Foreign Direct Investment and Local Cooperation:

A Contingent Claims Approach

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Abstract

We address key issues that a foreign investor needs to evaluate when deciding whether to enter into a joint venture with a local partner. We explicitly show how the values depend on the valuation methodology, i.e., the passive and the expanded NPV valuation approach. We derive the parties' ownership shares in the joint venture by applying the Nash bargaining solution. We find that the ownership shares may vary considerable depending on the valuation methodology. Ownership shares may also be influenced by an option to wait, even if investment takes place today.

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Brief Summary

Should you invest alone or together with a partner through a joint venture? How should the ownership shares of the joint venture be determined? We address these questions in a setting where a foreign investor contemplates whether to cooperate with a local partner in the host country of the investment. In an appendix we also give an example for another setting where a partner may provide new technology.

Within our framework the investor provides an investment opportunity, i.e., a stream of cash payments. The local partner has the ability to influence a part of this stream of cash payments. The local partner may increase revenue or reduce costs due to, e.g., increased market power in the market for finished products or input factors. Another potential valuable contribution from the partner is that he may influence the investment's exposure to country risk. He may work as a "problem solver" for the joint venture in the local market and towards to local bureaucracy.

The estimated value of the partner's contribution will depend on the valuation methodology. We value the partner's contribution by using the passive and the expanded net present value. The passive net present value is the value found when not considering management decisions, such as temporarily closure and reopening of production. The expanded net present value takes active management of the investment and it's operation into account. When determining the parties' ownership shares in the joint venture, we use the Nash bargaining solution. In short, the Nash bargaining solution implies that the difference between what the parties can achieve jointly as compared to what they can achieve independently is split equally between the parties. We show in a numerical example that the negotiated ownership

shares may vary considerably depending on whether the active or passive net present value is used.

Within our framework we are also able to analyze situations where the final investment decision may be deferred. This possibility opens up for different strategies in the negotiations over the establishment of the joint venture. It may, e.g., be optimal for the local partner to cause a delay in the negotiations because he expects to be in a better negotiation situation when the final investment decision will be made. We show that the option to defer the final investment decision may, even though a joint venture is established today, increase or reduce the local partner's ownership share in the joint venture.

The contribution of the framework we present is that it addresses jointly and consistently three issues: How the partner may influence the cash flow generated by the investment project, what the value of the additional cash flow is, and how the value of the joint investment project will be allocated between the parties. The conceptual framework presented in this paper may be used when analyzing many situations where cooperation is an issue. Even though we have chosen a high level of abstraction when modeling the cash payments from the investment, the same approach may be used for a more detailed specification of the cash payments. The presented framework may also be used to analyze situations where it is optimal to dissolve a joint venture at a future date.

I. Introduction

Foreign investors often have the choice between investing alone or investing together with a partner in the host country of the investment[1]. When evaluating whether to cooperate, the foreign investor needs to evaluate at least three issues: How the partner may influence the cash flow generated by the investment project, what the value of the additional cash flow is, and how the value of the joint investment project will be allocated between the parties. Our contribution is a conceptual framework addressing these three issues jointly and consistently. Even though the framework we present may be used to evaluate different forms of cooperation, we focus on cooperation through a *joint venture* (JV). By a joint venture we mean that the foreign investor and the local partner create a separate entity responsible for the operation of the real investment. For different types of cooperative arrangements, see Harrigan (1988). In some countries JVs are mandatory for foreign investors. In these cases there may be specific legislation regulating JVs. The framework we present is primarily aimed at analyzing voluntary formation of joint ventures, but it is also applicable when studying joint ventures forced upon the parties by a government.

When addressing how a local partner may influence the cash payments, we choose a high level of abstraction. We split the cash contribution to cover fixed costs into two parts. One part is primarily determined by global factors and cannot be influenced by the local partner. The second part is determined by local or country specific factors and may be influenced by the partner. Cooperation with a local partner may be beneficial in order to, e.g., increase market power in the local market and achieve synergies or cost reductions. If a JV partner increases market power in the market for finished products, this basically means that the income from the investment will be higher. A local company offering similar or close substitutes to the products offered by the foreign investor, may be a partner that can offer increased market power. Similarly, a local company employing the same input factors or technology in their production process as the foreign investor may cooperate with the foreign investor to reduce the operating and/or investment costs of the investment. For in-depth analyses of strategic use of cooperation, see, e.g., Harrigan (1985) and (1988). As noted by Lessard (1996), the local partner's ability to influence country risk may be a potentially valuable contribution to the joint investment. Country risk is the unique risk to the investment caused by the location of the investment in the specific country. More specifically, by country risk we mean non-deterministic changes in country specific conditions, i.e., operating conditions, general economic conditions in the country, and legislation, such as competition laws, laws protecting property rights, and repatriation restrictions. The local partner may work as a "problem solver" for the joint venture. The local partner may have better insight into the local labor market and business community than the foreign investor. The same may particularly be true regarding political risk and the official bureaucracy. For an example of events constituting political risk, see, e.g., Root (1972). By using locally determined cash contribution as one of the state variables, the partner's ability to influence country risk is included in the analysis in a straightforward manner as a reduction in volatility.

According to the "expanded net present value (NPV) rule", see, e.g., Trigeorgis (1996) page 124, the total value of the investment project equals the passive NPV, i.e., the value of the investment without including the value of managerial decision making, with addition of the value of managerial decision making:

$$NPV^{Exp} = NPV^{Passive} + NPV^{Mng} \quad . \tag{1}$$

By managerial decision making we mean decisions, such as temporarily closure of production, abandonment of the investment, changing of scale of the investment, etc. The option value or premium from active management corresponds closely with the uncertainty in the underlying cash payments or value of the investment. We would expect that the foreign investor's evaluation of the benefits from taking on a partner may differ depending on whether he uses the passive or expanded NPV valuation methodology. While Kogut and Kulatilaka (1994) consider decision making related to shifting of production between countries, we limit the analysis to a specific investment in a given country. For an article dealing with joint ventures and decision making related to the underlying values, see, e.g., Kogut (1991). For an article describing more practical issues related to formation of international JVs, see Inkpen and Li (1999).

Provided that there are some benefits to cooperation, the foreign investor needs to evaluate how the ownership of the joint venture will be determined. One alternative is that the partner's ownership share corresponds to the value he brings to the investment project. If the investor would invest alone in case of no joint endeavor, this approach would, however, make the investor indifferent between entering into a joint venture or investing alone. For the case when the value of investing jointly is positive, but the investor would abandon the investment opportunity if he were to invest alone, i.e., the value of the opportunity for the investor investing alone is negative, this approach would give the partner a hundred per cent ownership share. Another approach, which we adopt, is that the investor and the local partner negotiate over the ownership shares. More precisely, we assume that the parties negotiate over the value of the investment project made jointly and that the ownership shares correspond to this negotiation solution.

From a foreign investor's perspective, all the three issues stated initially will determine his value of the investment project and thereby on this decision of whether to invest. From the real options literature, see, e.g., McDonald and Siegel (1986), we know that the investor's investment decision may be influenced by an option to wait before finally deciding whether to invest. Within our framework, where the parties negotiate over the ownership shares, we will also see that the presence of an option to wait may cause the investment decision to be deferred. Even if the investment takes place today, the negotiated ownership shares may be influenced by an option to wait. This effect may at first seem puzzling. The cause of this effect is that the parties' credible threats in the negotiations may be changed by the option to wait.

