# Termination Clauses in Partnerships*

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**Abstract**

In this paper, we prove that two firms can choose not to include a termination clause in their partnership contract, thus inducing a costly termination in case of failure of the joint project. This ex-post inefficiency induces partners to exert large non-contractible efforts (investments) to decrease the probability of failure. Therefore, the absence of a termination clause works as a "discipline device" that mitigates the moral hazard problem within the partnership. We show that writing a contract without a termination clause is a credible commitment even when partners can add such a clause in the contract in any moment of their relationship.

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**Keywords:** moral hazard; termination clauses; partnerships.

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# 1 Introduction

Strategic alliances, in the form of joint ventures (JVs) or looser modes of cooperation, are an increasingly popular solution in order 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 has grown 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 in 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 it is well documented in the 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 little attention to predict what happens in case of termination of the alliance. A PricewaterhouseCoopers (2000) survey shows that less than half of 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, various might be the reasons for such a lack. Just as a pre-nuptial agreement, discussing a termination clause when forming the alliance might sour the deal; it might reveal the lack of trust of partners. In addition, also difficulties in working out the various 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 to the relationship.[5]

The model we present in the following sections develops formally this idea. We consider

[1] These 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.

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

[4] We 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.

two firms that set up a joint venture to pursue a joint project.[6] After signing the JV-contract, firms non-cooperatively choose the levels of effort (investment) to exert. These efforts (investments) determine the likelihood of success/failure of the joint project and we assume that they are non-contractible.[7] In case of failure of the project firms terminate the partnership and decide upon the allocation of the assets belonging to the JV. If the JV-contract regulates the terms for termination then assets allotment takes place at zero cost. On the contrary, absent a termination clause, partners start a (costly) bargaining process to assign the ownership of the assets. We assume that partners have the possibility of reaching an amicable settlement and, in case they fail to agree, they come up before a court which takes the final decision. We show that in equilibrium partners do go to court with positive probability thus making the bargaining costly due to the related legal expenses.[8] The main result of our paper is that, under some circumstances, it is rational not to include a termination clause in the JV-contract. The intuition for this result is simple; by not including the clause, partners are making the failure of the project an even worse event: not only they do not succeed in pursuing their project but also they generate a costly bargaining process due to litigation before the court. This fact induces partners to exert larger efforts (investments). In other words, the absence of a termination clause works as a "discipline device" that alleviates the hold-up problem.

The crucial aspect when committing to a device that induces a costly bargaining relates to the credibility of the commitment itself. In our paper, asymmetric information makes the absence of a termination clause a credible commitment. Following the argument put forward by several authors,[9] we assume that partners are asymmetrically informed about the assets' value. In particular, we assume that only one firm observes how much the assets are worth; the attempt of this firm to appropriate most of the surplus during the bargaining stage induces the partner to reject an amicable settlement with positive probability so that firms resort to court for the allotment of the assets.[10]

[6] In this paper we focus on the strategic effects of contract clauses when parties start a partnership, in particular the effect of termination clauses on the partners' behavior. However, here we will not analyze 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.

[7] Several papers, both empirical as well as theoretical ones, have highlighted the presence and the consequences of the non-contractible nature of (at least part of) partners' contribution (see Morasch, 1995 Pérez-Castrillo and Sandonís, 1996, Tao and Wu, 1997 and Veugelers, 1993). For instance, the "quality" of the researchers or labs that partners agree to assign to the JV is very difficult to be specified in a contract. These variables might be observable by partners while cooperating in the joint venture, but they might be not verifiable in a court and therefore not contractible.

[8] In 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.

[9] See for instance Chi and Seth (2002).

[10] The effect of private information on the design of the optimal property rights has a long tradition that stems from the seminal papers by Coase (1937) and Williamson (1975) and the fundamental works by Hart and Moore on incomplete contracts and hold-up problems (see, for instance, Hart and Moore,1999). More recently, Matouschek (2004) has formalized the idea that the ownership structure should be tailored in order to minimize the size of ex-post inefficiencies caused by private information.

**Review of the relevant literature**

There are different strands of the economic literature that are related to our paper. The idea that the absence of a termination clause mitigates the hold-up problem is in line with the "resource commitment" argument put forward in the business literature.[11] It is argued that by devoting substantial resources to the partnership, firms increase their level of involvement and therefore they reduce the advantages of behaving opportunistically. Resource commitment can be achieved in various ways. The governance form of the alliance is one possible way and, in this respect, 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 and therefore to stabilize the alliance; by bringing some critical assets (the hostages) to the partnership, parties become more vulnerable and therefore less prone to behave in an opportunistic manner.[12] Therefore, with reference to this strand of literature, we claim that the absence of a termination clause is a further way in which resource commitment can be obtained.

A relatively recent literature stemming from the paper of Cramton, Gibbons and Klemperer (1987) focuses on partnership dissolution; two are the main issues that are tackled: i) under what conditions there is 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)?[13] ii) what are the relative merits of commonly used dissolution clauses such as the so-called Texas-shootout? [14] Our paper departs from this literature quite substantially. We consider the relation between the effort (investment) decision made by the partners and the possible termination of the alliance while the existing literature on partnership dissolution focuses exclusively on the break-up decision.[15] Moreover, we show that under some circumstances it is rational to induce a costly bargaining by not regulating the terms for the break-up even in case a simple termination clause would induce an efficient termination decision.

The idea that it might be beneficial to improve ex-ante efficiency (in our paper, larger effort/investment) by imposing some inefficiencies ex-post (in our paper, costly bargaining) through the absence of a termination clause is similar to the one presented in a quite different context by Bordignon and Brusco (2001). These authors show that the lack of exit rules in federal constitutions can be a commitment device; high costs of secessions (secessions are

[11] The literature on "resource commitment" in strategic alliances is extremely vast. A comprehensive and neat discussion on this issue can be found in Buckley and Casson (1988) and Das and Rahman (2002).

[12] Williamson (1983) discusses the use of mutual hostages positions as means to stabilize relationships. For an application to joint ventures see Buckley and Casson (1988), Das and Rahman (2002) and Kogut (1989).

[13] See Fiesler, Kittsteiner and Moldovanu (2003) and McAfee (1992).

[14] In a Texas-shootout the procedure to assign the assets is such that one partner announces a price and the counterpart chooses whether to be the buyer or the seller of the assets. See Brooks and Spier (2004) and De Frutos and Kittsteiner (2004) for recent contributions on this topic.

[15] One relevant exception is represented by Li and Wolfstetter (2004) who consider both partners' contributions and possible termination of the JV. The fundamental difference with our paper and that of Li and Wolfstetter 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.

possible only by "independence wars") increase the stability of the federation, and therefore the ex-ante benefits of joining it. Even though the underlying idea is the same, the two papers differ for at least two fundamental aspects. First in Bordignon and Brusco (2001) the lack of exit rules is a credible commitment to an ex-post inefficiency (i.e. it is renegotiation-proof) only if there exists a positive cost of renegotiation. Contrarily, in our paper the contract without termination clause induces an ex-post inefficiency even though partners are allowed to reach an amicable (i.e. with no renegotiation cost) settlement. Second, in Bordignon and Brusco (2001) parties never litigate in equilibrium (there is never secession by an independence war). However, we want to explain why in reality we observe not only contracts without termination clauses, but also partnerships which terminate with costly litigations in front of courts.

Our paper is also related to the stream of literature which takes into consideration strategic reasons for contract incompleteness. Non-contigent contracts as a signaling/screening device are analyzed in Aghion and Bolton (1987), Diamond (1993), Hermalin (2001), Nicolò and Tedeschi (2003) and Spier's (1992). Bernheim and Whinston (1998) show that contracts which 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, then incomplete contracts that expand the set of discretionary choices/strategies may be used in order to induce parties to coordinate on Pareto superior equilibria.

The outline of the paper is as follows. In Section 2, we describe the main features of the model. In Section 3, we derive the main results while Section 4 is devoted to check their robustness. Finally, in Section 5 we present a concluding discussion. All the proofs that are not essential for a clear 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. The project will be successful, with probability $p = \min\left\{\frac{k_1+k_2}{2}, 1\right\}$ while with probability $(1-p)$ the project will fail . $k_i \geq 0$ represents the investment level chosen by partner $i = 1, 2$ and $c(k_i) = \frac{\gamma k_i^2}{2}$ is the corresponding private cost. $k_i$ can be interpreted as the economic value of the labs and researchers assigned by firm $i$ to the joint project. The quality of the assignments is not verifiable and therefore not contractible. At an intermediate stage of the project, after the investment levels have been chosen, firms observe a perfect signal of the future outcome, $\theta \in \{\theta_G, \theta_B\}$, where $\theta_j$ stands for the signal of outcome $j$, and may decide whether to continue or to terminate the partnership. When $\theta = \theta_G$ (where $G$ stays for "good") firms know that the project will generate a monetary value $v_G = v$ provided that the partnership is continued and 0 in case of early termination at the intermediate stage. When $\theta = \theta_B$ (where $B$ stays for "bad") they know that the project will generate a monetary value $v_B = 0$.

Firms' collaboration generates some intermediate result which is 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 of the partnership the asset can be acquired by one of them and used for its own business. We assume that the asset has a positive private value for one firm only, that is either $\varphi_1 = 0$ and $\varphi_2 > 0$ or $\varphi_1 > 0$ and $\varphi_2 = 0$, and that the two events occur with equal probability independently from the realization of the outcome or the investment levels.[16] Moreover, we assume that when the private evaluation of firm $i = 1, 2$ is positive, it can take value $\varphi_i \in \{\varphi^H, \varphi^L\}$ with $\varphi^H > \varphi^L > 0$ and that each realization is equally likely and independent from the outcome or 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 $\theta$ and the investment levels $k_i$, $i = 1, 2$, are observed by both firms even though they are not verifiable, that is, non-observable by third parties. The only source of asymmetric information between the two firms relies on the private value of the asset, since firm $i$ for which $\varphi_i = 0$ does not observe whether the counterpart's private value is $\varphi^H$ or $\varphi^L$.

*The exact timing of the game is as follows.*
At **time** $t = 0$ partners decide upon the terms of their partnership contract. The contract specifies how firms share the monetary value generated by the project and might include a termination clause; this last clause determines who has the right to terminate the partnership and the rules for allocating the asset $A$. If the contract is silent on some aspects, the commercial law directly completes the contract in some cases (for instance the law determines who has the right to terminate the partnership) while in other cases parties have to go in front of a court to settle their controversies. The cost of writing and modifying the contract is fixed and equal to $\varepsilon$, which is positive but arbitrarily small.[17] After agreeing on the terms of the contract, partners simultaneously choose the investment levels.
At **time** $t = 1$, firms observe the signal $\theta$ and decide whether to continue or to terminate the partnership, in accordance with the contract clauses or, in their absence, with the law. In case of termination, if the contract does not specify how to allocate the asset $A$, then firms start a bargaining stage to assign its ownership. If parties do not reach an agreement during the bargaining stage they resort to court which verifies the value of the asset and decides how to split this value and the overall legal expenses $2F$ between the two partners (we will be clearer on the rules of the court in Section 3.3). We assume that the court can verify (estimate) the value of $A$ and the monetary value of the project, but it cannot observe neither the levels of investment, nor the signal.
At **time** $t = 2$ the monetary or private values are realized.

