The asset is transferred to firm 1 at the fair price $\frac{\varphi^j}{2}$; the legal expenses $2F$ are allocated by means of a fee-shifting rule based on pre-trial proposals: they are equally shared unless firm 1 offers a price π smaller than the fair one. In this latter case, the whole legal expenses are charged to firm 1.¹⁷

The next proposition characterizes the equilibrium of the bargaining game we have just described.

Proposition 2 *The unique Perfect Bayesian Equilibrium of the bargaining game which satisfies the divinity criterion D1 is semi-separating: type φ^L of firm 1 offers $\frac{\varphi^L}{2}$, while type φ^H plays mixed strategies and offers $\frac{\varphi^L}{2}$ with probability $\alpha = \frac{2F}{\varphi^H - \varphi^L}$ and $\frac{\varphi^H}{2}$ with probability $(1 - \alpha)$; firm 2 accepts $\frac{\varphi^H}{2}$, while it accepts $\frac{\varphi^L}{2}$ only with probability $\beta = \frac{4F}{4F + \varphi^H - \varphi^L}$.*

Proof. See the Appendix, where a more detailed description of the equilibrium can be found. ■

In equilibrium type φ^H of firm 1 mimics with some positive probability the strategy of type φ^L , and offers a price $\frac{\varphi^L}{2}$ lower than the price that it would pay in front of Court. For this reason, firm 2 with some positive probability rejects the proposal $\frac{\varphi^L}{2}$. When this occurs firms resort to Court in order to allocate the asset as pointed out by the following corollary.

Corollary 1 *If the contract does not specify an asset allocation clause, then, in case of termination, firms litigate in front of the Court with positive probability; when this occurs, there is an ex-post inefficiency due to the legal expenses $2F$.*

Given the equilibrium at the bargaining stage we can characterize the second-best contract without an asset allocation clause.

Proposition 3 *The second best contract without an asset allocation clause provides that $s_1 = s_2 = \frac{1}{2}$. The equilibrium investment levels chosen by partners are*

$$k_1^{NC} = k_2^{NC} = \frac{(v - E[\varphi])\eta}{2\gamma} + \frac{\eta(2(F(1 - \beta) + 2\varepsilon) + \alpha(\varphi^H - \varphi^L))}{8\gamma}.$$

The second best contract provides that partners equally share the monetary value generated by the project, in analogy with Proposition 1.

¹⁷Fee-shifting rules are used in many legislations (as Rule 68 of the Federal Rules of Civil Procedures in the United States). These rules give strong incentives to parties in order to reach an amicable agreement thus avoiding costly litigations in front of Court. Indeed, Spier (1994) proves that “if litigants are asymmetrically informed about the merits of the case, then fee shifting rules that are based upon the settlement offers made before the trial have powerful incentive properties”. Therefore they are the most unfavourable rules in order to prove that partners may fail to reach an amicable agreement before going to Court.

3.3 The Choice of the Contract

We can now compare the pay-off generated by the two contracts defined above. The following proposition shows under which conditions the contract without an asset allocation clause outperforms the contract with a Texas-shootout.

Proposition 4 *The second-best contract without an allocation clause Pareto dominates the contract with a Texas-shootout if:*

$$v \geq \frac{2E[\varphi] - F}{2} + \frac{F^2}{4F + \varphi^H - \varphi^L} + \frac{2\gamma}{3\eta^2}. \quad (2)$$

Proof. The result is obtained by comparing the joint pay-off that partners obtain under the contracts defined in Propositions 1 and 3 exploiting the fact that ε is negligible. ■

The effect of not including an asset allocation clause in the initial agreement is twofold. On the one hand, it induces an ex-post inefficiency given that firms litigate in front of the Court with a positive probability. On the other hand, such inefficiency works as a “discipline device”. Litigation reduces the pay-off in case of failure of the project thus inducing partners to invest more in order to avoid this contingency; this second effect is apparent when comparing the equilibrium investment levels defined in Propositions 1 and 3. If condition (2) is satisfied the second effect dominates.

From a simple differentiation of the threshold level shown in condition (2) the following comparative statics results can be derived.

Corollary 2 *The set of parameters for which the second-best contract without an asset allocation clause Pareto dominates the contract with a Texas-shootout enlarges when i) $(\varphi^H - \varphi^L)$, F , or η increases, and (ii) γ or $E[\varphi]$ decreases.*

The intuition for this corollary follows from the twofold effect of the absence of an asset allocation clause. Larger values of $(\varphi^H - \varphi^L)$ and F increase the expected costs of litigation, but, at the same time, they also increase the incentives to invest. Under the specification of our model the latter effect dominates.¹⁸

Changes in γ , η and $E[\varphi]$ do not alter the ex-post inefficiency but they have an effect on the underinvestment problem; the difference between k_i^{FB} and k_i^{TS} is decreasing in γ and $E[\varphi]$ and increasing in η . Corollary 2 clarifies that the contract with Texas-shootout performs relatively better when the underinvestment problem becomes less severe.

¹⁸It is worth noticing that the effect of an increase in the legal expenses as shown in Corollary 2 holds under assumptions (A1) and (A2), which impose an upper bound on F . When F is large enough partners never find profitable to go to Court and the incentive effect of a contract without asset allocation clause vanishes.