In the next section we present a model of a representative investment project and the valuation methodology. We then introduce a negotiation solution and study both the foreign investor's and the local partner's strategies in the presence of an option to wait. In the final section we summarize the main points and suggest possible expansions of the model.

II. Model

A. Cash Payments

We consider a model where the cash contribution to cover fixed costs may be factored into two parts. The first part is determined by global factors that cannot be influenced by a partner, $X_t^{(G)}$, and the second part is determined by local factors that may potentially be influenced or altered by a partner, $X_t^{(L)}$. The total cash payment from the investment at time t if the foreign investor, *I*, invests alone is

$$C_t^{(I)}(X_t) = X_t^{(G)} + X_t^{(L)} - K_t \ , \qquad (2)$$

where $X_t = (X_t^{(G)}, X_t^{(L)})$ and K_t is the instantaneous fixed cost at time t. The evolutionary equation for the cash contribution is

$$dX_t^{(i)} = \alpha_i dt + \sigma_i dB_t^{(i)} \quad , \quad i = G, L \, , \tag{3}$$

where the parameters α_i and σ_i are constants, and where $dB_t^{(i)}$ is the increment of a standard Brownian motion. The Brownian motion $B_t^{(G)}$ captures the cash payment's exposure to global risk. The local or country specific risk is captured by the Brownian motion $B_t^{(L)}$. The global risk and the country risk may be correlated, i.e., $dB_t^{(G)} dB_t^{(L)} = \rho dt$. The fixed costs are assumed to be deterministic. In equation (2), $X_t^{(G)}$ and $X_t^{(L)}$ may be interpreted as the contribution from sales at, respectively, the global and host country market[2].

The cash payment from the investment project at time t if the investor invests jointly, *J*, with a local partner, *P*, is

$$C_t^{(J)}(X_t) = X_t^{(G)} + f_t(X_t^{(L)}) - K_t \, , \tag{4}$$

where $f_t(\cdot)$ is a function transforming the locally determined cash payment in the case that *I* invests alone into the cash payment in case of a joint investment. As indicated by the subscript, this function may be time dependent. We consider the function

$$f_t(X_t^{(L)}) = \exp(-\beta_0 t)\gamma_0 + \begin{cases} \exp(-\beta_1 t)\gamma_1 X_t^{(L)} & if \quad X_t^{(L)} \ge H \\ \exp(-\beta_2 t)\gamma_2 X_t^{(L)} & if \quad X_t^{(L)} < H \end{cases} \, , \tag{5}$$

where $(\beta_0, \beta_1, \beta_2)$, $(\gamma_0, \gamma_1, \gamma_2)$, and H are constants. The time dependence is captured by the parameters $(\beta_0, \beta_1, \beta_2)$. If the betas are positive, the specific effect of cooperation will diminish over time and will, eventually, have no effect on the locally determined cash contribution. With negative betas, the effect of cooperation will increase over time. An example of how a partner may influence the locally determined cash contribution at time zero is shown in Figure 1. The line *AA* is the cash contribution if the investor invests alone. We consider the case when *H* in (5) is equal to zero. Suppose that the partner only reduces the cash payment's exposure to country risk, i.e., $\gamma_0 = 0$ and $0 < \gamma_1 = \gamma_2 < 1$. This case is shown as the line *BB*. If in addition the partner increases the payment irrespective of country conditions, the locally determined cash payment will shift upwards to line *CC*. This corresponds to the case when $\gamma_0 > 0$. We finally show the case when the local partner, in addition to a fixed increase in level, only reduces the exposure to country risk if the partner investing alone would experience a negative cash payment, i.e., $\gamma_1 = 1$, and $0 < \gamma_2 < 1$. This case is shown as the line *CDE*. The line *CDE* compared to the line *AA* may be interpreted in the following way: The partner offers an immediate uniform increase in locally determined cash contribution (increased market power for input or output) and an enhanced ability to increase the cash contribution when the country conditions would leave the investor with a negative cash contribution, i.e., when $X_t^{(L)} < 0$. The latter effect may be explained by the partner working as a problem solver for the joint venture.

(Insert Figure 1 approx. here)

B. Valuation

We use the standard valuation methodology from the real options literature, see, e.g., Amran and Kulatilaka (1999), Dixit and Pindyck (1994), or Trigeorgis (1996). The valuation approach is based on the same principles used when pricing derivatives written on financial securities, as in Black and Scholes (1973). The *risk premium* for a financial asset solely influenced by risk of type *i* is $\pi^{(i)}$. The required expected return from holding a financial asset with an amount of risk equal to σ_i is α_i^*, i.e.,

$$\alpha_i^* = \pi^{(i)}\sigma_i + r \quad , \quad i = G, L \quad , \tag{6}$$

where *r* is the instantaneous risk free interest rate, assumed to be a constant. The risk premium may, e.g., be determined by applying CAPM, as in Dixit and Pindyck (1994) page 115. We define the drift adjustment or convenience yield, δ_i, as the difference between the required drift and the actual drift, i.e., $\delta_i \equiv \alpha^* - \alpha_i$. The value at time zero of the cash payment of type *i* at time *t* is then

$$V_0[X_t^{(i)}] = e^{-rt} E^*(X_t^{(i)}) \quad , \quad i = G, L \quad , \tag{7}$$

where the notation E^* means that the when computing the expectation we use the "risk neutral process"[3]

$$dX_t^{(i)} = (r - \delta_i)dt + \sigma_i dB_t^{(i)} \quad , \quad i = G, L \quad . \tag{8}$$

When the project ends at time T, the passive NPV of the investment when the investor invests alone is

$$V_0[C^{(I)}] = -A + E^*\left(\int_0^T X_t^{(G)} \exp(-rt)dt\right) + E^*\left(\int_0^T X_t^{(L)} \exp(-rt)dt\right) - \int_0^T K_t \exp(-rt)dt \quad , \qquad (9)$$

where A is the investment expenditure at time zero. The passive NPV of the joint investment is identical to (9), but where $f_t(X_t^{(L)})$ replaces $X_t^{(L)}$.

C. Decision Making

We now consider managerial decision making regarding temporary closure and reopening of production, g_t. The policy g_t is an indicator variable equaling one when the production is closed and zero if not. The optimal policy is g_t^*. When the investor is investing alone, the cash flow resulting from the optimal policy is

$$C^{(I)}(X_t, g_t^*) = Max[X_t^{(G)} + X_t^{(L)} - K_t, -K_t] \quad , \qquad (10)$$

which means that if the contribution to cover the fixed costs is negative, the production is stopped. Only fixed costs will have to be paid. For the joint investment $X_t^{(L)}$ is replaced by $f_t(X_t^{(L)})$ when $C^{(J)}(X_t, g_t^*)$ is computed.

The value of the investment at time t in investment mode i when there in addition is an option to abandon the investment is $F^{(i)}(X_t)$. With an optimal abandonment policy, this value will always, provided that the investment has not been abandoned, satisfy the equation

$$F^{(i)}(X_t) = Max[S_t, C^{(i)}(X_t, g_t^*) + V_t[F^{(i)}(X_{t+dt})]] \quad , \quad i = I, J \quad , \qquad (11)$$

where S_t is the salvage value at time t. The abandonment time is the first time t that $F^{(i)}(X_t) = S_t$ if $t \leq T$, or time T if the whole project is completed.