[16] We implicitly assume that the market value of the asset is nought. However, this assumption seems reasonable, given that the asset is worthless for one of the two partners.

[17] We are interested in showing that partners can choose to not write a termination clause even when the cost of writing such a clause is negligible, otherwise there are obvious reasons to observe contracts without termination clauses.

Throughout the paper we will assume that the following conditions are met:
(A1) $v > \varphi^H$ and $\varphi^L > 2F > 0$;
(A2) $\varphi^H - \varphi^L \geq 2F$;
(A3) $\gamma > \frac{v}{2}$.

The first inequality in (A1) implies that it is efficient to continue the partnership when $\theta = \theta_G$ while the second implies both that termination is efficient when $\theta = \theta_B$ and that firms are better-off going to court to allocate the asset rather than disposing of it, when they don't reach an agreement in the bargaining stage. Condition (A2) requires the two possible positive private values of the asset to be different enough. In particular, it guarantees that during the bargaining stage there is a meaningful asymmetry of information between partners so that the proposer of the settlement has incentives to try to appropriate most of the surplus of the relationship. Finally condition (A3) requires that the costs are "sufficiently" high; this last condition implies that partners will never choose investment levels so large as to induce $\theta = \theta_G$ with probability 1.[18]

*The set of contracts*
We denote with $C$ the set of all possible contracts that can be chosen at time $t = 0$ by the two firms. In turn, a contract is a set of clauses which contains some or all of the following provisions:
(i) the share $s \in [0, 1]$ of the monetary value that firm 1 receives at time $t = 2$ when the project is continued (and $(1 - s)$ is the share of firm 2);
(ii) an indicator function $d$ which specifies which firm has the right to terminate the partnership: $d = i$ if firm $i$ only has this right with $i = 1$ or 2, $d = 1 \vee 2$ if each firm is entitled to terminate the partnership unilaterally, and finally $d = 1 \wedge 2$ if termination requires unanimity;
(iii) the price $b$ at which the asset can be acquired/sold in case of early termination of the partnership;
(iv) the probability $f \in [0, 1]$ according to which, once termination has been decided upon, firm 1 is selected to choose whether to be the buyer or the seller of the asset at price $b$. $(1 - f)$ is the probability that firm 2 is selected.

# 3 Results

## 3.1 Benchmark: the Cooperative Solution

We start our analysis by defining the cooperative (and then efficient) solution. In order to maximize the joint expected pay-off of the two partners, decisions have to be efficient both ex-post, at $t = 1$ once firms have observed the signal $\theta$, as well as ex-ante, at $t = 0$ when firms are uncertain about the success of the project.

[18]Relaxing condition (A3) complicates the presentation of the results substantially without adding any interesting new insight.

Ex-post efficiency relates both to the continuation or termination decision and, in the latter case, to the rules of allotment of the asset $A$. >From condition (A1), the ex-post decisions are efficient if:
(1) when $\theta = \theta_G$, the partnership is continued;
(2) when $\theta = \theta_B$, the partnership is terminated and the asset is assigned to firm 1 if $\varphi_1 > 0$ and to firm 2 otherwise.

Ex-ante efficiency imposes that $k_1$ and $k_2$ are set at the levels that maximize the joint expected pay-off; that is:

$$\max_{\{k_1,k_2\}} pv + (1-p)\,E\left[\varphi\right] - \frac{\gamma k_1^2}{2} - \frac{\gamma k_2^2}{2},$$

with probability $p$ the project will be successful thus generating the overall pay-off $v$, while with probability $(1-p)$ the expected pay-off will be $E\left[\varphi\right]$. From the first order conditions it follows that the efficient investment levels are:

$$k_i^{Coop} = \frac{v - E[\varphi]}{2\gamma}, \qquad \text{for } i = 1, 2. \tag{1}$$

## 3.2 Ex-post Efficient Complete Contracts

Let us now consider the non-cooperative case in which each firm acts in order to maximize its own expected pay-off rather than the joint one. In this section, we focus on the set of complete contracts (contracts that specify all the four elements described in Section 2) that lead to ex-post efficiency, that is, that induce the efficient continuation/termination decision as well as the efficient assignment of the asset. We denote with $C^{epeff} \subset C$ the set of complete and ex-post efficient contracts.

We provide a couple of preliminary results which characterize the $C^{epeff}$ set. The first states that the price $b$ at which the asset can be acquired should not be too large, otherwise the firm which assign to the asset a positive private value could prefer to sell it instead of efficiently buying it. The second, instead, states the conditions which induce an efficient continuation/termination decision and shows that these conditions depend on how the rights to end the partnership are specified.

**Lemma 1** *Once termination has been decided, then under a complete contract there is always efficient allotment of the asset $A$ if and only if $b \in \left[0, \frac{\varphi^L}{2}\right]$.*

**Proof.** Suppose that the partnership has been terminated and call $i$ the firm that has been selected to choose whether to be the buyer or the seller of the asset. When $b \in \left[0, \frac{\varphi^L}{2}\right]$ the asset is always efficiently allotted, in fact: if $\varphi_i > 0$, then firm $i$ prefers to be the buyer rather than the seller since $\varphi^k - b \geq b$ for both $k \in \{H, L\}$; if $\varphi_i = 0$, then firm $i$ prefers to be the seller since $b \geq -b$. Suppose that $b > \frac{\varphi^L}{2}$ : when $\varphi_i > 0$, since $\varphi^L - b < b$, then type $L$

inefficiently prefers to be the seller. Hence, there is not always an efficient allotment of the asset in case of termination. ■

**Lemma 2** *A complete contract with efficient allotment of the asset A, induces an efficient decision about the termination of the partnership if and only if the following conditions are satisfied:*
*(i) if* $d = 1$*, then* $sv \geq \varphi^H - b$*;*
*(ii) if* $d = 2$*, then* $(1 - s)\,v \geq \varphi^H - b$*;*
*(iii) if* $d = 1 \vee 2$ *then* $sv \geq \varphi^H - b$ *and* $(1 - s)\,v \geq \varphi^H - b$*;*
*(iv) if* $d = 1 \wedge 2$*, then the decision is always efficient.*

**Proof.** >From Section 3.1 we know that efficiency requires continuation of the partnership in case $\theta = \theta_G$ and termination in case $\theta = \theta_B$. Consider case (i); firm 1 decides to continue the partnership when $\theta = \theta_G$ provided that: (1) $sv \geq \varphi^H - b$, this ensures continuation in case $\varphi_1 > 0$; and (2) $sv \geq b$, this ensures continuation in case $\varphi_1 = 0$. From condition $b \in \left[0, \frac{\varphi^L}{2}\right]$, (1) implies (2). Moreover, firm 1 always chooses to terminate the partnership when $\theta = \theta_B$ since, by Lemma 1, it obtains $b \geq 0$ in case $\varphi_1 = 0$ and $\varphi_1 - b > 0$ in case $\varphi_1 > 0$ rather than a pay-off of 0 that it would obtain by continuing the partnership. A similar argument applies for case (ii) when firm 2 has the unilateral right to decide upon termination/continuation of the partnership. In case (iii) the efficient continuation/termination decision is always taken provided that: (a) none of the firms wants to terminate the partnership when $\theta = \theta_G$; and (b) at least one firm wants to terminate the partnership when $\theta = \theta_B$. From the analysis of cases (i) and (ii) we know that (a) is verified provided that $sv \geq \varphi^H - b$ and $(1 - s)\,v \geq \varphi^H - b$ while (b) is always satisfied since condition $b \in \left[0, \frac{\varphi^L}{2}\right]$ implies that both firm prefer termination when $\theta = \theta_B$. In case (iv) an efficient continuation/termination decision is always taken provided that: (a) at least one of the firms wants to continue the partnership when $\theta = \theta_G$; and (b) both firms want to terminate the partnership when $\theta = \theta_B$. Condition $v > \varphi^H$ ensures that condition (a) is always verified; indeed, consider the case $\varphi_1 > 0$ and $\varphi_2 = 0$, then at least one of the following conditions $sv \geq \varphi^H - b$, $(1 - s)\,v \geq b$ is verified so that there is continuation. A similar argument applies for the alternative case $\varphi_1 = 0$ and $\varphi_2 > 0$. Finally, as for cases (i) and (ii) discussed above, condition $b \in \left[0, \frac{\varphi^L}{2}\right]$ implies that both firms prefer to terminate the partnership when $\theta = \theta_B$ so that condition (b) is always met. ■

The next proposition characterizes the efficient contracts in the $C^{epeff}$ set; that is, the contract that induces partners to choose the levels of investment that maximize their joint pay-off given that the investments have to be incentive compatible and that conditions of lemmas 1 and 2 are met.

**Proposition 1** *A contract is efficient in the set* $C^{epeff}$ *if and only if it satisfies the equal sharing rule, i.e., provided that* $s = \frac{1}{2} \equiv s^C$*. The equilibrium levels of investment chosen by partners under such a contract are* $k_i = \frac{v - E[\varphi]}{4\gamma} \equiv k_i^C$*, with* $i = 1, 2$*.*

**Proof.** See the Appendix. ■

The efficient contract within the $C^{epeff}$ set provides for an equal sharing of the monetary revenues generated by the partnership. This result can be easily understood. From Lemma 1 we know that in case $\theta = \theta_B$ the two firms obtain the same expected pay-off since with equal probability each of them is buyer or seller of the asset. Given the convexity of the cost function, then it is optimal to share equally the pay-off even in case $\theta = \theta_G$.

## 3.3 Contracts with no Termination Clauses (NC-Contract)

In this section, we focus on the set of incomplete contracts which do not include a termination clause. Such contracts specify only how the monetary value generated by the project is shared between partners, namely $s$ and $1 - s$. We denote this set $C^{NC} \subset C$.

Even though the contract is incomplete in several respects, some decisions are regulated by the relevant laws. The identity of the partner/partners who is entitled to terminate the partnership is defined by the commercial law which may allow a unilateral decision or require unanimity. In what follows we assume that unanimity is required to terminate the partnership.[19] What is not regulated by default by the law is how to assign the asset belonging to the JV: who will get the asset and how much she has to pay for it. Therefore, firms will decide the allocation of $A$ in a bargaining stage which takes place once termination has been chosen. Without loss of generality, in what follows we refer to 1 as the firm for which the asset has a positive value, that is, $\varphi_1 \in \left\{\varphi^H, \varphi^L\right\}$ and $\varphi_2 = 0$.