4 Robustness of the Results

In the analysis made so far we have considered two specific types of contracts: one with a Texas-shootout, and the other without an asset allocation clause. We have assumed, for this latter contract, that parties bargain over the asset allocation using a specific protocol, when the partnership is terminated. The aim of this section is to discuss how our results generalize once we consider different asset allocation clauses and bargaining protocols. Moreover, we check the robustness of our analysis with the possibility of renegotiation between $t = 0$ and $t = 1$ and with more general cost and probability functions.¹⁹

4.1 Resale and Efficient Asset Allocation

In Section 3.1 we have shown that, in case of termination of the partnership, the asset is efficiently allocated to the firm with the highest evaluation. This result is not driven by the particular asset allocation clause on which we have focussed, and it generalizes if the resale of the asset is possible. Consider any contract that, once implemented, assigns with some positive probability the asset to the firm with the lowest private evaluation, say firm 2; suppose that firms bargain as in Fudenberg, Levine and Tirole (1985): firm 2 makes price proposals which firm 1 can either accept or reject. If a proposal is accepted then the game ends. If a proposal is rejected, firm 2 makes another proposal during the following period. This represents a standard repeated-offers bargaining with one-sided incomplete information and with a “gap” between the seller’s evaluation and the buyer’s minimum evaluation. As shown in Fudenberg, Levine and Tirole (1985) and in Gul, Sonnenschein and Wilson (1986), in this case the Coase conjecture applies and the asset gets always efficiently allocated to the firm with highest evaluation.²⁰

4.2 Costly Asset Allocation

Asset resale rules out the possibility that A is inefficiently allocated. This fact has two important consequences. First, in our framework, the only way to create an ex-post inefficiency is by means of a costly procedure to allocate the asset.²¹ Second, any contract that specifies a procedure to allocate the asset which only involves the two partners (e.g. without providing for a possible intervention of the Court) leads to a costless and efficient asset allocation;

¹⁹The main results of our paper may be extended along other dimensions. In particular we checked that the results hold in the case of firms investments affecting the value generated by the project rather than its probability of success and in case Court verification technology is not perfect. The formal analysis has been omitted for the sake of brevity and it is available from the authors upon request.

²⁰We provide a more detailed discussion in the working paper version of the model; see Comino et al. (2006).

²¹Note that, in principle, partners might create an ex-post inefficiency also by inducing an inefficient continuation/termination decision. In a previous version of the paper we showed that contracts inducing such an inefficiency are either efficiently renegotiated, or they are Pareto-dominated; see Comino et al. (2006).

therefore, it is equivalent to the contract with a Texas-shootout clause considered in Section 3.1.

In the following paragraphs we investigate with further detail the issue of costly procedures to allocate the asset, focusing in particular on: i) how Corollary 1 generalizes to other bargaining protocols; ii) how the use of third parties or arbitrators different from the Court can induce a costly allocation of the asset.

4.2.1 Other Bargaining Protocols

In Section 3.2 we have assumed that if the contract is silent about asset allocation, the bargaining takes the form of a take-it-or-leave-it offer: the informed firm makes a proposal and, in case of rejection, the parties go to Court. In what follows we generalize the result of Proposition 2 by showing that in equilibrium litigation occurs with positive probability for a large class of bargaining protocols. Consider any bargaining protocol with discount factor $\delta \leq 1$ where one firm makes price proposals to the other firm, or where the two firms alternate in the role of price proposer, and at any round of the bargaining process both firms are entitled to bring the case to the Court in order to solve the dispute; the following result holds:²²

Proposition 5 *If the legal expenses are not too large and the discount factor is sufficiently high, then in any Perfect Bayesian Equilibrium of the bargaining game litigation in front of the Court occurs with positive probability.*

Proof. Suppose that an equilibrium of the game in which litigation does not occur exists. Call 1 the firm for which the asset is worthy and consider type φ^L . The Court would impose an overall payment $\frac{\varphi^L}{2} + F$ for the asset, and therefore during the bargaining game type φ^L is willing to pay a price π provided that $\pi \leq \frac{\varphi^L}{2} + F$. If in equilibrium litigation in front of the Court does not occur, then at a certain date \bar{t} one firm proposes to buy (sell) the asset at such $\pi \leq \frac{\varphi^L}{2} + F$ and the other accepts to sell (buy). If the discount factor δ is high enough type φ^H of firm 1 prefers to wait until period \bar{t} rather than accepting to pay a higher price in any previous period. It follows that, when δ is sufficiently large, firm 2 expects to obtain at most $\delta^{\bar{t}} \left(\frac{\varphi^L}{2} + F \right)$ in equilibrium. Consider now that firm 2 deviates from the equilibrium strategy and resorts to Court immediately (before making or receiving any proposal); by doing so firm 2 obtains an expected payoff of $\frac{1}{2} \left(\frac{\varphi^L}{2} + \frac{\varphi^H}{2} \right) - F$. Hence, firm 2 prefers such a deviation provided that $\frac{1}{2} \left(\frac{\varphi^L}{2} + \frac{\varphi^H}{2} \right) - F \geq \delta^{\bar{t}} \left(\frac{\varphi^L}{2} + F \right)$. This condition is verified for all δ if $\frac{1}{2} \frac{\varphi^H - \varphi^L}{2} \geq 2F$. ■

4.2.2 Legal Expenses and the Use of Private Arbitrators

Legal expenses play a central role in our analysis. We have shown that it is desirable for parties to incur a positive amount of legal expenses in case they solve their dispute before a

²²For the sake of simplicity we assume that the Court equally splits the legal expenses.

Court. The usual argument for having positive legal expenses is to avoid excessive litigation. In our paper the reason is different: legal expenses represent a credible commitment that induces firms to choose larger levels of non-contractible investments.²³ A natural question concerns the optimal level of legal expenses that firms should incur in case of litigation. Obviously, given a certain partnership, it is possible to determine the socially efficient amount of legal expenses; however, in order to fix $2F$ at such a level, the Court or a Regulator should have full information about the partnership and about the firms that are involved in it; for instance they should be able to observe the cost and the probability functions $c_i(k_1, k_2)$ and $p(k_1, k_2)$. Alternatively, the partners themselves might try to endogenize the amount of legal expenses by specifying in the contract the name of a private arbitrator that plays the same role as the Court. By choosing an arbitrator that uses the same verification technology as the Court but is costlier, partners increase their investment incentives. However, it is easily shown that such choice is ineffective. Partners anticipate that, ex-post, they will renegotiate the contract in case the joint project fails. In fact, once the partnership is terminated firms have the aligned interest of selecting the less expensive arbitrator (i.e. the Court) in order to solve their dispute.