D. Ownership Shares

We assume that the parties' ownership shares will correspond to the Nash bargaining solution[4], see Nash (1953). The parties negotiate over the value of the joint project. The Nash bargaining solution is a function G where the set of possible allocations Y and the set of disagreement allocations D are arguments, i.e., $G(Y, D) = (Y^{(I)}, Y^{(P)})$, where $Y^{(I)}$ and $Y^{(P)}$ are, respectively, the investor's and the partner's allocation of value. The investor's disagreement allocation is the maximum of the value of the investment made alone, or zero. We assume, for simplicity, that the investment project cannot be undertaken by the partner alone, or together with another investor. The disagreement allocation for the partner is therefore zero. In short, the Nash bargaining solution implies that the difference between what the parties can achieve jointly as compared to what they can achieve independently is divided equally between the parties.

An example is shown in Figure 2. We consider the case when the local partner contributes positively to the project, i.e., $F^{(J)}(X_t) > F^{(I)}(X_t)$. If the investor will invest in case the negotiations fail, the parties' threat point will be $\overline{D} = (F^{(I)}(X_0), 0)$. The accompanying allocation of project value will be $\overline{Y}^{(I)}$ and $\overline{Y}^{(P)}$. The corresponding ownership share for the investor is $\overline{Y}^{(I)} / (\overline{Y}^{(I)} + \overline{Y}^{(P)})$, which is more than fifty per cent. If the investor will not invest in case an agreement is not reached, the threat point is $\hat{D} = (0,0)$. The value of the investment will in this case be shared equally between the parties, i.e., each will have an ownership share of fifty per cent.

(Insert Figure 2 approx. here)

Numerical Example 1

A summary of the assumptions is shown in Table 1. We assume that the only effect of cooperation is that the locally determined cash contribution at low levels, i.e., lover than zero, will be higher compared to the situation when the investor invests alone. We do not assume any time dependency on the effect of cooperation. We assume the country risk to be non-systematic, i.e., the risk premium is zero and the correlation coefficient between local and global conditions is zero. While the globally determined cash contribution is expected to increase, the locally determined one is expected to be unchanged. We solve the model numerically by using discrete time steps and a two-dimensional binomial tree. For an explanation of this procedure, see, e.g., Clewlow and Strickland (1998). We use a time step of 0.25, i.e., a quarter of a year.

(Insert Table 1 and Figure 3 approx. here)

For an initial level of globally determined cash contribution of 25, we show in Figure 3 the passive and expanded NPV for initial levels of locally determined cash contribution. By construction, the value of the investment made jointly is never lower than the value of the investment if the investor invests alone. The investor would not invest alone if the locally determined cash contribution is lower than approx. –20 or –17 according to, respectively, the expanded or passive NPV. The corresponding break-even levels for $X_0^{(L)}$ in case of a joint investment are, respectively, approx. –30 and –27. Based on the figure it seems that the option premium from active management is relatively higher for the case when the investor invests alone compared to the case when a joint investment is made. Because the local partner reduces the country risk for low levels of $X_t^{(L)}$, the options to temporarily close operations or to abandon the investment are therefore *relatively* less valuable. The corresponding values and ownership shares are shown in Table 2. Here we also show the comparable values and ownership shares when $X_0^{(G)}$ equals 50. In the latter case the passive and expanded NPV are positive for all the presented levels of $X_0^{(L)}$. We note that the relative relationship between the globally and locally determined cash contribution is important for the value of the investment, and for the value of the local partner's contribution to the joint investment, irrespective of valuation methodology. Consider first the case when $X_0^{(G)}$ equals 25. If investment only will occur if the investment is made jointly, the partner's ownership share will be 50 %. If the investor will invest alone if a joint investment is not entered into, the partner's ownership share will be less than 50%. Note that the difference in ownership share may be large depending on the valuation methodology used. When $X_0^{(L)}$ equals –15, the partner's ownership share if the passive NPV is used is 42.5 %. The value of the investment if the parties cooperate is 230.6. If they don't cooperate, the total value is 34.8 (the value when the investor invests alone). The value allocated to the partner will be (230.6-34.8)/2=97.9, which is 42.5 % of the total value. If only temporarily closure of operations is included in the valuation, the partner's ownership share is 37.6 %. When also the option to abandon the investment is included, the ownership share drops to 28.7 %. Depending on the valuation methodology, the ownership share will in this case vary with as much as 13.8 percentage points (42.5-28.7). For higher levels of $X_0^{(L)}$ the partner's ownership share is reduced. We also see that the partner's ownership share is smaller when $X_0^{(G)}$ equals 50 compared to 25. The reason for this is that the partner's contribution in terms of additional value is relatively smaller for higher levels of the globally determined cash contribution.

(Insert Table 2 approx. here)

E. Option to Wait

Suppose the investment decision may be deferred from time zero to a future date t. At time t it must be decided whether to invest or abandon the investment opportunity. The value of the deferred investment opportunity in investment mode *i* is

$$W_0^{(i)}(t) = E^*[Max[V_t(F^{(i)}(X_t),0\}]e^{-rt} \quad , \quad i = I, J \ . \tag{12}$$

With a given investment mode, it is optimal to wait to time t if $W_0^{(i)}(t) \geq F^{(i)}(X_0)$ and not to wait if $W_0^{(i)}(t) < F^{(i)}(X_0)$. When the investment modes may be different at time zero and the future decision date, it is necessary to consider the negotiation problem at both these dates. We have already characterized the negotiation problem when there is no option to defer the investment decision. In order to establish the parties' credible threats in the negotiations at time zero, we look at the game given in Figure 4. The local partner may choose to cooperate or not cooperate at time zero. The investor may decide to invest jointly, invest alone, wait, or abandon the investment opportunity. We have introduced the notation D_t^* for the parties' credible threats at a given time *t*. At time zero we take the credible threat to be the Nash equilibrium in case the investor does not choose to invest through a JV and/or the partner does not cooperate. This is the equilibrium conditioned on no agreement being reached. There may be several such Nash equilibria depending on the project characteristics and the initial level of the state variable.

(Insert Figure 4 approx. here)

Consider first the equilibrium conditioned on no agreement being reached, where the investor invests alone and the local partner chooses to cooperate/ not cooperate, but where both would have been better off investing jointly. This situation is depicted in Figure 5 as the threat point $\overline{D}_0^*$. The negotiation solution involving joint investment will give the parties $(\overline{Y}_0^{(I)}, \overline{Y}_0^{(P)})$. Consider then the case when the threat point $\hat{D}_0^*$ corresponds to the situation when the partner refuses to cooperate and the accompanying optimal strategy for the investor is to wait. Alternatively, that the partner cooperates but the investor decides to wait. The accompanying allocation of the joint investment value is $(\hat{Y}_0^{(I)}, \hat{Y}_0^{(P)})$. For this specific case the partner will get a higher ownership share if the Nash equilibrium conditioned on no agreement being reached involves waiting, as compared to the Nash equilibrium when the investor invests alone. We have also shown a third example where both parties prefer to wait. The threat point is $\tilde{D}_0^*$. In this case a negotiation solution is not feasible. A negotiation solution will involve that at least one of the parties will be made worse of compared to the disagreement allocation. The investment decision will be deferred to the future time *t*.