### 3.3.1 Bargaining over Asset Ownership

We assume that the bargaining stage is as follows. Firm 1, observes the private value of the asset $\varphi_1 \in \left\{\varphi^H, \varphi^L\right\}$ and thereafter proposes a trading price $\pi$ at which it is willing to buy $A$.[20] The cost of making the proposal is $\varepsilon$. Partner 2 can either accept or reject the offer. In case of acceptance, the terms of the proposal are enforced. In case of rejection firms go to court. We assume that the court uses the following rules.

**The Court's Rules** The court verifies the value of the asset (i.e. firm 1's evaluation) and then decides: (i) about the allotment of $A$, (ii) the compensation of the seller and (iii) how the division of the legal expenses $2F$. We assume that the court decision is efficient, that is, it assigns $A$ to firm 1. Moreover, it compels firm 1 to pay the fair price (i.e. half of the value of the asset) to firm 2. Finally, court allocates the legal expences $2F$ adopting fee-shifting rules based on pre-trial proposals. Namely, $2F$ is equally shared unless firm 1 offered a price $\pi$ for the asset smaller than the fair one; in this latter case, the whole legal expenses are

[19] It can be shown that our results are not altered if unilateral termination is specified in the commercial law.

[20] In Section 4 we consider the case in which firm 2 makes the proposal.

charged to firm 1.[21] This rule implies that the court wishes to promote amicable settlements between firms.

With a little abuse of notation, we let $\varphi^k$ denote firm 1' type when it observes that the asset value is $\varphi^k$, with $k \in \{H, L\}$. Moreover, we let $\mu\left(\varphi^k\right)$ be the probability that firm 2 assigns to the event "firm 1 is of type $\varphi^k$" after receiving an offer $\pi$. The next proposition characterizes the equilibrium of the bargaining game.

**Proposition 2** *The unique PBE of the bargaining game which satisfies the divinity criterion D1 is the following:*

- *firm 1:*
  - *type $\varphi^L$ offers $\frac{\varphi^L}{2}$;*
  - *type $\varphi^H$ offers $\frac{\varphi^L}{2}$ with probability $\alpha$ 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 he offer;*
  - *if $\pi = \frac{\varphi^L}{2}$ it accepts the offer with probability $\beta$ 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 $\mu(\varphi^H) = 1$;*
  - *if $\pi = \frac{\varphi^L}{2}$, then firm 2 believes that $\mu(\varphi^H) = \frac{\alpha}{1+\alpha}$.*

**Proof.** See the Appendix. ■

As Proposition 2 shows the equilibrium of the bargaining game is semi-separating. Type $\varphi^L$ makes the fair offer while type $\varphi^H$ plays mixed strategies: with probability $(1-\alpha)$ it makes the fair proposal and with complementary probability it mimics the other type in order to obtain the asset at a lower price. Firm 2 accepts to sell the asset at a price $\frac{\varphi^H}{2}$ while

[21] Fee-shifting rules are used in many legislation (as Rule 68 of the Federal Rules of Civil Procedures in the United States). These rules provide strong incentives to parties in order to avoid costly litigations in front of the court and to induce them to reach a (costless) agreement. Indeed, Spier (1994) proves that "if litigants are asymetrically 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 unfovourable rules in order to prove that partners do not reach an agreement in the bargaining stage.

when $\frac{\varphi^L}{2}$ is offered it randomizes between accepting and rejecting the proposal. This last fact implies that in equilibrium there is a positive probability that a proposal is rejected and that parties solve their dispute in front of the court; when this happens, there is an ex-post inefficiency: in order to assign the asset parties incur an additional cost $2F$, that is, the legal expenses.

The equilibrium characterized in the Proposition 2 is the onòy one which satisfies the divinity D1 criterion. Given that we will employ this refinement concept several times, it is worth giving an informal intuition of how it works. Consider that firm 1 makes an out-of-equilibrium proposal and consider any conjecture that this firm has about how the partner reacts. If it happens that, given any conjecture, type $\varphi^H$ finds it optimal to deviate whenever it is optimal for type $\varphi^L$ while the opposite does not hold, then the D1 criterion imposes to assign probability 1 that the proposer is of type $\varphi^H$. Loosely speaking, type $\varphi^H$ values the asset the most and therefore he is also the one which would obtain the largest benefit in case of acceptance of an out-of-equilibrium proposal. Hence, only type $\varphi^H$ has an interest in making an out-of-equilibrium proposal for a sufficiently small probability of acceptance.

### 3.3.2 The Efficient NC-Contract

Given the equilibrium at the bargaining stage we can characterize the efficient contract with no termination clause, that is, in the set $C^{NC}$.

**Proposition 3** *A contract is efficient in the set $C^{NC}$ if and only if it satisfies the equal sharing rule, i.e. provided that $s = \frac{1}{2} \equiv s^{NC}$. The investment equilibrium levels induced by such a contract are*

$$k_i = \frac{v - E[\varphi]}{4\gamma} + \frac{4\left(F\left(1-\beta\right)+\varepsilon\right)+\alpha\left(\varphi^H - \varphi^L\right)}{16\gamma} \equiv k_i^{NC}, \qquad i = 1, 2.$$

**Proof.** See the Appendix. ■

The efficient contract provides for the equal sharing of the monetary values generated by the project also in this case, in analogy with Proposition 1. Indeed, the two firms have the same probability ex-ante of acting as proposer (i.e. of assigning a positive value to the asset) in the bargaining game which implies that they obtain the same expected pay-off in case of failure of the project. The convexity of the cost function implies that it is efficient for the two partners to share equally the expected pay-off also when the project is successful. The reason is that in a symmetric model equal sharing of the revenues gives to the partners the same incentives to invest. Therefore it induces equal investment levels for the two firms, minimizing total costs for given level of total investment.

## 3.4 The Choice of the Contract

We can now compare the performances of the complete and incomplete contracts that we have considered in the previous sections. The following result shows that, under some circumstances, the incomplete contract defined in Proposition 3 outperforms in terms of efficiency any complete and ex-post efficient contract.

**Proposition 4** *The NC-contract of Proposition 3 Pareto dominates any complete contract in $C^{epeff}$ if:*

$$v \geq \frac{4F\left(12E[\varphi] + 32\gamma - 3F\right) + \left(\varphi^H - \varphi^L\right)\left(32\gamma + 12E[\varphi] - 9F\right)}{48F + 12\left(\varphi^H - \varphi^L\right)}$$

**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 $\varepsilon$ is negligible. ■

Compared with a complete and ex-post efficient contract, the effect of not including a termination clause in the initial agreement is twofold. On the one hand, it induces an ex-post inefficiency given that with a positive probability firms will litigate in front of the court in order to assign the asset. On the other hand, the absence of a termination clause has also an incentive effect. The inefficiency due to litigation reduces the expected pay-off in case of failure of the project and this fact induces partners to make larger investments in order to avoid the occurrence of the bad outcome $\theta = \theta_B$. This second effect emerges by a simple comparison of the equilibrium investment levels defined in Propositions 1 and 3.[22] The main message of the above result is that it might be rational for firms to write an incomplete contract which will be completed in front of the court, bearing the litigation costs. Costly litigation, induced by the absence of a termination clause, works as a "discipline device" that mitigates the moral hazard problem induced by the non-contractibility of the investment levels.

# 4 Robustness of the Results

## 4.1 Complete Contracts with ex-post Inefficiencies

In principle, also a complete contract can introduce some kind of ex-post inefficiency as in an NC-contract and therefore give correct incentives to the partners in the investment stage. For instance, a very large price for the asset might induce some kind of inefficiency in case of $\theta = \theta_B$ with similar incentive effects as the absence of a termination clause. Indeed, with such contracts partners might reduce their expected pay-off in case of failure of the joint project by inducing the continuation of the partnership or by assigning the asset to the "wrong" firm. However, the following proposition shows that complete contracts that induce ex-post inefficiencies are meaningless given that they are efficiently renegotiated by partners at time $t = 1$.[23]

[22] It can be verified that the investment is lower than the efficient one both under the complete and the incomplete contracts.

[23] Note that here, unlike the previous sections, we say that parties renegotiate (and not bargain) their contract at time $t = 1$. In fact, we refer to bargainig as the attempt to reach a settlement when the initial contract is "incomplete" and does not specify termination clauses for $A$. For this reason here we prefer to use the word "renegotiation".

**Proposition 5** *Any complete contract that induces some inefficiency at* $t = 1$ *either*
*(i) is efficiently renegotiated; that is there exists a new contract* $\tilde{c} \in C^{epeff}$ *that both firms agree to sign at time* $t = 1$*; or*
*(ii) is Pareto dominated by the contract defined in Proposition 1.*

**Proof.** See Appendix. ■

An inefficient clause is a credible commitment only if at least one partner rejects all renegotiation proposals. In the proof we show that (i) when a complete contract induces inefficient allotment of the asset or inefficient continuation (that is continuation when $\theta = \theta_B$), firm 1 can always make a proposal (ex-post efficient) such that firm 2 finds optimal to accept this proposal when its beliefs satisfy the D1 criterion; (ii) contracts which induce inefficient termination (i.e. termination when $\theta = \theta_G$) with positive probability can be renegotiation-proof. However partners never draw these contracts since they induce an even lower level of investments than $k_i^C$.

## 4.2 Less Informed Firm Acting as Proposer

In Section 3.3 we have assumed that the more informed firm acts as proposer in the bargaining stage. We prove that our results remain qualitatively the same when changing the bargaining structure; namely, even if the proposer is the less informed firm (i.e. the firm which ignores the exact value of $A$) firms litigate in front of a court with positive probability in order to assign the asset. In what follows we maintain the convention of referring to 2 as the firm which ignores the value of $A$, i.e. $\varphi_2 = 0$.

Consider that firms have terminated the partnership. The bargaining stage follows the usual rules, but firm 2 is the proposer. Firm 2 has three alternatives. The first is to make no offer at all so that the dispute is solved in front of the court. The second alternative is to propose a selling price so high so that for type $\varphi^H$ can eventually accept it. Finally, the last possibility is asking for a lower price, which can be accepted also by type $\varphi^L$. The following proposition shows that when $F$ is not too large, then firm 2 prefers to make no proposal so that partners always resort to court in case of termination.