4.2.3 Contracting with Third Parties

A different way of creating an ex-post inefficiency might be that of including a third party in the contract. For instance the contract might specify that, in case of termination, the asset is assigned to a third, “silent”, party for free or at a nominal price. According to our knowledge, such contracts are rarely observed in reality. One possible explanation is that these contracts can be renegotiated easily before termination occurs. Firms have an aligned interest against the third party and can “cooperate” to renegotiate the contract. For instance, once firms have observed $\theta = \theta_B$ they can formally continue their alliance even though, de facto, they have abandoned it. If this is possible, then firms can renegotiate the contract by offering a very small compensation to the third party in order to tear up the initial contract. Contracts with third parties may be problematic for another reason too. Such contracts might induce collusion between one of the firms and the third party: they can free-ride on the other firm’s investment and, at the same time, agree to share the value of the asset, which is always positive when resale is possible.²⁴

4.3 Further Generalizations

4.3.1 Renegotiation between $t = 0$ and $t = 1$

In the analysis of the contract without asset allocation clause we assumed that parties bargain to determine the price for the asset A only once the partnership has been terminated.

²³See however note 18

²⁴However, in a recent contribution Baliga and Sjöström (2009) show that third parties can be used as a credible threat to induce the efficient level of investment, in case the parties have the ability to commit to secret message games.

However, in principle, this price could be determined at other points in time. In particular, after having chosen the level of investment and before observing θ (i.e. after $t = 0$ and before $t = 1$) partners do not face the hold-up problem any longer. Therefore, at this moment, it would be efficient for them to agree on a price for the asset in order to avoid the possible costly litigation.

However, it is possible to show that if there exists a positive (infinitely small) probability that between $t = 0$ and $t = 1$, one of the two firms has already observed its private value of the asset, then parties do not renegotiate the contract.²⁵ In fact any renegotiation proposal is rejected. If a firm proposes a low price for the asset, then the partner believes that the proposer has already observed to be the firm for which the asset has a positive (and large) value. If a firm proposes a high price, then the partner believes that the proposer has observed that its private value is zero.²⁶

4.3.2 Generalizing Distribution and Cost Functions

The main result of the paper, summarized in Proposition 4, has been derived under specific assumptions about the probability and cost functions. In what follows, we provide sufficient and reasonable conditions that ensure that the contract without asset allocation clause induces larger investment levels than any contract that contains this clause. Suppose that $s_i v - \frac{E[\varphi]}{2} > 0$ for both $i = 1, 2$ so that each firm prefers the success of the joint project to its failure. Moreover, suppose that the probability of success is increasing in k_i , $i = 1, 2$ and that firms benefit from weak complementarities in their investments: the marginal productivity of the investment is (weakly) increasing and its marginal cost is (weakly) decreasing in the partner's investment, that is, $\frac{\partial p(k_1, k_2)}{\partial k_1 \partial k_2} \geq 0$, and $\frac{\partial^2 c_i(k_1, k_2)}{\partial k_1 \partial k_2} \leq 0$ for $i = 1, 2$. Under these assumptions, the investment game is a supermodular game with positive spillover (firms' payoff are increasing in the level of partner's investment). For these games a Nash equilibrium in pure strategies always exists and the largest equilibrium, that is the Nash equilibrium such that the levels of investment are highest, is the Pareto preferred one. Assuming that partners are able to coordinate to the Pareto preferred Nash equilibrium, then it follows that the investment levels are increasing in the costs of litigation. The following proposition summarizes the previous discussion.

Proposition 6 *Suppose that $\frac{\partial p(k_1, k_2)}{\partial k_i} > 0$, $s_i v - \frac{E[\varphi]}{2} > 0$, $\frac{\partial p(k_1, k_2)}{\partial k_1 \partial k_2} \geq 0$ and $\frac{\partial^2 c_i(k_1, k_2)}{\partial k_1 \partial k_2} \leq 0$ for both $i = 1, 2$, then the investment levels that firms choose in the Pareto preferred Nash equilibrium are increasing in the cost of litigation.*

Given that litigation occurs only in case of the contract without asset allocation, then Proposition 6 generalizes our main result; that is:

²⁵A precise statement of this argument and its formal proof can be found in Comino et al. (2006)

²⁶The same argument applies if a party proposes to include a Texas-shootout. With a Texas-shootout the partner with a high evaluation for the asset is the one that obtains the largest benefit from including this clause, as shown in Lemma 1. Therefore, the receiver of the proposal rejects it since it assigns probability 1 to the event: the asset has a positive and *High* value for the proposer.

Corollary 3 *The investment levels that firms choose in the Pareto preferred Nash equilibrium are larger in the case of a contract without asset allocation clause than in the case of a contract with it.*

5 Concluding Remarks

The model we have presented shows that when forming a partnership firms may prefer not to specify how to allocate the commonly owned assets in case of an early termination of the alliance. The absence of such an allocation provision induces partners to litigate before a Court with positive probability. This ex-post inefficiency is beneficial for the partners since it works as a “discipline device” that alleviates the hold-up problem: in equilibrium partner firms select larger levels of non-contractible investment in order to reduce the probability of litigation.