Numerical Example 2

We consider the investment project in Example 1. We now allow the final investment decision to be delayed one year. The parties' value of waiting and the resulting ownership shares from the negotiations at time zero are given in Table 3 for the cases when the globally determined cash contribution equals 25 and 50. We only consider the case with an expanded NPV. Consider first the case when $X_0^{(G)}$ equals 25. If $X_0^{(L)}$ is lower than -25, the negotiations will fail. The reason is that both parties will not prefer to invest through a JV to the alternative of waiting. This corresponds to the threat point $\tilde{D}_0^*$ pictured in Figure 5. When $X_0^{(L)}$ is –25 or higher, an agreement solution is feasible. In case negotiations fail, the investor will choose to wait if $X_0^{(L)}$ is -5 or lower, and to invest for higher levels. The investor will decide his optimal action by comparing the value of waiting with the value of investing alone today, see Table 2. The option to wait may influence the ownership shares even if the investment takes place at time zero. When the investor will invest in case of a breakdown in negotiations, the credible threat points in the negotiations are not changed by the option to wait. The ownership shares will therefore be unchanged. If the investor will wait if negotiations break down, the threat points will most likely change. For $X_0^{(L)}$ equal to –20 the partner's ownership share with no option to wait is 48.4 %. If the investor invests alone, the value of the investment is 4.7, see Table 2. If the investor waits, the present value of his payoff at the future decision date t is 86. It is therefore optimal for the investor to wait. The partner's present value of his payoff at the future date t is 35.1. The parties' total value if negotiations fail is therefore (86+35.1) $\approx$ 121. If they cooperate and invest today, the value of the joint investment is 150.6. The negotiation solution involving investment today will leave the partner with a value of (35.1+(150.6-121)/2) $\approx$ 42.8, which corresponds to an ownership share of 33.1 %. In this case the presence of an option to wait changes the partner's ownership share from 48.4 % to 33.1 %, which is considerable. For the case when $X_0^{(G)}$ is 50, the presence of an option to wait will slightly increase the partner's ownership shares if $X_0^{(L)}$ is between –25 and –10.

(Insert Figure 5 and Table 3 approx. here)

III. Summary

We have addressed three issues that a foreign investor needs to evaluate when deciding whether to enter into a joint venture with a local partner: How the partner may influence the cash flow generated by the investment project, what the value of the additional cash flow is, and how the value of the joint investment project will be allocated between the parties. We explicitly show the effect of the valuation methodology, i.e., the passive and the expanded NPV valuation approach. By using the Nash bargaining solution we determine the parties' ownership shares in the joint venture. We show that if the final investment decision may be deferred, the ownership shares may be influenced even if investment takes place today. The approach presented here allows us to value the services a partner provides. In essence, the partner is characterized by his ability to influence a part of the cash payment generated by the investment. We find that the ownership shares may vary considerable depending on the valuation methodology employed and by an option to defer the final investment decision. In the numerical examples we have studied the case with an option to temporarily close down and reopen production and to abandon the investment. These options are potentially valuable when investing in countries with high country risk.

The presented framework may be expanded in several ways. We may allow the partner's opportunity cost to be positive. This will change his threat point in the negotiations over ownership shares. We may also include several competing partners and/or investors. Within the presented model we may also study specific cases where the partnership may be dissolved or formed at a future points in time, depending on the future value of the state variable. This approach may help explain why investment coalitions change over time.

Appendix. Reinterpretation of the Model: A Partner Providing New Technology

Consider the case when the partner may provide new technology to the current owner of a company. The technology offered by the partner allows the owner to sell his products via a new sales channel. More specifically, assume that the partner provides the owner to internet customers. The cash contribution $X_t^{(G)}$ in equation (2) may then be interpreted as stemming from the owner's traditional sales channels, e.g., store outlets. The cash contribution from the new sales channel is $X_t^{(L)}$. If we assume that increased sales through the new channel may reduce the sales through the traditional channel, the correlation coefficient ρ is negative.

The owner of the company may work on his own to acquire the new technology to access the new sales channel. His *expected* success with this is captured trough the drift term α_L of $dX_t^{(L)}$. The increment of the Brownian motion $B_t^{(L)}$ may be though of as representing the news of the viability of the new technology, i.e., an increase in $B_t^{(L)}$ represents a higher than expected increase in the cash contribution from the new channel. Similarly, a reduction in $B_t^{(L)}$ represent a lower than expected contribution.

The effect of the partner on the owner's cash contribution is captured by the function $f_t(\cdot)$. If the partner does not have proprietary technology, it is reasonable to assume that the effect of the cooperation will fade over time, i.e., the betas in (5) are positive. We discuss the specific contributions offered by the partner by referring to figure A. We study the situation at time zero. At a later date, the effects may be time-adjusted, as indicated by equation (5). The line *AA* is the cash contribution incorporating the owner's own efforts to acquire the new technology. The partner may increase this contribution irrespective of the owner's current level. This shifts the line up to *BB*. The reason for this uniform shift may be, e.g., that the partner has a popular web site and that a cooperation will instantly allow the owner to acquire new customers. Suppose that the partner increases the payments' exposure to the success of the new sales channel compared to what the owner could achieve alone. This is captured by an increased slope of the curve *BB*, i.e., the actual curve is *CC*. This has a positive and negative effect. As long as the cash payment from the channel is positive, the increased exposure will give a larger cash contribution. If the cash payment is negative, the increased exposure will give a higher negative cash payment. We have shown the case when the new technology offers the possibility to increase the exposure only if the cash payment is positive as the line *BDC*. The line *BDC* compared to the line *AA* has the interpretation that the partner offers an immediate uniform positive increase (ability to tap into a new customer base) and an enhanced ability to increase the cash contribution as long as the new technology contributes positively, i.e., as long as $X_t^{(L)} \geq 0$.

(Insert Figure A approx. here)

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[1] The approach presented here is quite general and may be applied when analyzing many situations where cooperation is an issue. I thank Nalin Kulatilaka for suggesting to apply the model when analyzing the case where a partner may provide new technology to the investor. An example of such an application is the valuation of a start-up company in the internet or "dot com" industry. In the appendix we provide a re-interpretation of the model for this case.

[2] It is worthwhile to note that the chosen specification of cash payment in equation (2), where the globally determined and locally determined part of the cash contributions are additive, is only one of several possible specifications. Another specification may be to, e.g., specify the production function and the prices of the output and input factors. The cost of this approach is more involved expressions that we think is not justified by additional insights.

[3] The relationship to pricing of contingent claims in a complete market for financial securities may be illustrated by the following example. Suppose there is a financial security with a price at time t equal to Z_t. This security is perfectly correlated with $X_t^{(G)}$. We consider a Black and Scholes' world where prices are specified as geometric Brownian motions with constant parameters. We assume that $dZ_t / Z_t = k(\alpha_G dt + \sigma_G dB_t^{(G)})$, where k is a positive constant. In order for investors to be willing to hold this security in equilibrium, the security must pay a constant proportional dividend δ_Z, where $\delta_Z \equiv \pi^{(G)} k\sigma_G + r - k\alpha_G$. For a discussion of this drift adjustment of *the gains process* from holding the security, see, e.g., McDonald and Siegel (1984). Assume further that the globally determined cash contribution at a future date t may be written as a function $h(\cdot)$ of the value of our holdings, n, of the security at that

date, i.e., $X_t^{(G)} = h(nZ_t)$. We select $h(nZ_t) = \ln(nZ_t)/k + 0.5\sigma_G^2\, k\, t$. We then see, by inserting in $h(\cdot)$ that

$$h(nZ_t) = \ln(nZ_0)/k + \alpha_G t + \sigma_G\,(B_t^{(G)} - B_t^{(0)}).$$

If the number of securities n is chosen such that $\ln(nZ_0)/k = X_0^{(G)}$, we get the desired property that $X_t^{(G)} = h(nZ_t)$. According to the general pricing principle of derivatives on financial securities, $V_0[X_t^{(G)}] = E^*[h(Z_t)]e^{-rt}$, where the process $dZ_t / Z_t = (r - \delta_Z)dt + k\sigma_G dB_t^{(G)}$ is used when computing the expectation. By inserting the formula for the future value of Z_t based on this process in $h(\cdot)$, collecting terms and simplifying, we get that $E^*[h(Z_t)] = E^*[X_t^{(G)}]$, where the process $dX_t^{(G)} = (r - \delta_G)dt + \sigma_G dB_t^{(G)}$ is used when computing the expectation.