**Proposition 6** *Suppose that the less informed firm is the proposer of a settlement in the bargaining stage. If* $F \leq \frac{1}{2}\left(\frac{\varphi^H - \varphi^L}{2}\right) + \varepsilon$*, it makes no proposal and then, in case of termination, the asset* $A$ *is always assigned by the court.*

**Proof.** Let $\pi$ denote firm 2's proposal. Firm 2 knows that by not making any proposal it obtains an expected pay-off $E[\varphi^k] - F$ since the assignation of the asset is decided by the court. Therefore the only sensible proposals for firm 2 are those such that $b - \varepsilon \geq E[\varphi^k] - F$. Type $\varphi^H$ accepts a proposal if and only if $\pi \leq \frac{\varphi^H}{2}$, since if $\pi$ is larger than $\frac{\varphi^H}{2}$ all the litigation costs are borne by the the proposer, while if it rejects such a proposal it obtains $\frac{\varphi^H}{2} - F$. Similarly, type $\varphi^L$ accepts a proposal if and only if $b \leq \frac{\varphi^L}{2}$. Firm 2 either proposes $\pi = \frac{\varphi^H}{2}$ and expects $\frac{1}{2}\left(\frac{\varphi^H}{2}\right) + \frac{1}{2}\left(\frac{\varphi^L}{2} - 2F\right) - \varepsilon = E[\varphi^k] - F - \varepsilon$, or it proposes $\frac{\varphi^L}{2}$ and expects $\frac{\varphi^L}{2} - \varepsilon$. Therefore firm 2 makes no proposal if and only if $E[\varphi^k] - \frac{\varphi^L}{2} + \varepsilon \geq F$, that is $F \leq \frac{1}{2}\left(\frac{\varphi^H - \varphi^L}{2}\right) + \varepsilon$. ■

As shown in the proof of Proposition 6, when the court adopts a fee-shifting rule to allot the legal expenses, proposing a selling price which is accepted by type $\varphi^H$ only is a dominated choice for firm 2. Indeed, by making such an offer it will be required to pay the whole legal expenses whenever type $\varphi^L$ rejects this (unfair) offer.[24] By proposing a selling price which is always accepted by the partner, firm 2 can ask at most half of the lowest possible value of the asset (at most it can ask $\frac{\varphi^L}{2}$) but it avoids the legal expenses. On the contrary, by making no offer at all, firm 2 gets from the court half of the value of the asset but it pays the legal expenses $F$ with certainty. As shown, in the above proposition making no offer is the preferred option for firm 2 whenever the $F$ is not too large.

The assumption that the court uses a fee-shifting rule to assign the legal expenses might seem at odds with the fact that, when making the proposal, firm 2 ignores the true value of the asset. The following remark shows that even when the court adopts other rules to assign the legal expenses, then still partners go to court whenever $F$ is not too large.[25]

**Remark 1** *Suppose that the court's rule is such that each litigant always bears half of the overall legal expenses (the so-called American Rule ). In this case, the less informed firm either asks for* $\pi = \frac{\varphi^H}{2} + F$ *and expects* $\frac{1}{2}\left(\frac{\varphi^H}{2} + F\right) + \frac{1}{2}\left(\frac{\varphi^L}{2} - F\right) - \varepsilon = \frac{E[\varphi]}{2} - \varepsilon$, *since the proposal is accepted by type* $\varphi^H$ *only; or it asks for* $\pi = \frac{\varphi^L}{2} + F$ *and expects* $\frac{\varphi^L}{2} + F - \varepsilon$ *since both types of firm 1 accept the proposal. When* $F \leq \frac{1}{2}\left(\frac{\varphi^H - \varphi^L}{2}\right)$, *the less informed firm proposes* $\pi = \frac{\varphi^H}{2} + F$ *so that parties go to court whenever firm 1 is of type* $\varphi^L$*; that is, when* $\theta = \theta_B$ *they go to court with probability* $\frac{1}{2}$.[26]

## 4.3 Renegotiation between $t = 0$ and $t = 1$

So far we allowed partners to "complete" (i.e. agree upon a price for the asset) their NC-contract only once the partnership has been terminated. However, in principle, renegotiation could take place at other points in time. In particular, the possibility of renegotiating the initial contract after having chosen the level of investment and before observing $\theta$ (i.e. after $t = 0$ and before $t = 1$) might undermine the discipline device properties of a NC-contract.

[24] The fee-shifting rule that we have specified in Section 3.3.1 does not require the court to verify whether the proposer has observed the true value of the asset or not. As shown in the proof of Proposition 6, this rule implies that the proposer can be punished for not having offered the fair price even if it ignores the true value of the asset (i.e. even if it ignores what the fair price is). Therefore, the rule can probably be justified in case the court is unable to verify whether the proposer is informed and it is unaware of it. Under milder assumptions other rules (as the one suggested in the following Remark 1) seem to be more reasonable.

[25] Note that this time parties solve their disputes in front of the court because firm 2 asks for such a large price that only type $\varphi^H$ is willing to accept.

[26] Making no proposal firm 2 expects $\frac{E[\varphi]}{2} - F$ which is certainly less that what it gets by asking a price $\frac{\varphi^H}{2} + F$.

At this time, partners do not face the moral hazard problem any longer and therefore it would be efficient for them to agree on a termination clause in order to avoid the possible costly litigation.

In Proposition 7 we show that if there exists a positive (infinitely small) probability that, between $t = 0$ and $t = 1$, one of the two firms has of already observed its private valuation of the the asset $A$, then parties do not complete their contract signing an ex-post efficient contract. In particular, we assume that at the time of renegotiation three events might have occurred: (i) with probability $\frac{\lambda}{2}$ firm 1 only observed its private valuation of the asset (either $\varphi_1 = 0$, $\varphi_1 = \varphi^H$ or $\varphi_1 = \varphi^L$), (ii) with probability $\frac{\lambda}{2}$ firm 2 only observed its private valuation of the asset (either $\varphi_2 = 0$, $\varphi_2 = \varphi^H$ or $\varphi_2 = \varphi^L$), (iii) with probability $(1 - \lambda)$ neither firm observed its private valuation of the asset, where $\lambda$ is positive but infinitely small.

We assume that the renegotiation is as follows. One of the two firms proposes to amend the initial contract by including a termination clause. If the proposal is accepted, then it is enforced in case of termination. In case of rejection the usual bargaining stage follows when the partnership is terminated. We focus on simple renegotiation proposals that induce efficient termination and efficient asset allotment, namely $r \in \left[0, \frac{\varphi^L}{2}\right]$. Indeed, from Proposition 5 other proposals are, in turn, not renegotiation-proof.

**Proposition 7** *Suppose that there is a positive, infinitely small probability that one firm observes its private valuation of the asset between* $t = 0$ *and* $t = 1$, *then there is a PBE satisfying the divinity criterion D1 where the NC-contract is not renegotiated.*

**Proof.** See the Appendix. ■

The intuition is the following. Suppose that firm 1 makes a proposal. For any $r \leq \frac{\varphi^L}{2}$, then according to the divinity criterion, firm 2 believes that firm 1 has already observed $\varphi_1 = \varphi^H$ and therefore it prefers to reject the proposal. Hence no proposal is made in equilibrium.

## 4.4 Generalizing Distribution and Cost Functions

In the above analysis we have assumed specific functional forms for the probability and the cost of the investment. However, the results we have derived do not hinge on these assumptions. The purpose of this subsection is to show that the fundamental result according to which the absence of a termination clause has an incentive effect holds even when allowing for more general functions.

In what follows we focus on symmetric partnerships i.e. partnership in which firms equally share the monetary benefits generated by the project ($s = \frac{1}{2}$). Moreover, we assume: (a) that the investment game has an interior equilibrium, that is, an equilibrium such that both firms make some positive investment and the probability of the outcome $\theta = \theta_G$ is strictly smaller than 1; (b) if the investment game shows more than one equilibrium, then firms are able to coordinate on the Pareto-dominant one.

We call $p(k_1, k_2) \equiv \Pr\{\theta = \theta_G | k_1, k_2\}$ and $c(k_i)$ $i = 1, 2$ the generic probability and cost functions. Furthermore, we indicate with $c'(k_i)$ and $c''(k_i)$ the first and second derivatives of the cost function.

**Proposition 8** *Suppose that:*
*i)* $\frac{\partial p(k_1,k_2)}{\partial k_i} > 0$ *and* $\frac{\partial^2 p(k_1,k_2)}{\partial k_i^2} \leq 0$, *for* $i = 1, 2$;
*ii)* $\frac{\partial^2 p(k_1,k_2)}{\partial k_1 \partial k_2} \geq 0$;
*iii)* $c'(k_i) > 0$ *and* $c''(k_i) \geq 0$, *for* $i = 1, 2$.

*Then in a symmetric partnership the investment level chosen by each firm under an NC-contract is larger than that chosen under a complete contract inducing ex-post efficiency. Moreover, both contracts induce underinvestment.*

**Proof.** See the Appendix. ■

# 5 Discussion

In this last section, we discuss some of the assumptions we made all through the paper.

**Unbounded Penalties**

In Section 3.3 we assumed that firm 1 can only make simple offers in the bargaining stage: a price $\pi$ to buy the asset. In principle, firm 1's proposals might be more sophisticated. Let $(\hat{\varphi}_1, \pi, \alpha, L)$ be firm 1's proposal at the bargaining stage, where $\hat{\varphi}_1$ is the asset value that firm 1 announces, $\pi$ is the price for asset, $\alpha$ is an exogenous random probability to go to court and $L$ is a penalty paid by firm 1 to firm 2 in case the court verifies that $\hat{\varphi}_1 \neq \varphi_1$. If the penalty $L$ is sufficiently large, then there exists an equilibrium in which firm 1 sets $\pi = \frac{\varphi_1}{2}$ and announces the true state of the world, firm 2 accepts the proposal and therefore parties litigate in front of the court with probability $\alpha$. The possibility of using penalties in the bargaining stage makes the contract without termination clause a less effective device, even though it can be shown that $\alpha$ can be set equal to 0 only if $L$ goes to infinity, in order to have the truthful revelation equilibrium. Nevertheless, contracts with large penalties are not always feasible or ex-post efficient. This is the case for instance when firms have limited liability, or when they are risk averse and courts have not a perfect verification technology (they can rule that $\hat{\varphi}_1$is different from the true asset value even if a firm reports truthfully, i.e. $\hat{\varphi}_1 = \varphi_1$). Moreover, in many legislations such contracts are not enforceable in front of a court, even though there exists a huge debate in the law and economics literature about the rationales for such limitation to the will of parties (see for instance the seminal works on liquidated damages by Shavell, 1980 and Rogerson, 1984 and for more recent contributions Aghion and Hermalin, 1990, Chung, 1992 and Che and Chung, 1999). With respect to this point, one may also interpret the result of our paper as a further argument that rationalizes the non-enforceability of unbounded penalties. Very large penalties reduce the frequency of ex-post litigation, but a certain amount of litigation is a useful discipline device to reduce the hold-up problem, and therefore having bounded penalties may turn out to be ex-ante efficient.

**Courts' Rules**

In Section 3.3, we have assumed that, in order to allot the legal expenses, courts adopt a fee shifting rule based on the bargaining proposals. As said, these rules make it easier for parties to reach an amicable settlement without resorting to court and therefore strengthen our result. Many other rules may be taken into consideration. For instance we could have considered a two-sided rule which charges all legal expenses to the proposer of an unfair proposal or to the party which rejects a fair one, or we could have employed the "American rule" according to which legal expenses are always split equally. In both cases the one described in Proposition 2 is still an equilibrium even though it is not unique. Different equilibria arise with different rules, but our argument generally holds: litigation in front of the court appears as an equilibrium phenomenon in all of them.