Relatively few empirical studies focus specifically on partnership termination clauses.²⁷ However, some indirect evidence supporting our results can be found in the empirical literature on the governance form of strategic alliances and in those studies that analyze the rationales to form partnerships rather than maintaining arm’s length relationships. The trade-off addressed in our paper closely resembles the classical “commitment vs. flexibility dilemma” that characterizes the choice of the governance form of partnerships. In the literature it is argued that by devoting substantial resources, i.e. by committing, firms reduce their advantages of behaving opportunistically thus increasing the stability of the alliance. Commitment can be achieved in different ways. Equity alliances are considered to require greater levels of financial as well as organizational commitment than non-equity ones. The exchange of “mutual hostages” is another way to increase commitment: by bringing critical assets (the hostages) to the partnership, parties become more vulnerable and therefore less prone to behave in an opportunistic manner.²⁸ A rather robust finding of the empirical literature is that when R&D activities are on the agenda of the partnership commitment is a superior strategy. In fact, in this case partners’ contributions are more likely to be non-contractible, and therefore partners find it profitable to select a commitment strategy in order to lessen the hold-up problem (see, for instance, Gulati, 1995, Pisano, 1989, Oxley, 1997 and Gulati and Singh, 1998). The results in our paper are in line with this finding. A contract without an asset allocation clause makes the partnership costlier to dissolve and therefore it represents an alternative way in which firms may commit to the alliance. As we have shown in the paper, partners might benefit from such a contract provided that invest-

²⁷Lerner and Malmendier (2009) and Reuer and Tong (2005) consider cases where the hold-up problem is one-sided, that is, only one firm suffers from the possible opportunistic behavior of the partner. These authors find that in these cases the partnership contract normally protects the firm at risk of opportunistic behavior by granting it some specific rights such as the “right to terminate” the partnership. In our paper, instead, we prove that when the hold-up problem is two-sided, the absence of an asset allocation clause can be used to reduce the incentives to behave opportunistically.

²⁸Williamson (1983) discusses the use of mutual hostages as a mean to stabilize relationships. For an application to joint ventures see Buckley and Casson (1988), Das and Rahman (2002) and Kogut (1989).

ments are non-contractible; a condition more likely to hold in case of R&D partnership, as stressed by the studies quoted above. Moreover in Corollary 2 we have pointed out that the set of parameters for which the absence of a termination clause is beneficial increases in the difference $(\varphi^H - \varphi^L)$ of the intermediate asset value. Again, this difference (more in general the support of the probability distribution over the asset's values) is likely to be larger in case of R&D partnership where the intermediate asset is often intangible.

Finally, the empirical literature also stresses that the presence of resource complementarities induces firms to select business strategies that require larger levels of commitment (see Harrison et al., 2001). Also in our framework complementarities increase the benefits from signing the contract without asset allocation clause. Suppose for instance that the probability function takes the form $p(k_1, k_2) = \min\{\eta(k_1 + k_2 + \tau k_1 k_2), 1\}$, with parameter τ measuring the level of complementarities. It is possible to show that as τ enlarges then the set of parameters for which the contract without asset allocation clause is preferred gets larger. We have proven this result in a previous version of the paper, see Comino et al. (2006).

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6 Appendix

Proof of Proposition 1

From Lemma 1 firm i chooses k_i in order to maximize (1) in the text. The benefit from marginally increasing k_i is

$$\eta \left(s_i v - \frac{1}{2} \left(\chi \left(E[\varphi] + \frac{\varphi^L}{2} \right) + (1 - \chi) \left(E[\varphi] - \frac{\varphi^L}{2} \right) \right) \right),$$

thus the optimal investment level of firm i is 0, $k_i = 0$, if:

$$s_i \leq \frac{1}{2v} \left(\chi \left(E[\varphi] + \frac{\varphi^L}{2} \right) + (1 - \chi) \left(E[\varphi] - \frac{\varphi^L}{2} \right) \right)$$

otherwise it is:

$$k_i = \frac{\eta}{\gamma} \left(s_i v - \frac{1}{2} \left(\chi \left(E[\varphi] + \frac{\varphi^L}{2} \right) + (1 - \chi) \left(E[\varphi] - \frac{\varphi^L}{2} \right) \right) \right)$$

The investment game has a unique equilibrium, but, depending on the selected values for s_i and χ , it can have different characteristics: (i) only one firm makes a positive investment or (ii) both firms make a positive investment. It can be shown that, due to the convexity of the cost function, for any equilibrium of type (i) there is equilibrium of type (ii) which is more efficient. Therefore we consider values of s_i and χ such that both firms are induced to invest. The second best contract solves the following problem:²⁹

$$\begin{aligned} \max_{s_1, \chi} & \eta \cdot (k_1 + k_2) v + (1 - \eta \cdot (k_1 + k_2)) E[\varphi] - \frac{\gamma}{2} k_1^2 - \frac{\gamma}{2} k_2^2, \\ \text{s.t.} & \quad k_1 = \frac{\eta}{\gamma} \left(s_1 v - \frac{1}{2} \left(\chi \left(E[\varphi] + \frac{\varphi^L}{2} \right) + (1 - \chi) \left(E[\varphi] - \frac{\varphi^L}{2} \right) \right) \right) \\ & \quad k_2 = \frac{\eta}{\gamma} \left((1 - s_1) v - \frac{1}{2} \left((1 - \chi) \left(E[\varphi] + \frac{\varphi^L}{2} \right) + \chi \left(E[\varphi] - \frac{\varphi^L}{2} \right) \right) \right). \end{aligned}$$

Straightforward calculations show that the $s_1 = \frac{1}{2}$ and $\chi = \frac{1}{2}$ solve the above program; plugging these values into the expressions of the firms' investment one obtains $k_1^{TS} = k_2^{TS} = \frac{(v - E[\varphi])\eta}{2\gamma}$. ■

²⁹Without loss of generality we denote by χ the probability that firm 1 is the proposer.

Proof of Proposition 2.