[4] An alternative would be to use the Rubinstein-Ståhl approach, see Rubinstein (1982) and Ståhl (1972). It is well known that the Rubinstein-Ståhl solution is identical to the Nash bargaining solution, provided that the parameters of the model are selected appropriately. The Rubinstein-Ståhl approach involves, however, several “negotiation rounds” which implies that negotiations take time. This complicates the analysis when studying the effect of deferring the final investment decision.

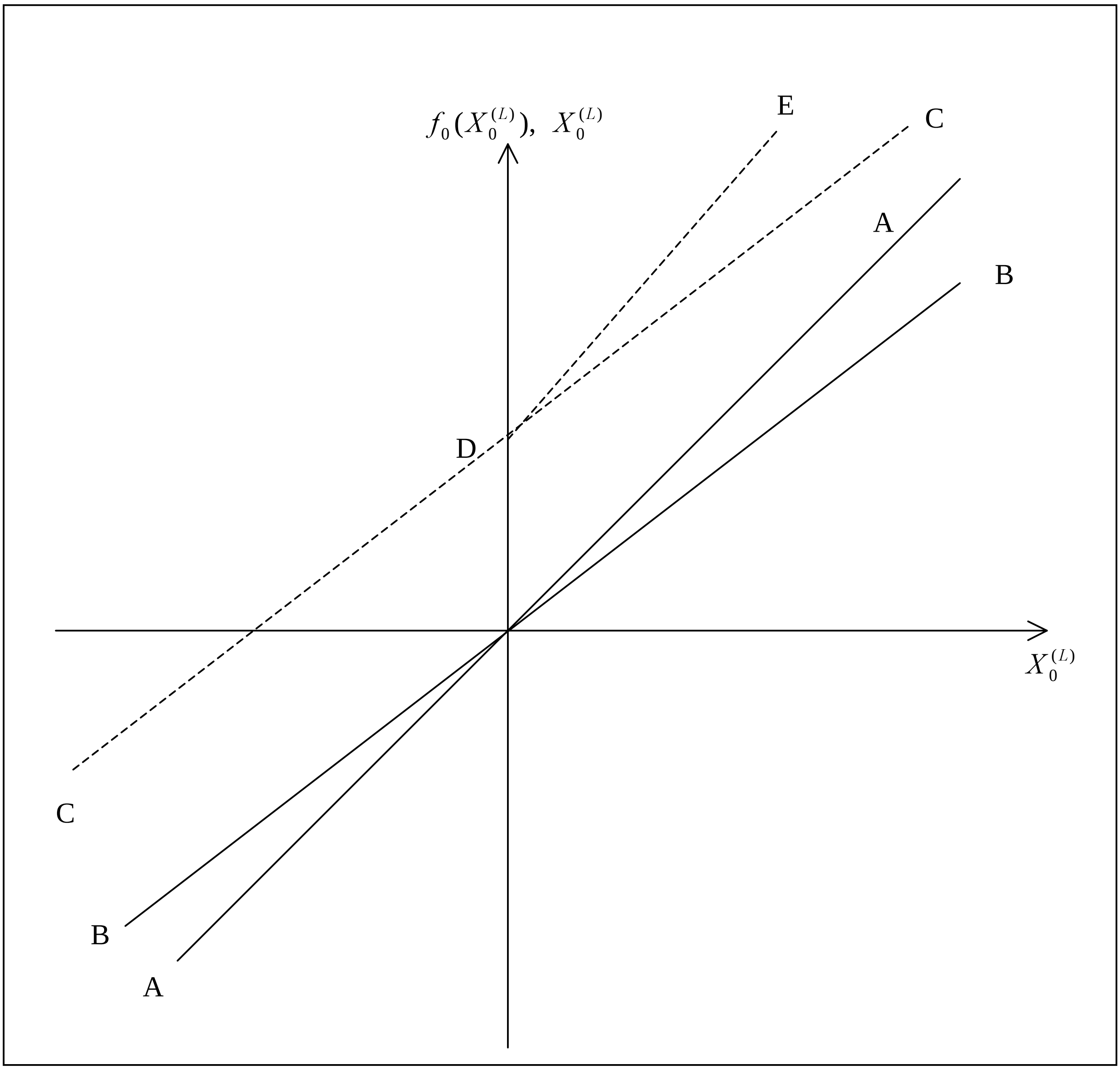

Figure 1. The Effect of Cooperation on Locally Determined Cash Contribution

Examples of the function $f_0(X_0^{(L)})$, based on equation (5).