**Contracting with Third Parties**

In the paper we have disregarded the possibility for partners to sign contracts involving third parties. The main motivation for this choice is that such contracts do not seem useful in order to mitigate the hold-up problem faced by partners. For instance, consider a contract according to which partners commit to a large payment to a third party (e.g. a charity) in case of termination of the partnership. This contract would decrease the pay-off that partners obtain in case of failure of the project thus involving an incentive effect similar to that created by the contract without termination clause. However, this decrease in partners' pay-off is not credible given that ex-post there is a trivial way of avoiding the large payment to the third party once they have observed $\theta = \theta_B$: partners can formally continue their alliance even though, de facto, they have abandoned it.

**Asset Value**

All through the paper we have assumed that the value of the asset does not depend on the investment levels chosen by the partners but rather it is exogenously determined by Nature. This assumption greatly simplifies the analysis and it formalizes the idea that the fundamental aim of partners is to carry out the joint project so that the incentives to invest in the alliance are mainly driven by the share of the monetary value $v$ generated by the project to which each partner is entitled.

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# 6 Appendix

**Proof of Proposition1**

Consider an ex-post efficient contract $\{s, d, b, f\}$. From Lemma 1 we know that in case of $\theta = \theta_B$ firm $i = 1, 2$ obtains $(E[\varphi] - b)$ if $\varphi_i > 0$ and $b$ if $\varphi_i = 0$. Therefore, when choosing the investment level it solves

$$\max_{k_i} \frac{k_1 + k_2}{2} (\sigma_i v) + \left(1 - \frac{k_1 + k_2}{2}\right) \left(\frac{1}{2} (E[\varphi] - b) + \frac{1}{2} (b)\right) - \frac{\gamma}{2} k_i^2,$$

where, $\sigma_1 = s$ and $\sigma_2 = 1 - s$.

The benefit from marginally increasing $k_i$ is $\frac{1}{2}\left(\sigma_i v - \frac{E[\varphi]}{2}\right)$, thus the optimal investment level of firm $i$ is: 0 if $\sigma_i \leq \frac{E[\varphi]}{2v}$ and $\frac{2\sigma_i v - E[\varphi]}{4\gamma}$ otherwise. The investment game has a unique equilibrium but depending on the selected values for $\sigma_1$ and $\sigma_2$ 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) which is more efficient. Therefore we consider values of $\sigma_1$ and $\sigma_2$ such that both firms are induced to invest.

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

$$\max_{\substack{s \\ s.t.\ k_1=\frac{2sv-E[\varphi]}{4\gamma} \\ k_2=\frac{2(1-s)v-E[\varphi]}{4\gamma}}} \frac{k_1+k_2}{2}v+\left(1-\frac{k_1+k_2}{2}\right)E[\varphi]-\frac{\gamma}{2}k_1^2-\frac{\gamma}{2}k_2^2,$$

Straightforward calculations show that the $s=\frac{1}{2}$ solves the above program; plugging this value of $s$ into the expressions of the firms' investment one obtains $k_1=k_2=\frac{v-E[\varphi]}{4\gamma}$. ■

**Proof of Proposition 2.**
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 $\varphi_1 \in \left\{\varphi^H, \varphi^L\right\}$.

1. **Existence**.

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

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

since the proposal is accepted with probability $\beta$ 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 $\varphi^L$ obtains $\frac{\varphi^L}{2}-F$, which is less than what it obtains in equilibrium provided that $\varepsilon$ 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 $\varphi^H$ 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 $\beta$ and ensures

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

Type $\varphi^H$ 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 $\pi$ 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 $\frac{\varphi^H}{2}$. Consistently 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 $\varphi^H$ with probability $\frac{\alpha}{1+\alpha}$ and of type $\varphi^L$ with probability $\frac{1}{1+\alpha}$. Therefore, firm 2 is indifferent between 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 $\pi$ such that $\frac{\varphi^L}{2} < \pi < \frac{\varphi^H}{2}$. Let $\rho$ denote the probability that firm 2 accepts the offer $\pi$. Type $\varphi^H$ 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

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

In turn, type $\varphi^L$ prefers to offer $\pi$ rather than playing according to the equilibrium provided that $\rho\left(\varphi^L - \pi\right) + (1-\rho)\left(\frac{\varphi^L}{2} - F\right) - \varepsilon \geq \frac{\varphi^L}{2} - F(1-\beta) - \varepsilon$. 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 $\varphi^H$. For any $\frac{\varphi^L}{2} < \pi \leq \frac{\varphi^L}{2} + F$ we have

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

One can verify that $\overline{\rho_H} < \overline{\rho_L}$ : 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 to be equal to $\left(2F + \varphi^H - \varphi^L\right) z > 0$, 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 $\pi^k$ denote the proposal made by type $k \in \{H, L\}$ of firm 1.

*A. Separating equilibria*

A1 the two types of firm 1 make two different offers: by definition of separating equilibrium it has to be $\pi^H \neq \pi^L$. Moreover, firm 2 has to accept both offers otherwise the type whose offer is rejected would prefer to make "no proposal" and save $\varepsilon$. 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;

A2 type $\varphi^H$ makes "no proposal" while type $\varphi^L$ proposes $\pi^L$: in such an equilibrium $\pi^L$ has to satisfy the following conditions: $\pi^L \geq \frac{\varphi^L}{2}$, otherwise the proposal is rejected and type $\varphi^L$ is better-off making "no proposal"; $\pi^L \leq \frac{\varphi^L}{2} + F - \varepsilon$, otherwise type $\varphi^L$ prefers to make "no proposal". However, this cannot be an equilibrium since type $\varphi^H$ prefers to propose $\pi^L$ rather than to make "no proposal";

A3 type $\varphi^L$ makes "no proposal", while type $\varphi^H$ proposes $\pi^H$: in such an equilibrium it has to be $\pi^H = \frac{\varphi^H}{2}$. Indeed, $\pi^H$ reveals that firm 1 is of type $\varphi^H$ and firm accepts if and only if $\pi^H \geq \frac{\varphi^H}{2}$. Given this fact, it is optimal for type $\varphi^H$ to propose $\frac{\varphi^H}{2}$. Moreover, 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 $\varphi^H$ when observing a proposal $\pi < \frac{\varphi^H}{2}$. However, 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 $\mu(\varphi^H \mid \pi = \tilde{\pi}) = 0$. Hence given these beliefs firm 2 should accept proposal $\pi$ and type $\varphi^L$ would be better-off offering such a $\pi$ rather then playing according to the equilibrium. Let $\tilde{\pi} \in \left(\frac{\varphi^L}{2}, \frac{\varphi^L}{2} + F\right)$ and let $\rho$ be the probability that firm 2 accepts the proposal. The minimal probability for which type $\varphi^H$ 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:

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

The minimal probability for which type $\varphi^L$ 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:

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

For $\varepsilon$ small enough it follows that $\overline{\rho_L} < \overline{\rho_H}$. Hence the divinity criterion D1 imposes $\mu(\varphi^H \mid \pi = \tilde{\pi}) = 0$.

*B. Semi-separating equilibria*

As first we prove that we can have a semi-separating equilibrium only in the case in which type $\varphi^H$ randomizes between two different proposals and type $\varphi^L$ 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 $\varphi^H$ plays "no offer" with strictly positive probability: making no offer type $\varphi^H$ 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 $\varphi^H$;

B2 There exists no equilibrium in which type $\varphi^L$ plays "no offer" with strictly positive probability: to check that this claim is true we need to consider two cases:

- type $\varphi^L$ plays "no offer" with probability 1. This cannot be the case since (by definition of semi-separating) this implies that type $\varphi^H$ plays mixed strategies randomizing between "no offer" and some offer $\pi$. However, this cannot be true by what we have proven in the previous point B1;

- type $\varphi^L$ plays mixed strategies randomizing between"no offer" and an offer $\pi$. Clearly, it has to be $\pi \in \left[\frac{\varphi^L}{2}, \frac{\varphi^L}{2} + F - \varepsilon\right]$ since otherwise "no offer" would dominate $\pi$. Type $\varphi^L$ is indifferent between playing "no offer" and $\pi$ if the latter offer is accepted by firm 2 with probability $\beta$ such that $\frac{\varphi^L}{2} - F = \beta\left(\varphi^L - \pi\right) + (1-\beta)\left(\frac{\varphi^L}{2} - F\right) - \varepsilon$, that is $\beta = \frac{\varepsilon}{\varphi^L + 2F - 2\pi}$. In a semi-separating equilibrium type $\varphi^H$ should make the same offer $\pi$ as type $\varphi^L$. However, it is easy to check that type $\varphi^H$ prefers offering $\frac{\varphi^H}{2}$ rather than $\pi$; indeed $\frac{\varphi^H}{2} - \varepsilon > \beta\left(\varphi^H - \pi\right) + (1-\beta)\left(\frac{\varphi^H}{2} - 2F\right) - \varepsilon$ if and only if $4F > \frac{\varepsilon}{\varphi^L + 2F - 2\pi}\left(\varphi^H + 4F - 2\pi\right)$ which is certainly true for $\varepsilon$ small enough.

B3 There exists no equilibrium in which type $\varphi^L$ plays mixed strategies randomizing between any $\pi$ and $\pi + \delta$. Suppose that type $\varphi^L$ plays mixed strategies randomizing between $\pi$ 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. We need to distinguish the following sub-cases:

- type $\varphi^H$ offers $\pi$. The offer $\pi+\delta$ reveals that firm 1 is of type $\varphi^L$ and therefore it is accepted by firm 2. Therefore, type $\varphi^L$ is indifferent between $\pi$ and $\pi+\delta$ if and only if the former offer is accepted by firm 2 with probability $\beta$ and rejected otherwise and with $\beta$ such that $\varphi^L - (\pi+\delta) - \varepsilon = \beta\left(\varphi^L - \pi\right) + (1-\beta)\left(\frac{\varphi^L}{2} - F\right) - \varepsilon$, that is, $\beta = \frac{\varphi^L + 2(F - \delta - \pi)}{\varphi^L - 2(\pi - F)}$. Given this $\beta$ it is easy to verify that type $\varphi^H$ prefers offering $\pi+\delta$ (pay-off $\varphi^H - (\pi+\delta) - \varepsilon$) rather than $\pi$ (pay-off $\beta\left(\varphi^H - \pi\right) + (1-\beta)\left(\frac{\varphi^H}{2} - 2F\right) - \varepsilon$) if and only if $\left(\frac{\varphi^H}{2} - \pi + 2F\right)(1-\beta) + \delta > 0$ which is surely verified.
- type $\varphi^H$ offers $\pi + \delta$. This cannot be the case since in equilibrium $\pi$ would be offered only by type $\varphi^L$ and would be accepted by firm 2. Therefore, both types of firm 1 prefer offering $\pi$ with probability 1.
- type $\varphi^H$ plays mixed strategies. First note that the two types have to randomize over the same support. On the contrary both types would be making at least one offer that reveals their own types and all such proposals should be accepted with probability one. But then this cannot be an equilibrium since there exists one type who should deviate offering the smallest revealing offer. Consider, hence, the case in which type $\varphi^H$ randomizes between $\pi$ and $\pi + \delta$. The proposed equilibrium has to be sustained by the following beliefs: for any $\widetilde{\pi} \in (\pi, \pi+\delta)$, $\mu(\varphi^H \mid \pi = \tilde{\pi}) > 0$. Indeed, if this is not the case then both types prefer to deviate and make such offer instead of offering $\pi + \delta$. Call $\psi$ the probability that firm 2 accepts the equilibrium offer $\pi + \delta$ and consider an out of equilibrium offer $\pi + \delta - \gamma$, with $0 < \gamma < \delta$. Type $\varphi^L$ is willing to make such offer provided that it is accepted at least with probability $\rho$ such that
$\rho\left(\varphi^L - \pi - \delta + \gamma\right) + (1-\rho)(\frac{\varphi^L}{2} - F) \geq \psi\left(\varphi^L - \pi - \delta\right) + (1-\psi)\left(\frac{\varphi^L}{2} - F\right)$.