With a little abuse of notation, we let φ^k denote firm 1's type when it observes that the asset value is φ^k , with $k \in \{H, L\}$. Moreover, we let $\mu(\pi)$ be the probability that firm 2 assigns to the event "firm 1 is of type φ^H " after receiving an offer π . The unique Perfect Bayesian Equilibrium of the bargaining game which satisfies the divinity criterion D1 is the following:

- *firm 1:*
 - type φ^L offers $\frac{\varphi^L}{2}$;
 - type φ^H offers $\frac{\varphi^L}{2}$ with probability α and $\frac{\varphi^H}{2}$ with probability $(1 - \alpha)$, where $\alpha = \frac{2F}{\varphi^H - \varphi^L}$;
- *firm 2:*
 - if $\pi \geq \frac{\varphi^H}{2}$ it accepts the offer;
 - if $\frac{\varphi^L}{2} < \pi < \frac{\varphi^H}{2}$ it rejects the offer;
 - if $\pi = \frac{\varphi^L}{2}$ it accepts the offer with probability β and it rejects it with probability $(1 - \beta)$, where $\beta = \frac{4F}{4F + (\varphi^H - \varphi^L)}$;
 - if $\pi < \frac{\varphi^L}{2}$ it rejects the offer;
- *beliefs:*
 - if $\pi \neq \frac{\varphi^L}{2}$, then firm 2 believes that $\mu(\pi) = 1$;
 - if $\pi = \frac{\varphi^L}{2}$, then firm 2 believes that $\mu(\pi) = \frac{\alpha}{1 + \alpha}$.

The proof is in three steps. First, we show the strategy profile stated in Proposition 2 is an equilibrium. Second, we show that the out of equilibrium beliefs satisfy the divinity criterion D1. Finally, we show that there are no other equilibria of the bargaining game that satisfy the divinity criterion D1. Recall that we refer to 1 as the firm for which the asset has a positive value, that is $\varphi_1 \in \{\varphi^H, \varphi^L\}$.

1. Existence.

Type φ^L of firm 1. In equilibrium, it proposes $\pi = \frac{\varphi^L}{2}$ and obtains

$$\beta \left(\frac{\varphi^L}{2} \right) + (1 - \beta) \left(\frac{\varphi^L}{2} - F \right) - \varepsilon = \frac{\varphi^L}{2} - F(1 - \beta) - \varepsilon$$

since the proposal is accepted with probability β and rejected otherwise. Any other proposal smaller than $\frac{\varphi^H}{2}$ is rejected and it is therefore dominated by $\pi = \frac{\varphi^L}{2}$. Making "no offer",

type φ^L obtains $\frac{\varphi^L}{2} - F$, which is less than what it obtains in equilibrium provided that ε is small enough. Any proposal $\pi \geq \frac{\varphi^H}{2}$ is accepted by firm 2 but it is dominated since $\varphi^H - \varphi^L \geq 2F(1 - \beta) + 2\varepsilon$.

Type φ^H of firm 1. The proposal $\pi = \frac{\varphi^H}{2}$ is accepted and ensures a pay-off of $\frac{\varphi^H}{2} - \varepsilon$. The proposal $\pi = \frac{\varphi^L}{2}$ is accepted with probability β and ensures

$$\beta(\varphi^H - \frac{\varphi^L}{2}) + (1 - \beta)(\frac{\varphi^H}{2} - 2F) - \varepsilon.$$

Type φ^H is indifferent between proposals $\pi = \frac{\varphi^H}{2}$ and $\pi = \frac{\varphi^L}{2}$ provided that firm 2 accepts the second proposal with probability $\beta = \frac{4F}{4F + (\varphi^H - \varphi^L)}$. Any other proposal π different from $\frac{\varphi^H}{2}$ and $\frac{\varphi^L}{2}$ is dominated by $\pi = \frac{\varphi^H}{2}$; similarly, also making “no offer” at all is dominated by $\pi = \frac{\varphi^H}{2}$ provided that $\varepsilon < F$.

Firm 2. Accepting any $\pi \geq \frac{\varphi^H}{2}$ is optimal since its rejection ensures at most $\frac{\varphi^H}{2}$. Consistent with its beliefs, to reject any $\frac{\varphi^L}{2} < \pi < \frac{\varphi^H}{2}$ and any $\pi < \frac{\varphi^L}{2}$ is optimal for firm 2 since in this way it obtains $\frac{\varphi^H}{2}$ from the Court. When receiving a proposal $\pi = \frac{\varphi^L}{2}$, firm 2 believes that the proposer is of type φ^H with probability $\frac{\alpha}{1+\alpha}$ and of type φ^L with probability $\frac{1}{1+\alpha}$. Therefore, firm 2 is indifferent to accepting or rejecting $\pi = \frac{\varphi^L}{2}$ when $\frac{\varphi^L}{2} = \frac{\alpha}{1+\alpha}(\frac{\varphi^H}{2}) + \frac{1}{1+\alpha}(\frac{\varphi^L}{2} - F)$, that is when $\alpha = \frac{2F}{\varphi^H - \varphi^L}$. It can be easily verified that $\alpha \in (0, 1)$ provided that $\varphi^H - \varphi^L \geq 2F$.

2 Divinity criterion D1. First note that for any offer $\pi < \frac{\varphi^L}{2}$ to accept the proposal is a strictly dominated strategy. Similarly for any offer $\pi > \frac{\varphi^H}{2}$ to accept is a strictly dominant strategy and therefore beliefs over the proposer’s type are irrelevant.

Consider any offer π such that $\frac{\varphi^L}{2} < \pi < \frac{\varphi^H}{2}$. Let ρ denote the probability that firm 2 accepts the offer π . Type φ^H prefers to make such an offer than playing according to the equilibrium, provided that $\rho(\varphi^H - \pi) + (1 - \rho)\left(\frac{\varphi^H}{2} - 2F\right) - \varepsilon \geq \frac{\varphi^H}{2} - \varepsilon$, that is

$$\rho \geq \frac{4F}{\varphi^H - 2\pi + 4F} \equiv \bar{\rho}_H.$$

In turn, type φ^L prefers to offer π rather than playing according to the equilibrium, provided that $\rho(\varphi^L - \pi) + (1 - \rho)\left(\frac{\varphi^L}{2} - F\right) - \varepsilon \geq \frac{\varphi^L}{2} - F(1 - \beta) - \varepsilon$. First, note that if $\pi > \frac{\varphi^L}{2} + F$, the intuitive criterion ensures that firm 2 has to assign probability one that the proposer is type φ^H . For any $\frac{\varphi^L}{2} < \pi \leq \frac{\varphi^L}{2} + F$ we have

$$\rho \geq \frac{2\beta F}{\varphi^L - 2\pi + 2F} \equiv \bar{\rho}_L.$$

One can verify that $\bar{\rho}_H < \bar{\rho}_L$: in fact, substituting $\beta = \frac{4F}{4F + (\varphi^H - \varphi^L)}$ and denoting $\pi = \frac{\varphi^L}{2} + z$ with $0 < z \leq F$, after some manipulations the condition turns out to be equal to