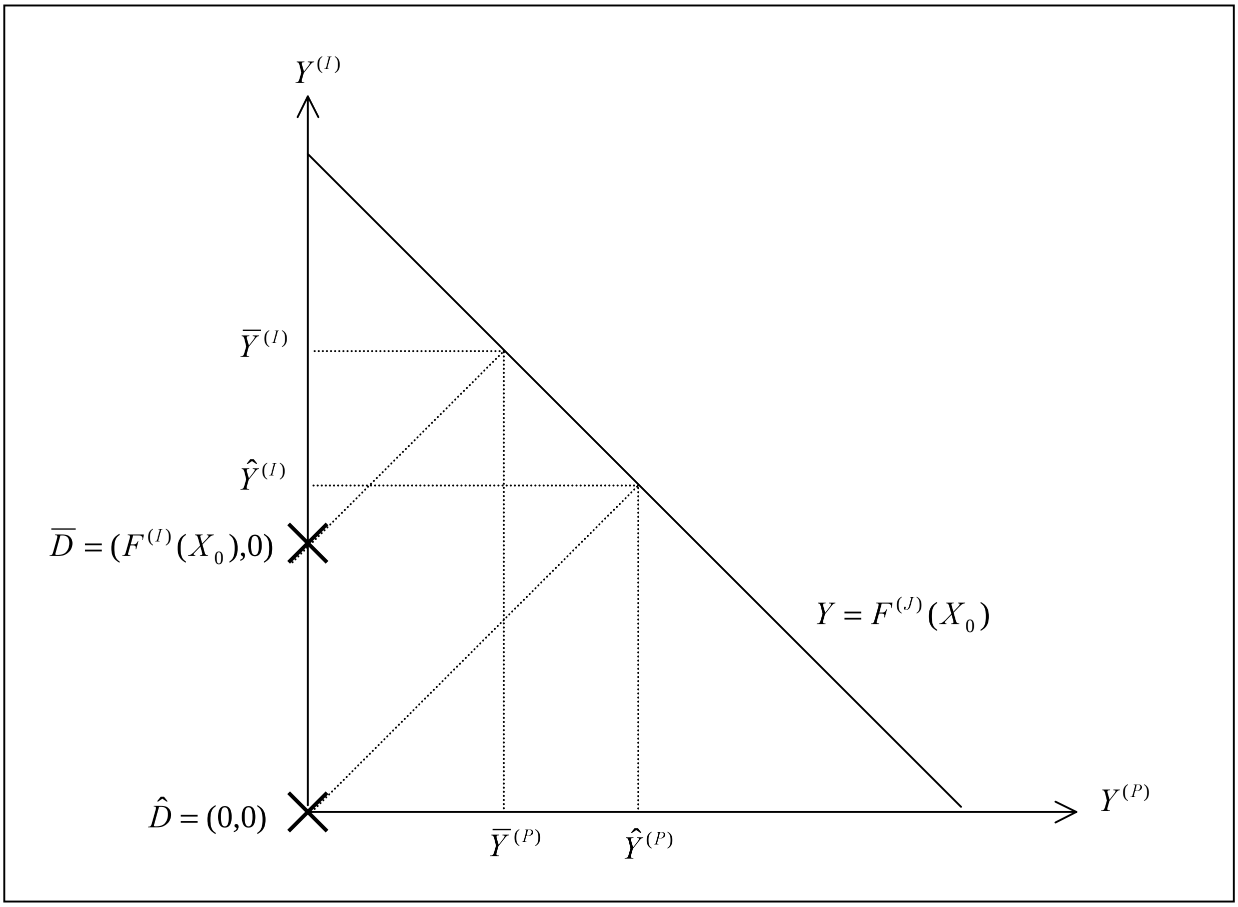

Figure 2. Negotiation Situations.

Examples of negotiation solutions at time zero when applying the Nash bargaining solution.

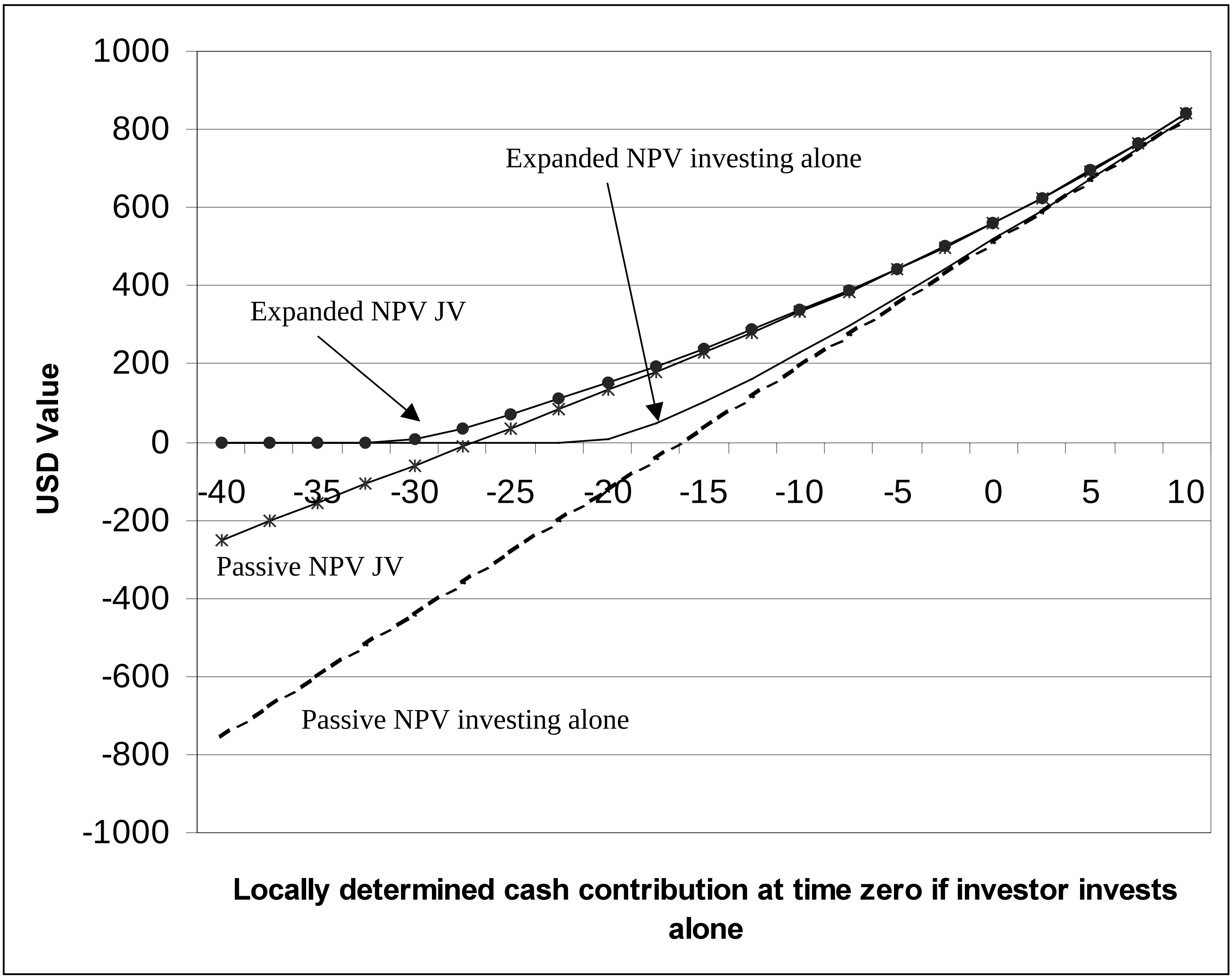

Figure 3. Passive and Expanded NPVs, Numerical Example 1

For different levels of $X_0^{(L)}$ when $X_0^{(G)} = 25$, the graphs show the passive and expanded NPVs when the investment is made alone or trough a joint venture (JV)

Local partner

Foreign investor

	Cooperate now	Not cooperate now
Invest now via JV	$(G(F^{(J)}(X_0), D_0^*)$	$(F^{(I)}(X_0),0)$
Invest now alone	$(F^{(I)}(X_0),0)$	$(F^{(I)}(X_0),0)$
Wait	$V_0[(G(F^{(J)}(X_t), D_t^*)]$	$V_0[(G(F^{(J)}(X_t), D_t^*)]$
Abandon	(0,0)	(0,0)

Figure 4. Game between Foreign Investor and Local Partner with an Option to Wait

Payoffs to, respectively, the investor and the partner in the game played at time zero when the final investment decision may be deferred to a future date *t*.