Similarly, type $\varphi^H$ is willing to offer $\pi+\delta-\gamma$ provided that $\rho\left(\varphi^H-\pi-\delta+\gamma\right)+(1-\rho)(\frac{\varphi^H}{2}-2F)\geq\psi\left(\varphi^H-\pi-\delta\right)+(1-\psi)\left(\frac{\varphi^H}{2}-2F\right)$. Using the standard arguments it can be shown that the divinity criterion D1 imposes to assign $\mu(\varphi^H\mid\pi=\tilde{\pi})=0$ when $\pi+\delta-\gamma$ is offered.

Finally, we have to check the case where type $\varphi^H$ plays mixed strategies, while type $\varphi^L$ plays pure strategies. Obviously it has to be that one offer is made by both types and another offer is made by type $\varphi^H$ only. In equilibrium the latter offer has to be $\frac{\varphi^H}{2}$. Moreover, the offer which is made by both types has to be no smaller than $\frac{\varphi^L}{2}$ to be accepted by firm 2. Let's denote $\frac{\varphi^L}{2}+\Delta$ the offer which is made by the two types. 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 $\varphi^H$ 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 $\mu(\varphi^H)>0$ when receiving $\frac{\varphi^L}{2}+\Delta-\gamma$ for $0<\gamma<\Delta$. However, in what follows we show that such beliefs do not satisfy the divinity criterion D1.
Type $\varphi^H$ prefers offering $\frac{\varphi^L}{2}+\Delta-\gamma$ 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 $\varphi^L$ prefers offering $\frac{\varphi^L}{2}+\Delta-\gamma$ rather the equilibrium offer $\frac{\varphi^L}{2}+\Delta$ provided that

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

that is, if:

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

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 $\mu(\varphi^H)=0$ when $\pi+\Delta-\gamma$ is offered.

*C. Pooling equilibria*

C1 Both types make no offer. In the proposed equilibrium type $\varphi^H$ obtains $\frac{\varphi^H}{2}-F$. However, an offer $\frac{\varphi^H}{2}$ is accepted by firm 2 and guarantees type $\varphi^H$ a pay-off $\frac{\varphi^H}{2}-\varepsilon$.

C2 Firm 2 is willing to accept an offer provided that $\pi\geq\frac{1}{2}\left(\frac{\varphi^H}{2}\right)+\frac{1}{2}\left(\frac{\varphi^L}{2}-F\right)$, that is provided that $\pi\geq\frac{E\left[\varphi^L\right]}{2}-\frac{F}{2}$ where $E\left[\varphi^L\right]=(\frac{\varphi^H}{2}+\frac{\varphi^L}{2})$. Consider that firm 1 makes an out of equilibrium offer $\tilde{\pi} = \pi - \varepsilon$. To sustain $\pi$ as a pooling equilibrium, firm 2 has to assign probability $\mu(\varphi^H \mid \tilde{\pi}) > 0$. However, the divinity criterion D1 imposes $\mu(\varphi^H \mid \tilde{\pi}) = 0$ and with such beliefs the one proposed cannot be an equilibrium because both types of firm 1 prefer to deviate. Consider type $\varphi^L$. It prefers to offer $\tilde{\pi}$ rather than $\pi$ provided that the offer is accepted with probability $\rho$ such that

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

that is:

$$\rho \geq \frac{\varphi^L - 2\pi + 2F}{\varphi^L - 2\tilde{\pi} + 2F} \equiv \overline{\rho_L}.$$

Type $\varphi^H$ prefers to offer $\tilde{\pi}$ rather than $\pi$ provided that

$$\rho\left(\varphi^H - \tilde{\pi}\right) + (1-\rho)\left(\frac{\varphi^H}{2} - 2F\right) - \varepsilon \geq \varphi^H - \pi - \varepsilon$$

that is:

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

It can be verified that $\bar{\rho}_L < \bar{\rho}_H$ provided that $\varepsilon\left(\varphi^H - \varphi^L + 2F\right) > 0$ which follows by assumption.

Both types of firm 1 play mixed strategies randomizing between no offer and $\pi$. Firm 2 is not willing to accept any offer smaller than $\frac{\varphi^L}{2}$, while type $\varphi^L$ does not make any offer larger than $\frac{\varphi^L}{2} + F - \varepsilon$. Given that the offer has to satisfy these restrictions, then type $\varphi^L$ is indifferent between offering $\pi$ and making "no offer" provided that $\pi$ is accepted with probability $\psi$ such that $\psi\left(\varphi^L - \pi\right) + (1-\psi)\left(\frac{\varphi^L}{2} - F\right) - \varepsilon = \frac{\varphi^L}{2} - F$, that is provided that $\psi = \frac{2\varepsilon}{\varphi^L - 2\pi + 2F} \equiv \psi_L$. Similarly, type $\varphi^H$ is indifferent between offering $\pi$ and making "no offer"provided that $\pi$ is accepted with probability $\psi'$ such that $\psi'\left(\varphi^H - \pi\right) + (1 - \psi')\left(\frac{\varphi^H}{2} - 2F\right) - \varepsilon = \frac{\varphi^H}{2} - F$, that is provided that $\psi\prime = \frac{2(\varepsilon+F)}{\varphi^H - 2\pi + 4F} \equiv \psi_H$. Therefore, the proposed one can be an equilibrium only when $\psi_H = \psi_L$ and this is not true for $\varepsilon > 0$ small enough. ■

**Proof of Proposition 3**

Firm $i = 1, 2$ anticipates that in case $\theta = \theta_B$ it will be buyer or seller of the asset with equal probability and it will obtain the pay-off as defined in Lemma 2. Therefore, when choosing $k_i$ firm solves

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

where, $\sigma_1 = s$ and $\sigma_2 = 1 - s$. The benefit from increasing marginally $k_i$ is $\frac{1}{2}\left(\sigma_i v - \frac{Q}{2}\right)$, where

$$Q \equiv \left(\frac{E[\varphi]}{2} - F(1-\beta) - \varepsilon\right) + \left(\frac{E[\varphi]}{2} - \frac{\alpha}{4}\left(\varphi^H - \varphi^L\right)\right)$$

thus the optimal investment level of firm $i$ is:

$$k_i(\sigma_i) = \begin{cases} 0 & \text{if} \quad \sigma_i \leq \frac{Q}{2v} \\ \frac{4(2\sigma_i v - E[\varphi] + F(1-\beta)+\varepsilon) + \alpha\left(\varphi^H - \varphi^L\right)}{16\gamma} & \text{otherwise} \end{cases}$$

The investment game has a unique equilibrium but depending on the selected values for $\sigma_1$ and $\sigma_2$ 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) which is more efficient. Therefore we consider values of $\sigma_1$ and $\sigma_2$ such that both firms are induced to invest.

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

$$\max_s \frac{k_1(s) + k_2(1-s)}{2} v + \left(1 - \frac{k_1(s) + k_2}{2}\right) E[\varphi] - \frac{\gamma}{2} k_1^2 (s)^2 - \frac{\gamma}{2} k_2^2 (1-s)^2$$

Straightforward calculations show that the $s^{NC} = \frac{1}{2}$ solves the above program; 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:

$$k_1^{NC} = k_2^{NC} = \frac{v - E[\varphi]}{4\gamma} + \frac{4(F(1-\beta)+\varepsilon) + \alpha\left(\varphi^H - \varphi^L\right)}{16\gamma}$$

■

**Proof of Proposition 5**

Without loss of generality, let firm 1 be the firm for which the asset has a positive value, that is $\varphi_1 \in \{\varphi^H, \varphi^L\}$. We distinguish between two cases, according to whether the inefficiency occurs when $\theta = \theta_B$ or $\theta = \theta_G$.

**Case 1**: Inefficient decisions when $\theta = \theta_B$.We consider two sub-cases: contracts with an inefficient allotment of the asset $A$ and contracts with inefficient continuation of the partnership.

1.1 *Contracts with an inefficient allotment of the asset $A$*

An inefficient allotment of the asset occurs whenever the asset is not assigned to firm 1. Consider the case where $b \geq 0$. Note first that in this case an inefficient allotment of $A$ might occur only when the buy/sell decision is taken by firm 1 since firm 2 always chooses to sell $A$. Therefore, we consider the case in which firm 1 has been selected to choose whether to buy or to sell the asset. Two cases are possible:

1. $b > \frac{\varphi^H}{2}$;both types of firm 1 prefer to sell the asset given that $\varphi^k - b < b$ for both $k = \{H, L\}$. The expected pay-off of firm 1 is $b$ while that of firm 2 is $-b$. In this case the contract can be efficiently renegotiated in the following way: firm 1 proposes to set a new price $\hat{b} = -b$. Provided that the proposal is accepted, then firm 1 buys the asset and obtains $\varphi^k - \hat{b} > b$ for $k = \{H, L\}$ . Firm 2 is indifferent between accepting or rejecting the offer and therefore accepting it is a best response.

2. $\frac{\varphi^L}{2} < b \leq \frac{\varphi^H}{2}$; type $\varphi^H$ is willing to buy the asset thus obtaining $\varphi^H - b$, while type $\varphi^L$ is sells $A$ thus obtaining $b$. The expected pay-off of firm 2 is $\frac{1}{2}(b) + \frac{1}{2}(-b) = 0$ and there is an inefficient allotment of the asset with probability $\frac{1}{2}$. The following proposal is beneficial for both firms and leads to an efficient allotment of the asset: firm 1 proposes to set a new price $\hat{b} = 0$. More precisely, the (pooling) equilibrium is such that firm 1 offers $\hat{b} = 0$ independently of its type and firm 2 accepts this proposal. Note that, independently of its beliefs, firm 2 rejects any renegotiation proposal $\hat{b} < 0$. Finally suppose that the initial contract specifies a negative price for acquiring the asset: $b < 0$. In this case there is inefficient allotment of the asset whenever firm 2 takes the buy/sell decision. Indeed, firm 2 inefficiently buys the asset and the pay-off of firm 1 and 2 is $-b$ and $b$ respectively. This contract can be efficiently renegotiated in the following way: firm 1 propose $\hat{f} = 1$, $\hat{b} = 0$ and pays $-b$ to firm 2 conditional upon acceptance of the proposal.