$(2F + \varphi^H - \varphi^L)z > 0$, which holds true. Therefore only the out of equilibrium beliefs stated in the Proposition satisfy the divinity criterion D1.

3 Uniqueness.

To prove that there are no other equilibria of the bargaining game that satisfy the divinity criterion D1 we need to check all possible equilibria: separating, pooling and semi-separating. Let π^k denote the proposal made by type $k \in \{H, L\}$ of firm 1.

A. Separating Equilibria

First note that if in equilibrium a proposal has to be accepted, otherwise the type whose offer is rejected would prefer to make “no proposal” and save ε . If the two types of firm 1 make two different offers firm 2 has to accept both offers. However, the proposed one cannot be an equilibrium since the type whose equilibrium offer is the largest prefers to deviate and mimic the other type. It follows that one type makes no proposal in equilibrium. Suppose first that type φ^H makes “no proposal” and type φ^L proposes π^L . Then $\pi^L \leq \frac{\varphi^L}{2} + F - \varepsilon$, otherwise type φ^L prefers to make no proposal. This cannot be an equilibrium since type φ^H prefers to propose π^L rather than to make “no proposal”.

Suppose, then, that type φ^L makes “no proposal” while type φ^H proposes π^H : in such an equilibrium it has to be $\pi^H = \frac{\varphi^H}{2}$. For this to be an equilibrium, firm 2 has to reject any offer smaller than $\frac{\varphi^H}{2}$. This is the case provided that firm 2 assigns a positive probability to type φ^H when observing a proposal $\pi < \frac{\varphi^H}{2}$. We now prove that there exists $\tilde{\pi} \in \left(\frac{\varphi^L}{2}, \frac{\varphi^L}{2} + F\right)$ such that the divinity criterion D1 imposes that $\mu(\tilde{\pi}) = 0$. Hence given these beliefs firm 2 should accept proposal π and type φ^L would be better-off offering such a π rather than playing according to the equilibrium. Let $\tilde{\pi} \in \left(\frac{\varphi^L}{2}, \frac{\varphi^L}{2} + F\right)$ and let ρ be the probability that firm 2 accepts the proposal. The minimal probability for which type φ^H prefers to make such a proposal rather than offering $\frac{\varphi^H}{2}$ according to the separating equilibrium is such that $\rho(\varphi^H - \tilde{\pi}) + (1 - \rho)\left(\frac{\varphi^H}{2} - 2F\right) - \varepsilon \geq \frac{\varphi^H}{2} - \varepsilon$, or:

$$\rho \geq \frac{4F}{\varphi^H - 2\tilde{\pi} + 4F} \equiv \bar{\rho}_H.$$

The minimal probability for which type φ^L prefers to offer $\tilde{\pi}$ rather than, as required by the equilibrium, making no offer at all is $\rho(\varphi^L - \tilde{\pi}) + (1 - \rho)\left(\frac{\varphi^L}{2} - F\right) - \varepsilon \geq \frac{\varphi^L}{2} - F$, or:

$$\rho \geq \frac{2\varepsilon}{\varphi^L - 2\tilde{\pi} + 2F} \equiv \bar{\rho}_L.$$

For ε small enough it follows that $\bar{\rho}_L < \bar{\rho}_H$. Hence the divinity criterion D1 imposes $\mu(\tilde{\pi}) = 0$.

B. Semi-Separating Equilibria

As first we prove that we can have a semi-separating equilibrium only in the case in which type φ^H randomizes between two different proposals and type φ^L makes only a proposal.

Then, we prove that within this class of equilibria only the one stated in Proposition 2 survives to the scrutiny of the divinity criterion D1.