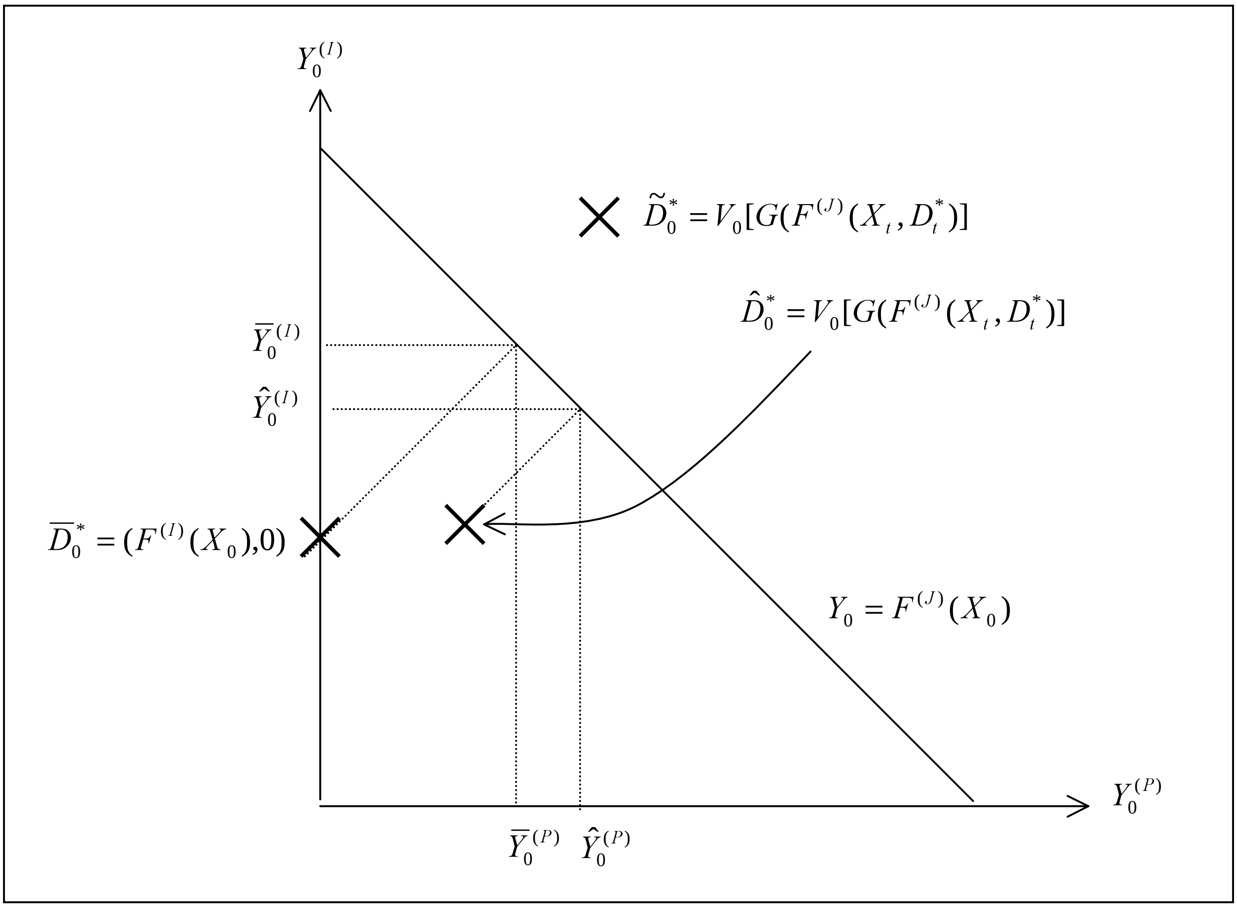

Figure 5. Negotiation Situations with an Option to Wait

Alternative negotiation situations at time zero when the final investment decision may be deferred to a future date *t*.

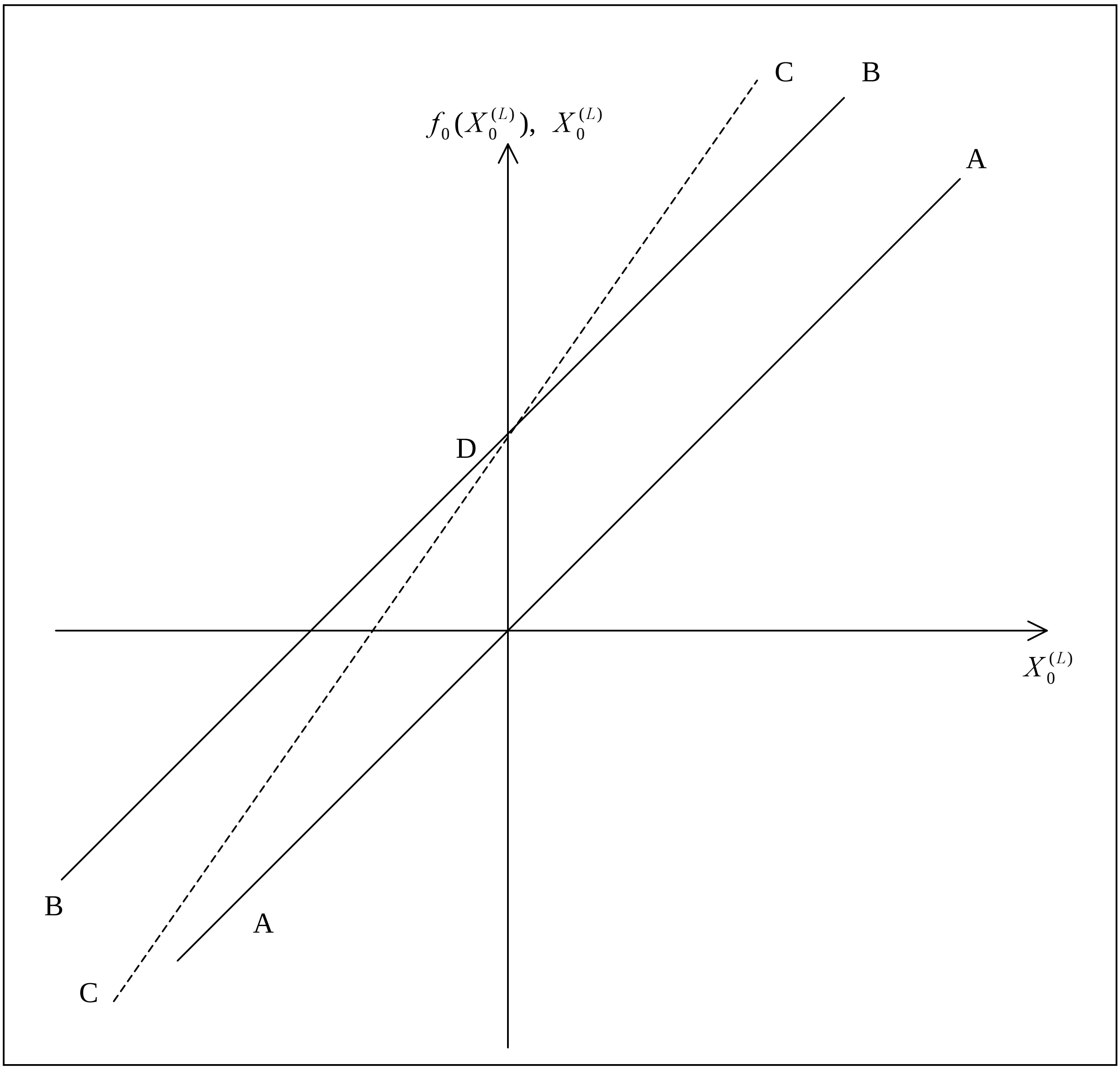

Figure A. The Effect of Cooperation on Cash Contribution from a New Sales Channel

Example of the function $f_0(X_0^{(L)})$, based on equation (5).

Table 1 Assumptions for Numerical Example 1

<table>
<tr><td rowspan="3">Cash payment processes</td><td rowspan="3">$\alpha_{(G)} = 0.8$, $\alpha_{(L)} = 0$
$\sigma_{(G)} = 2$, $\sigma_{(L)} = 5$ $\rho = 0$
$K = 40$, $A = 50$
$S = 0$, $T = 10$ (years)</td><td>Risk premiums</td><td>$\pi^{(G)} = 0.1$, $\pi^{(L)} = 0$</td></tr>
<tr><td>Risk free interest rate</td><td>$r = 0.05$</td></tr>
<tr><td rowspan="3">Effect of local cooperation</td><td rowspan="3">$H = 0$,
$\beta_0 = \beta_1 = \beta_2 = 0$,
$\gamma_0 = 0$, $\gamma_1 = 1$,
$\gamma_2 = 0.6$</td></tr>
<tr><td>Implied convenience yield</td><td>$\delta^{(G)} = -0.55$,
$\delta^{(L)} = 0.05$</td></tr>
<tr><td></td><td></td></tr>
</table>

Table 2. Values and Negotiated Ownership Shares for Numerical Example 1

The table contains passive NPVs, the values when only the operational policy g_t^* is considered, and the expanded NPVs for the cases when the investor invests alone and for the cases when the investment is made jointly. We also show the partner's ownership shares corresponding to the Nash bargaining solution. The numbers may not add up due to rounding errors.