1.2 *Contracts with inefficient continuation of the partnership*
An inefficient continuation of the partnership occurs whenever a firm which can veto the termination of the partnership prefers to continue it when $\theta = \theta_B$.

1. Firm 2 prefers to continue the partnership. Suppose that firm 2 prefers to continue the partnership once $\theta = \theta_B$ occurred. Then both firms obtain 0. However, the contract can be efficiently renegotiated in the following way: firm 1 proposes to include the following termination clause: $\hat{d} = 1, \hat{b} = 0$ and $\hat{f} = 1$. If the proposal is accepted, firm 1 terminates the partnership and buys the asset at price $\hat{b} = 0$; therefore its expected pay-off is $\varphi^k > 0$ for both $k = \{H, L\}$ . Firm 2 is indifferent between accepting or rejecting the proposal and thus accepting is optimal.

2. Firm 1 prefers to continue the partnership. Consider that $\theta = \theta_B$ occurred. We need to consider two subcases.

   (a) Both types of firm 1 prefer to continue the partnership (this happens for instance when $d = 1$, $b > \varphi^H$ and $f = 0$) and then both firms expect to obtain 0. In this case the initial contract can be efficiently renegotiated in the following way: firm 1 proposes to include the following clause: $\hat{d} = 1, \hat{b} = 0$ and $\hat{f} = 1$. If the proposal is accepted, firm 1 terminates the partnership and buys the asset at the price $\hat{b} = 0$; therefore its expected pay-off is $\varphi^k$ for both $k = \{H, L\}$ . Firm 2 is indifferent between accepting or rejecting the proposal and thus accepting it is optimal.

(b) Only type $\varphi^L$ prefers to continue the partnership (this happens for instance when $d = 1$, $\varphi^L < b \leq \varphi^H$ and $f = 0$). In this case firm 2 expects to obtain $\frac{b}{2}$ and the partnership is inefficiently continued with probability $\frac{1}{2}$. The following proposal by firm 1 eliminates this inefficiency: $\hat{d} = 1$, $\hat{b} = \frac{b}{2}$ and $\hat{f} = 1$. More precisely, the (pooling) equilibrium is the following. Independently of its type, firm 1 offers $\hat{b} = \frac{b}{2}$; firm 2 accepts $\hat{b} = \frac{b}{2}$ and any $\hat{b} \geq b$, and rejects otherwise. Firm 2 believes that $\mu\left(\varphi^H \mid \hat{b} \neq \frac{b}{2}\right) = 1$ and $\mu\left(\varphi^H \mid \hat{b} = \frac{b}{2}\right) = \frac{1}{2}$. Consider firm 1. According to the equilibrium it obtains a pay-off equal $\varphi^k - \frac{b}{2} - \varepsilon$ for $k = \{H, L\}$. Offering $\hat{b} \neq \frac{b}{2}$ cannot be part of the equilibrium, since either the proposal is rejected or it is dominated by $\hat{b} = \frac{b}{2}$. Making no proposal firm 1 obtains a pay-off equal to 0,if it is of type $\varphi^L$, or equal to $\varphi^H - b < \varphi^L$, if it is of type $\varphi^H$, where $b$ is the price of the asset $A$ in the original inefficient contract (which is greater than $\varphi^L$). Both payoffs are less than the equilibrium payoff. Consider firm 2. Firm 2 is indifferent between accepting the proposal $\frac{b}{2}$, and rejecting it. Moreover, accepting any $\hat{b} \geq b$ is a dominant strategy. Finally, the equilibrium beliefs satisfy the D1 criterion. In fact, let $\rho$ denote the probability that the proposal is accepted. First note that to offer $\hat{b} > b$ is a dominated strategy for both types of firm 1; $\mu\left(\varphi^H \mid \hat{b} \neq \frac{b}{2}\right) = 1$ follows directly by the intuitive criterion if $\varphi^L < \hat{b} \leq b$. Consider any $\hat{b} \leq \varphi^L$; type $\varphi^H$ is willing to make such an offer if

$$\rho(\varphi^H - \hat{b}) + (1 - \rho)(\varphi^H - b) - \varepsilon \geq \varphi^H - b$$

which implies

$$\rho \leq \frac{\varepsilon}{b - \hat{b}} \equiv \bar{\rho}_H$$

Type $\varphi^L$ is willing to offer $\hat{b}$ if

$$\rho(\varphi^L - \hat{b}) - \varepsilon \geq 0$$

which implies

$$\rho \leq \frac{\varepsilon}{\varphi^L - \hat{b}} \equiv \bar{\rho}_L$$

Since $\bar{\rho}_H < \bar{\rho}_L$, the D1 criterion applies.

**Case 2**: Inefficient decision when $\theta = \theta_G$ occurred.
There is inefficiency at $t = 1$ once $\theta = \theta_G$ occurred when the partnership is terminated with some positive probability. There exists at least one case in which such a contract is renegotiation-proof. Suppose that firm 1 has the unilateral right to terminate the partnership (namely $d = 1$ or $d = 1 \vee 2$), $\varphi^H - b > sv$ and $\varphi^L - b \leq sv$. In this case type $\varphi^H$ chooses termination and type $\varphi^L$ chooses continuation. This contract is renegotiation-proof. Indeed, the contract could be efficiently renegotiated only if firm 2 would accept a lower share of the

profits in order to induce type $\varphi^H$ to continue the partnership. However it can be checked that according to the divinity criterion D1, any proposal with a new share $s' < s$ is rejected by firm 2 since it assigns probability one that the proposer is type $\varphi^L$. Therefore whenever firm 1 is of type $\varphi^H$ there is inefficient termination when $\theta = \theta_G$ occurred. Nevertheless, we show that the contract defined in Proposition 1 Pareto dominates any contract which induces inefficient termination with positive probability. Let $\tau$ the probability that the partnership is continued when $\theta = \theta_G$ and $(1-\tau)$ the probability that it is terminated. In this latter case the selling firm obtains $b$ while the buyer obtains $\varphi_i - b$. As shown in the first part of this proof the contract either provides for an efficient termination and allotment of the asset or it is efficiently renegotiated when $\theta = \theta_B$. Suppose that parties wrote a contract that induces inefficient termination with probability $(1-\tau)$ when $\theta = \theta_G$. Then firm 1 and firm 2 choose $k_1$ and $k_2$ in order to maximize:

$$p\left(\tau s v + (1-\tau)\left(\frac{E[\varphi]}{2}\right)\right) + (1-p)\left(\frac{E[\varphi]}{2}\right) - \frac{\gamma k_1^2}{2},$$

$$p\left(\tau(1-s)v + (1-\tau)\left(\frac{E[\varphi]}{2}\right)\right) + (1-p)\left(\frac{E[\varphi]}{2}\right) - \frac{\gamma k_2^2}{2},$$

respectively. From the first order condition one can derive

$$k_1(s,\tau) = \frac{\tau\left(sv - \frac{E[\varphi]}{2}\right)}{2\gamma}, k_2(s,\tau) = \frac{\tau\left((1-s)v - \frac{E[\varphi]}{2}\right)}{2\gamma}$$

and check that $k_1(s,\tau) + k_2(s,\tau)$ is increasing in $\tau$. This means that the overall investment (and the probability of $\theta = \theta_G$) is largest if there is always efficient continuation when $\theta = \theta_G$. ■

**Proof of Proposition 7**

First we show that there exist a PBE in which the initial contract is not renegotiated; afterwords we show that the beliefs that support such equilibrium satisfy the divinity criterion D1. Let $\Phi_i$ denote the type of firm $i$ that has not observed its valuation of the asset and $O_i$, $L_i$, $H_i$ denote the type of firm $i$ that has observed that its valuation is 0, $\varphi^L$ and $\varphi^H$ respectively and with $i = 1, 2$. Without loss of generality, let firm 1 be the proposer during the renegotiation stage. Firm 1 can make no proposal or it can propose to set a price $r$ for the asset that induces efficient allotment in case of termination, that is $r \in \left[0, \frac{\varphi^L}{2}\right]$.

*Equilibrium strategies*

Firm 1 does not make any renegotiation proposal; type $\Phi_2$ of firm 2 rejects any renegotiation proposals and holds the following beliefs: $\mu(H_1/r) = 1$ for all $r \in \left[0, \frac{\varphi^L}{2}\right]$.[27] Consider firm

[27] To prove formally this result we should specify what is the best response of types $(0)_2, (L)_2, (H)_2$ when receiving a proposal $r$. However, given that the probability that firm 2 has already observed its type is infinitely small what types $(0)_2, (L)_2, (H)_2$ do is not relevant to characterize the equilibrium choice of firm 1.

1. Type $\Phi_1$ knows that a proposal is rejected at least with probability $\left(1-\frac{\lambda}{2-\lambda}\right)$, which is the probability that firm 2 is of type $\Phi_2$ conditional on the fact that firm 1 is of type $\Phi_1$. Therefore, for $\lambda$ infinitely small the probability of acceptance tends to zero and type $\Phi_1$ prefers not to make a proposal in order to avoid the cost of making the proposal, $\varepsilon$. The same argument holds for types $O_1, L_1$ and $H_1$. Consider firm 2. Given its beliefs, when it receives an offer $r \in \left[0, \frac{\varphi^L}{2}\right]$ type $\Phi_2$ expects to obtain $r$ by accepting; by rejecting such proposal it expects to obtain $\frac{\varphi^H}{2}$ since in the ensuing signalling game it will face type $H_1$ with probability 1. Therefore, rejecting $r$ is optimal for type $\Phi_2$ given its beliefs.

*Beliefs*

We show now that $\mu\left(H_1/r\right)=1$ satisfies the divinity criterion D1.

Consider type $H_1$; making an offer $r \in \left[0, \frac{\varphi^L}{2}\right]$ which is accepted by firm 2 with probability $\rho$ is a best response provided that:

$$p\left(sv\right)+\left(1-p\right)\left(\rho\left(\varphi^H-r\right)+\left(1-\rho\right)\left(\frac{\varphi^H}{2}-\varepsilon\right)\right)-\varepsilon \geq$$
$$p\left(sv\right)+\left(1-p\right)\left(\left(\frac{\varphi^H}{2}-\varepsilon\right)\right)$$

Consider what happens in case $\theta=\theta_B$. If firm 1 has made an offer that has been accepted, then it will buy the asset at the price $r$. If the proposal has been rejected, then firm 2 believes that it faces type $H_1$ and, in the ensuing bargaining, it will accept only offers equal or larger than $\frac{\varphi^H}{2}$. On the contrary, if type $H_1$ does not make any offer then, in case of $\theta=\theta_B$ the equilibrium of Proposition 2 follows. Rearranging the above inequality, type $H_1$ is better-off making a proposal provided that it is accepted with probability

$$\rho \geq \frac{2\hat{\varepsilon}}{\varphi^H-2r+2\varepsilon} \equiv \overline{\rho_{H_1}}$$

where $\hat{\varepsilon}=\frac{\varepsilon}{1-p}$.