- B1 There exists no equilibrium in which type φ^H plays “no offer” with strictly positive probability: making no offer type φ^H obtains $\frac{\varphi^H}{2} - F$. This is a dominated strategy since an offer $\frac{\varphi^H}{2}$ is accepted by firm 2 and guarantees a pay-off $\frac{\varphi^H}{2} - \varepsilon$ to type φ^H ;
- B2 There exists no equilibrium in which type φ^L plays “no offer” with strictly positive probability: to check that this claim is true we need to consider two cases. Firstly, suppose that type φ^L plays “no offer” with probability 1. This cannot be the case since (by definition of semi-separating) this implies that type φ^H plays mixed strategies randomizing between “no offer” and some offer π , contradicting previous point B1. Secondly, suppose that type φ^L plays mixed strategies randomizing between “no offer” and an offer $\pi \in \left[\frac{\varphi^L}{2}, \frac{\varphi^L}{2} + F - \varepsilon\right]$ since otherwise “no offer” would dominate π . Type φ^L is indifferent between playing “no offer” and π if the latter offer is accepted by firm 2 with probability β such that $\frac{\varphi^L}{2} - F = \beta(\varphi^L - \pi) + (1 - \beta)\left(\frac{\varphi^L}{2} - F\right) - \varepsilon$, that is $\beta = \frac{\varepsilon}{\varphi^L + 2F - 2\pi}$. In a semi-separating equilibrium type φ^H should make the same offer π as type φ^L . However, it is easy to check that type φ^H prefers offering $\frac{\varphi^H}{2}$ rather than π ; indeed $\frac{\varphi^H}{2} - \varepsilon > \beta(\varphi^H - \pi) + (1 - \beta)\left(\frac{\varphi^H}{2} - 2F\right) - \varepsilon$ if and only if $4F > \frac{\varepsilon}{\varphi^L + 2F - 2\pi}(\varphi^H + 4F - 2\pi)$ which is certainly true for ε small enough.
- B3 There exists no equilibrium in which type φ^L plays mixed strategies randomizing between any π and $\pi + \delta$. Clearly it has to be that $\pi \geq \frac{\varphi^L}{2}$ and $\pi + \delta \leq \frac{\varphi^L}{2} + F - \varepsilon$ since any other strategy is dominated. Suppose, firstly, that type φ^H plays a deterministic strategy. If π is offered only by type φ^L , it is accepted by firm 2, but then both types of firm 1 prefer offering π with probability 1. Then type φ^H offers π . The offer $\pi + \delta$ reveals that firm 1 is of type φ^L and therefore it is accepted by firm 2. Therefore, type φ^L is indifferent between π and $\pi + \delta$ if and only if the former offer is accepted by firm 2 with probability β and rejected otherwise and with β such that $\varphi^L - (\pi + \delta) - \varepsilon = \beta(\varphi^L - \pi) + (1 - \beta)\left(\frac{\varphi^L}{2} - F\right) - \varepsilon$, that is, $\beta = \frac{\varphi^L + 2(F - \delta - \pi)}{\varphi^L - 2(\pi - F)}$. Given this β it is easy to verify that type φ^H prefers offering $\pi + \delta$ rather than π . Suppose now that type φ^H plays mixed strategies, randomizing between π and $\pi + \delta$. The proposed equilibrium has to be sustained by the following beliefs: for any $\tilde{\pi} \in (\pi, \pi + \delta)$, $\mu(\tilde{\pi}) > 0$. Indeed, if this is not the case then both types prefer to deviate and make such an offer instead of offering $\pi + \delta$. Using the standard arguments it can be shown that the divinity criterion D1 imposes to assign $\mu(\tilde{\pi}) = 0$ when $\pi + \delta - \gamma$ with $\gamma < \delta$ is offered.

Finally, we have to check the case where type φ^H plays mixed strategies while type φ^L plays pure strategies. Obviously it has to be that one offer is made by both types and another

offer is made by type φ^H only. In equilibrium the latter offer has to be $\frac{\varphi^H}{2}$. Moreover, the offer that is made by both types has to be no smaller than $\frac{\varphi^L}{2}$ to be accepted by firm 2. Let's denote the offer that is made by the two types as $\frac{\varphi^L}{2} + \Delta$. Note that, the case $\Delta = 0$ coincides with the equilibrium in Proposition 2 and therefore we restrict the attention to the case of $\Delta > 0$. It can be easily shown that type φ^H is willing to randomize between $\frac{\varphi^L}{2} + \Delta$ and $\frac{\varphi^H}{2}$ provided the former offer is accepted with probability $\beta = \frac{4F}{4F - 2\Delta + (\varphi^H - \varphi^L)}$ and rejected otherwise. Moreover, these offers are equilibrium strategies if firm 2 assigns $\mu(\pi) > 0$ when receiving $\frac{\varphi^L}{2} + \Delta - \gamma$ for $0 < \gamma < \Delta$. Again, such beliefs do not satisfy the divinity criterion D1. In fact, Type φ^H prefers to offer $\frac{\varphi^L}{2} + \Delta - \gamma$ rather than $\frac{\varphi^H}{2}$, provided that $\rho \left(\varphi^H - \frac{\varphi^L}{2} - \Delta + \gamma \right) + (1 - \rho) \left(\frac{\varphi^H}{2} - 2F \right) - \varepsilon \geq \frac{\varphi^H}{2} - \varepsilon$; that is provided that

$$\rho \geq \frac{2F}{\frac{\varphi^H}{2} - \frac{\varphi^L}{2} - \Delta + \gamma + 2F} \equiv \bar{\rho}_H.$$

Type φ^L prefers offering $\frac{\varphi^L}{2} + \Delta - \gamma$ rather the equilibrium offer $\frac{\varphi^L}{2} + \Delta$ provided that

$$\rho \left(\frac{\varphi^L}{2} - \Delta + \gamma \right) + (1 - \rho) \left(\frac{\varphi^L}{2} - F \right) - \varepsilon \geq \beta \left(\frac{\varphi^L}{2} - \Delta \right) + (1 - \beta) \left(\frac{\varphi^L}{2} - F \right) - \varepsilon$$

that is, if:

$$\rho \geq \frac{4F(F - \Delta)}{(4F - 2\Delta + (\varphi^H - \varphi^L))(F - \Delta + \gamma)} \equiv \bar{\rho}_L.$$

It can be easily shown that $\bar{\rho}_H > \bar{\rho}_L$ given that $2F + (\varphi^H - \varphi^L) > 0$ and therefore the divinity criterion D1 imposes $\mu(\pi) = 0$ when $\pi + \Delta - \gamma$ is offered.