		Value when investor invests alone, USD			Value when investing jointly, USD			Negotiated ownership share for local partner		
	$X_0^{(L)}$	Passive NPV	Only g_t^*	Exp. NPV	Passive NPV	Only g_t^*	Exp. NPV	Passive NPV	Only g_t^*	Exp. NPV
$X_0^{(G)} =$ 25	-40	-757.1	-334.7	0.0	-250.3	-207.1	0.0	N.A.	N.A.	N.A.
	-35	-598.7	-306.9	0.0	-155.2	-133.3	0.0	N.A.	N.A.	N.A.
	-30	-440.4	-260.4	0.0	-59.9	-49.3	5.0	N.A.	N.A.	50.0%
	-25	-282.0	-186.2	0.0	35.7	40.7	70.9	50.0%	50.0%	50.0%
	-20	-123.6	-76.0	4.7	132.3	134.5	150.6	50.0%	50.0%	48.4%
	-15	34.8	57.3	102.4	230.6	231.5	239.8	42.5%	37.6%	28.7%
	-10	193.1	203.2	227.2	332.4	332.7	336.8	20.9%	19.5%	16.3%
	-5	351.5	355.8	367.8	440.5	440.6	442.5	10.1%	9.6%	8.4%
	0	509.9	511.6	517.3	559.4	559.5	560.3	4.4%	4.3%	3.8%
	5	668.3	668.9	671.4	693.9	693.9	694.2	1.8%	1.8%	1.6%
	10	826.6	826.8	827.9	839.2	839.2	839.3	0.7%	0.7%	0.7%
	15	985.0	985.1	985.5	990.8	990.8	990.8	0.3%	0.3%	0.3%
$X_0^{(G)} =$ 50	-40	34.8	57.3	102.4	541.6	541.6	542.3	46.8%	44.7%	40.6%
	-35	193.1	203.2	227.2	636.7	636.7	636.10	34.8%	34.0%	32.2%
	-30	351.5	355.8	367.8	732.0	732.0	732.1	26.0%	25.7%	24.9%
	-25	509.9	511.6	517.3	827.6	827.6	827.7	19.2%	19.1%	18.8%
	-20	668.3	668.9	671.4	924.1	924.1	924.1	13.8%	13.8%	13.7%
	-15	826.6	826.8	827.9	1022.4	1022.4	1022.4	9.6%	9.6%	9.5%
	-10	985.0	985.1	985.5	1124.2	1124.2	1124.2	6.2%	6.2%	6.2%
	-5	1143.4	1143.4	1143.5	1232.3	1232.3	1232.3	3.6%	3.6%	3.6%
	0	1301.8	1301.8	1301.8	1351.3	1351.3	1351.3	1.8%	1.8%	1.8%
	5	1460.1	1460.1	1460.1	1485.7	1485.7	1485.7	0.9%	0.9%	0.9%
	10	1618.5	1618.5	1618.5	1631.0	1631.0	1631.0	0.4%	0.4%	0.4%
	15	1776.9	1776.9	1776.9	1782.6	1782.6	1782.6	0.2%	0.2%	0.2%

Table 3. Values and Negotiated Ownership Shares with and without an Option to Wait, Numerical Example 2

The table contains the partner's ownership shares and expanded NPVs when investment is made jointly at time zero with no waiting (these numbers correspond to the ones presented in Table 2). We also show the parties' present values of their payoffs at the future decision date *t* in case the investment decision is deferred. We report whether a negotiation solution is feasible and the investor's optimal action if negotiations fail at time zero. For the cases where the investor chooses to wait if negotiations fail, the partner's ownership shares and the corresponding values may be computed based on the numbers provided in the table. For the cases where the investor chooses to invest alone if negotiations fail, the ownership share and values are identical to those in Table 2. The numbers may not add up due to rounding errors.

		Negotiated ownership shares with no waiting				Value of waiting			Is neg. solution fea-sible?	I's action if neg. fail	Negotiated ownership shares with waiting		
	$X_0^{(L)}$	Share *P*	Value in USD			Value in USD					Share *P*	Value in USD	
			I	*P*	Total	*I*	*P*	Total				*I*	*P*
$X_0^{(G)}=$ 25	-40	N.A.	N.A.	N.A.	0.0	0.1	0.1	0.3	No	Wait	N.A.	N.A.	N.A.
	-35	N.A.	N.A.	N.A.	0.0	1.9	1.9	3.8	No	Wait	N.A.	N.A.	N.A.
	-30	50.0%	2.5	2.5	5.0	10.4	9.0	19.4	No	Wait	N.A.	N.A.	N.A.
	-25	50.0%	35.5	35.5	70.9	35.2	22.6	57.8	Yes	Wait	41.2%	41.7	29.2
	-20	48.4%	77.7	73.0	150.6	86.0	35.1	121.0	Yes	Wait	33.1%	100.8	49.8
	-15	28.7%	171.1	68.7	239.8	165.6	36.8	202.4	Yes	Wait	23.1%	184.3	55.5
	-10	16.3%	282.0	54.8	336.8	267.9	27.5	295.4	Yes	Wait	14.3%	288.6	48.2
	-5	8.4%	405.1	37.4	442.5	385.8	14.5	400.3	Yes	Wait	8.0%	406.9	35.6
	0	3.8%	538.8	21.5	560.3	516.8	4.8	521.7	Yes	Invest	3.8%	538.8	21.5
	5	1.6%	682.8	11.4	694.2	658.5	0.8	659.2	Yes	Invest	1.6%	682.8	11.4
	10	0.7%	833.6	5.7	839.3	806.1	0.0	806.1	Yes	Invest	0.7%	833.6	5.7
$X_0^{(G)}=$ 50	-40	40.6%	322.3	219.9	542.3	307.7	178.9	486.6	Yes	Wait	38.1%	335.5	206.7
	-35	32.2%	432.1	204.9	637.0	408.5	168.1	576.6	Yes	Wait	31.1%	438.7	198.3
	-30	24.9%	549.9	182.1	732.1	519.2	147.9	667.1	Yes	Wait	24.6%	551.7	180.4
	-25	18.8%	672.5	155.2	827.7	635.1	123.1	758.3	Yes	Wait	19.1%	669.8	157.8
	-20	13.7%	797.8	126.4	924.1	754.1	96.4	850.5	Yes	Wait	14.4%	790.9	133.2
	-15	9.5%	925.2	97.3	1022.4	875.4	69.4	944.8	Yes	Wait	10.6%	914.3	108.2
	-10	6.2%	1054.9	69.4	1124.2	999.4	43.7	1043.1	Yes	Wait	7.5%	1040.0	84.3
	-5	3.6%	1187.9	44.4	1232.3	1127.7	21.8	1149.5	Yes	Invest	3.6%	1187.9	44.4
	0	1.8%	1326.5	24.7	1351.3	1263.7	7.3	1270.9	Yes	Invest	1.8%	1326.5	24.7
	5	0.9%	1472.9	12.8	1485.7	1408.2	1.2	1409.3	Yes	Invest	0.9%	1472.9	12.8
	10	0.4%	1624.8	6.3	1631.0	1557.7	0.0	1557.7	Yes	Invest	0.4%	1624.8	6.3