Consider type $L_1$; making an offer $r \in \left[0, \frac{\varphi^L}{2}\right]$ which is accepted by firm 2 with probability $\rho$ is a best response provided that:

$$p\left(sv\right)+\left(1-p\right)\left(\rho\left(\varphi^L-r\right)+\left(1-\rho\right)\left(\frac{\varphi^L}{2}-F\right)\right)-\varepsilon \geq$$
$$p\left(sv\right)+\left(1-p\right)\left(\frac{\varphi^L}{2}-F\left(1-\beta\right)-\varepsilon\right).$$

Note that in this case if the proposal is rejected then in case of $\theta=\theta_B$, in the ensuing bargaining game, type $L_1$ does not make any offer and firms litigate in front of the court; indeed, after rejecting the proposal firm 2 believes with probability 1 that it faces type $H_1$

and accepts only offers equal or larger than $\frac{\varphi^H}{2}$. Rearranging the above inequality, type $L_1$ is better-off making a proposal provided that it is accepted with probability

$$\rho \geq \frac{2\left(F\beta - \varepsilon + \hat{\varepsilon}\right)}{\varphi^L - 2r + 2F} \equiv \overline{\rho_{L_1}}$$

Consider type $O_1$; making an offer $r \in \left[0, \frac{\varphi^L}{2}\right]$ which is accepted by firm 2 with probability $\rho$ is a best response provided that:

$$p\left(sv\right) + \left(1-p\right)\left(\rho\left(r\right) + \left(1-\rho\right)\left(\frac{1}{2}\left(\frac{\frac{\varphi^L}{2}}{2}\right) + \frac{1}{2}\left(\alpha\frac{\varphi^L}{2} + \left(1-\alpha\right)\frac{\varphi^H}{2}\right)\right)\right) - \varepsilon \geq$$
$$p\left(sv\right) + \left(1-p\right)\left(\frac{1}{2}\left(\frac{\varphi^L}{2}\right) + \frac{1}{2}\left(\alpha\frac{\varphi^L}{2} + \left(1-\alpha\right)\frac{\varphi^H}{2}\right)\right).$$

In case $\theta = \theta_B$, if the proposal has been accepted, then firm 1 will sell the asset at the price $r$; if the proposal has been rejected then type $O_1$ knows that it is facing type $L_2$ or type $H_2$ with equal probability (note that, when making the renegotiation proposal type $O_1$ knows that it is facing type $\Phi_1$); therefore in case of rejection firms will play the bargaining game specified in Proposition 2, where firm 1 is the firm that receives the proposal. Rearranging the above inequality it can be shown that type $O_1$ is better-off making a proposal provided that it is accepted with probability

$$\rho \geq \frac{4\hat{\varepsilon}}{4r - 2E[\varphi] + \alpha\left(\varphi^H - \varphi^L\right)} \equiv \overline{\rho_{O_1}}$$

Finally consider type $\Phi_1$. This type of firm 1 ignores the type of firm 2 that it is facing; conditional upon the fact that firm 1 has not observed its type, then the probability that firm 2 has already observed its type is $\frac{\lambda}{2-\lambda}$, while the probability that 2 is of type $\Phi_2$ is $\left(1 - \frac{\lambda}{2-\lambda}\right)$. For $\lambda$ infinitely small then only what type $\Phi_2$ is relevant. Therefore, type $\Phi_1$ is better-off making an offer $r$ which is accepted by firm 2 with probability $\rho$ provided that:

$$p\left(sv\right) + \left(1-p\right)\left\{\rho\left[\frac{1}{2}\left(E[\varphi] - r\right) + \frac{1}{2}\left(r\right)\right] + \right.$$
$$\left(1-\rho\right)\left[\frac{1}{2}\left(\frac{1}{2}\left(\frac{\varphi^L}{2} - F\right) + \frac{1}{2}\left(\frac{\varphi^H}{2} - \varepsilon\right)\right) + \right.$$
$$\left.\left.\frac{1}{2}\left(\frac{1}{2}\left(\frac{\varphi^L}{2}\right) + \frac{1}{2}\left(\alpha\frac{\varphi^L}{2} + \left(1-\alpha\right)\frac{\varphi^H}{2}\right)\right)\right]\right\} - \varepsilon \geq$$
$$p\left(sv\right) + \left(1-p\right)\left[\frac{1}{2}\left(\frac{1}{2}\left(\frac{\varphi^L}{2} - F\left(1-\beta\right) - \varepsilon\right) + \frac{1}{2}\left(\frac{\varphi^H}{2} - \varepsilon\right)\right) + \right.$$
$$\left.\frac{1}{2}\left(\frac{1}{2}\left(\frac{\varphi^L}{2}\right) + \frac{1}{2}\left(\alpha\frac{\varphi^L}{2} + \left(1-\alpha\right)\frac{\varphi^H}{2}\right)\right)\right].$$

Consider what happens in case of $\theta = \theta_B$. When making the renegotiation proposal firm 1 ignores whether it will be the buyer or the seller of the asset. If the proposal is accepted, then with probability $\frac{1}{2}$ firm 1 will be the buyer thus obtaining $E[\varphi]-r$, and with probability $\frac{1}{2}$ it will be the seller thus obtaining $\frac{1}{2}$. Similarly, in case of rejection of the proposal with equal probability firm 1 will be the buyer or the seller of the asset; in the former case, firm 2 will accept only proposals larger than $\frac{\varphi^H}{2}$ while in the latter the two firms play the bargaining game specified in Proposition 2 with firm 2 being the proposer. Finally, if no renegotiation proposal is made, then the usual bargaining game of Proposition 2 is played with firm 1 and firm 2 being the proposer with probability $\frac{1}{2}$. Rearranging the above inequality, one obtains that type $\Phi_1$ is willing to make a renegotiation proposal provided that firm 2 accepts it at least with probability:

$$\rho \geq \frac{2\left(4\hat{\varepsilon}+F\beta-\varepsilon\right)}{2F+2\varepsilon+\alpha\left(\varphi^H-\varphi^L\right)} \equiv \bar{\rho}_{\Phi_1}.$$

It is easy the verify that for $\varepsilon$ small enough $\bar{\rho}_{H_1}$ is smaller than $\bar{\rho}_{L_1}$and $\bar{\rho}_{\Phi_1}$. Moreover, $\bar{\rho}_{H_1} < \bar{\rho}_{O_1}$ provided that $r < \frac{1}{8}\left(2\varphi^H+4\varepsilon+2E[\varphi]-\alpha\left(\varphi^H-\varphi^L\right)\right)$ which is verified since

$$\frac{\varphi^L}{2} < \frac{1}{8}\left(2\varphi^H+4\varepsilon+2E[\varphi]-\alpha\left(\varphi^H-\varphi^L\right)\right)$$

■

**Proof of Proposition 8**
Consider a symmetric partnership where partners have signed a complete contract inducing ex-post efficiency. Then the equilibrium investment levels are $k_1^C$ and $k_2^C$ defined by the following system of equations:

$$\begin{aligned}
\left.\frac{\partial p\left(k_1,k_2\right)}{\partial k_1}\right|_{\substack{k_1=k_1^C\\k_2=k_2^C}}\left(\frac{v}{2}-\frac{E[\varphi]}{2}\right) &= c'\left(k_1^{TC}\right)\\
\left.\frac{\partial p\left(k_1,k_2\right)}{\partial k_2}\right|_{\substack{k_1=k_1^C\\k_2=k_2^C}}\left(\frac{v}{2}-\frac{E[\varphi]}{2}\right) &= c'\left(k_2^{TC}\right).
\end{aligned}$$

Similarly, the equilibrium investment levels chosen under an NC-contract are those $k_1^{NC}$ and $k_2^{NC}$ defined by the following system of equations:

$$\begin{aligned}
\left.\frac{\partial p\left(k_1,k_2\right)}{\partial k_1}\right|_{\substack{k_1=k_1^{NC}\\k_2=k_2^{NC}}}\left(\frac{v}{2}-\frac{E[\varphi]}{2}+\Delta\right) &= c'\left(k_1^{NC}\right),\\
\left.\frac{\partial p\left(k_1,k_2\right)}{\partial k_2}\right|_{\substack{k_1=k_1^{NC}\\k_2=k_2^{NC}}}\left(\frac{v}{2}-\frac{E[\varphi]}{2}+\Delta\right) &= c'\left(k_2^{NC}\right),
\end{aligned}$$

where $\Delta \equiv \frac{F(1-\beta)}{4}+\frac{\alpha\left(\varphi^H-\varphi^L\right)}{8}+\frac{\varepsilon}{2}>0$ with $\beta$ and $\alpha$ defined in Proposition 2.
The fact that $\Delta>0$ implies that:

$$
\begin{aligned}
\left.\frac{\partial p\left(k_1,k_2\right)}{\partial k_1}\right|_{\substack{k_1=k_1^C\\ k_2=k_2^C}}\left(\frac{v}{2}-\frac{E[\varphi]}{2}+\Delta\right) &> c'\left(k_1^{TC}\right),\\
\left.\frac{\partial p\left(k_1,k_2\right)}{\partial k_2}\right|_{\substack{k_1=k_1^C\\ k_2=k}}\left(\frac{v}{2}-\frac{E[\varphi]}{2}+\Delta\right) &> c'\left(k_2^{TC}\right),
\end{aligned}
$$

and therefore conditions i), ii) and iii) imply that $k_i^{NC} > k_i^C$ for $i = 1, 2$.
Consider now the cooperative solution; the efficient investment levels $k_1^{Coop}$ and $k_2^{Coop}$ satisfy the following system of equations:

$$
\begin{aligned}
\left.\frac{\partial p\left(k_1,k_2\right)}{\partial k_1}\right|_{\substack{k_1=k_1^{Coop}\\ k_2=k_2^{Coop}}}\left(v-E[\varphi]\right) &= c'\left(k_1^{Coop}\right)\\
\left.\frac{\partial p\left(k_1,k_2\right)}{\partial k_2}\right|_{\substack{k_1=k_1^{Coop}\\ k_2=k_2^{Coop}}}\left(v-E[\varphi]\right) &= c'\left(k_2^{Coop}\right).
\end{aligned}
$$

Using the equilibrium values for $\alpha$ and $\beta$ and the conditions $v > \varphi^H$ and $\left(\varphi^H - \varphi^L\right) > 2F$, then one can show that $(v - E[\varphi]) > \frac{v}{2} - \frac{E[\varphi]}{2} + \Delta$. Therefore, the same arguments as above apply to prove that $k_i^{Coop} > k_i^{NC}$ for $i = 1, 2$. ■