C. Pooling Equilibria

Firstly note that it is not possible that both types make no offer. In the proposed equilibrium type φ^H obtains $\frac{\varphi^H}{2} - F$. However, an offer $\frac{\varphi^H}{2}$ is accepted by firm 2 and guarantees type φ^H a pay-off $\frac{\varphi^H}{2} - \varepsilon$. Secondly, direct calculation shows that there is no equilibrium in which both types of firm 1 play mixed strategies randomizing between no offer and the same offer $\pi \in \left(\frac{\varphi^L}{2}, \frac{\varphi^L}{2} + F - \varepsilon \right)$ (both types should be indifferent to making no proposal and making this proposal π). Finally both types making the same offer π cannot be an equilibrium. In order to be accepted it must that $\pi \geq \frac{1}{2} \left(\frac{\varphi^H}{2} \right) + \frac{1}{2} \left(\frac{\varphi^L}{2} - F \right)$, however the divinity criterion D1 imposes $\mu(\tilde{\pi}) = 0$ for $\tilde{\pi} = \pi - \varepsilon$. ■

Proof of Proposition 3

In case $\theta = \theta_B$, firm $i = 1, 2$ is the buyer ($\varphi_i > 0$) or the seller ($\varphi_i = 0$) of the asset with equal probability. If firm i is the buyer, it obtains

$$\frac{1}{2} \frac{\varphi^H}{2} + \frac{1}{2} \left(\frac{\varphi^L}{2} - F(1 - \beta) \right) - \varepsilon = \frac{E[\varphi]}{2} - \frac{F(1 - \beta)}{2} - \varepsilon.$$

if it is the seller

$$\frac{1}{2} \frac{\varphi^L}{2} + \frac{1}{2} \left(\frac{\varphi^L}{2} \alpha + \frac{\varphi^H}{2} (1 - \alpha) \right) = \left(\frac{E[\varphi]}{2} - \frac{\alpha}{4} (\varphi^H - \varphi^L) \right).$$

Hence, when choosing k_i firm $i = 1, 2$ solves the following maximization problem:

$$\max_{k_i} \quad \eta \cdot (k_1 + k_2) s_i v + (1 - \eta \cdot (k_1 + k_2)) \cdot \left[\frac{1}{2} \left(\frac{E[\varphi]}{2} - \frac{F(1-\beta)}{2} - \varepsilon \right) + \frac{1}{2} \left(\frac{E[\varphi]}{2} - \frac{\alpha}{4} (\varphi^H - \varphi^L) \right) \right] - \frac{\gamma}{2} k_i^2$$

The benefit from increasing marginally k_i is $\eta \cdot (s_i v - \frac{Q}{2})$, with $Q \equiv E[\varphi] - \left(\frac{F(1-\beta)}{2} + \varepsilon \right) - \frac{\alpha}{4} (\varphi^H - \varphi^L)$. Thus the optimal investment level of firm i is:

$$k_i(s_i) = \begin{cases} 0 & \text{if } s_i \leq \frac{Q}{2v} \\ \frac{v s_i - \frac{1}{2} [E[\varphi] - (\frac{F(1-\beta)}{2} + \varepsilon) - \frac{\alpha}{4} (\varphi^H - \varphi^L)]}{\gamma} & \text{otherwise} \end{cases}$$

The investment game has a unique equilibrium, but, depending on the selected values for s_1 and s_2 , it can have different characteristics: (i) only one firm makes a positive investment or (ii) both firms make a positive investment. It can be shown that, due to the convexity of the cost function, for any equilibrium of type (i) there is equilibrium of type (ii) that is more efficient. Therefore we consider values of s_1 and s_2 such that both firms are induced to invest. In what follows we let $s_1 = s$ and $s_2 = 1 - s$.

The (ex-ante) efficient share of the monetary values solves

$$\begin{aligned} \max_s \quad & \eta \cdot [k_1(s) + k_2(1-s)] v + \\ & + [1 - \eta \cdot [k_1(s) + k_2(1-s)]] \left[E[\varphi] - \left(\frac{F(1-\beta)}{2} + \varepsilon \right) - \frac{\alpha}{4} (\varphi^H - \varphi^L) \right] \\ & - \frac{\gamma}{2} [k_1(s)]^2 - \frac{\gamma}{2} [k_2(1-s)]^2 \end{aligned}$$

Direct calculations show that the $s^{NC} = \frac{1}{2}$ solves the above program; by plugging this value of s into the expressions of the firms' investment one obtains that in case of an (ex-ante) efficient without termination clause:

$$k_1^{NC} = k_2^{NC} = \frac{(v - E[\varphi]) \eta}{2\gamma} + \frac{\eta (2(F(1-\beta) + 2\varepsilon) + \alpha (\varphi^H - \varphi^L))}{8\gamma}. \blacksquare$$

Proof of Proposition 6

Consider the investment game. The profit that firm $i = 1$ or 2 obtains is $u_i(k_1, k_2, \xi) = p(k_1, k_2) s_i v + (1 - p(k_1, k_2)) \left(\frac{E[\varphi]}{2} - \xi \right) - c_i(k_1, k_2)$. ξ denotes the expected cost of litigation and is positive and bounded above when firms sign a contract without asset allocation clause and litigate with positive probability if the project fails, as shown in Proposition 2. s is zero in the case of a contract which includes an asset allocation clause. The assumptions of

Proposition 6 guarantee that $\frac{\partial u_i(k_i, k_{3-i}, \xi)}{\partial k_i \partial k_{3-i}} \geq 0$ for both $i = 1, 2$ which, in turn, imply that investment game is supermodular and, therefore, that a Nash equilibrium in pure strategies exists. Moreover, note that $\frac{\partial u_i(k_i, k_{3-i}, \xi)}{\partial k_i \partial \xi} = \frac{\partial p(k_i, k_{3-i})}{\partial k_i} > 0$ and, then, it follows that the profit function $u_i(k_i, k_{3-i}, \xi)$ has increasing differences in (k_i, ξ) . Therefore, since the investment game is a supermodular game indexed by ξ , the largest (and the smallest) Nash equilibria are increasing in ξ , by well-known results on supermodular games (see Vives, 1999 for a review). Finally, the assumption $s_i v - \frac{E[\varphi]}{2} > 0$ for $i = 1, 2$ implies that $\frac{\partial u_i(k_i, k_{3-i}, \xi)}{\partial k_{3-i}} = \frac{\partial p(k_i, k_{3-i})}{\partial k_{3-i}} (\sigma_i v - \frac{E[\varphi]}{2} + \xi) > 0$, so the investment game is supermodular with positive spillovers, and the largest Nash equilibrium is the Pareto-preferred. ■