

Evaluation of International Joint Venture Agreements: Real Options in Practice

Carmen Juan and Fernando Olmos

Instituto de Economía Internacional
Universidad de Valencia
Avda. de los Naranjos s/n
46022 Valencia (Spain)
Phone: +34 963 82 83 69
m.carmen.juan@uv.es
fernando.olmos@uv.es

Rahim Ashkeboussi

Department of Marketing and Finance
Frostburg State University
101 Braddock Road
Frostburg, MD 21532-2303 (USA)
Phone: (301) 791-4020
ashkeboussi@frostburg.edu

Abstract

The main goal of this study is to develop practitioner-friendly methodologies, in a real options framework, for evaluating joint venture (JV) agreements. Avoiding the general issue of JVs' design, we illustrate the application of real options methodology by valuing specific clauses extracted from actual JV agreements. Additionally, we have tried to contribute to the real options field by designing valuation methodologies to capture the value of more complex embedded options ("Compensation Options" and "Options with Uncertain Initial Date") in JV agreements with certain nonstandard features, due to contractual requirements.

1. Introduction

Joint venture (JV) agreements are widely studied, however, the application of real options to assess joint venture agreements is not extensive in the literature. The main goal of this study is to develop practitioner-friendly methodologies, in a real options framework, for evaluating joint venture agreements.

The design of a JV is the result of a negotiation process. Although there is no standard negotiation, we could draft a sequence from the key economic and legal terms to the detailed statement of clauses governing specific features of the business operations of the new venture. In order to fit the present research into the JV field and stress its main contributions, Figure 1 describes how the key issues and additional clauses important for our research are interconnected.

In the early steps of the negotiation, the parties agree on two main issues: their contributions to the JV and their percentages of ownership in the JV. The extent of linkage among these issues depends upon particular aspects of the legal and economic framework where the JV is meant to operate. Situations where the percentages of ownership cannot be negotiated (and, therefore, cannot be linked with the partners'

contributions) often arise, especially in international joint ventures (IJV), due to legal restrictions on the percentage of foreign ownership. (A limit of 49% foreign equity interests in an IJV is not unusual in certain countries and sectors.)

On the other hand, with no restrictions, the partners may wish to accomplish an ownership distribution that would reflect, as precisely as possible, the value of each partners' contributions. Between these two scenarios many other intermediate situations could be envisioned. The question of ownership in JVs has been broadly studied. An interesting recent survey on ownership patterns can be found in Hausbald, R., Hege, U. (2003), where the authors found that "Joint ventures exhibit the following intriguing ownership pattern: the vast majority allocate equal or almost equal equity stakes to the parent firms. Large sample data indicate that about two thirds of two-parent joint ventures have 50%-50% equity allocations, while up to 12% show 50.1% or 51% majority stakes".

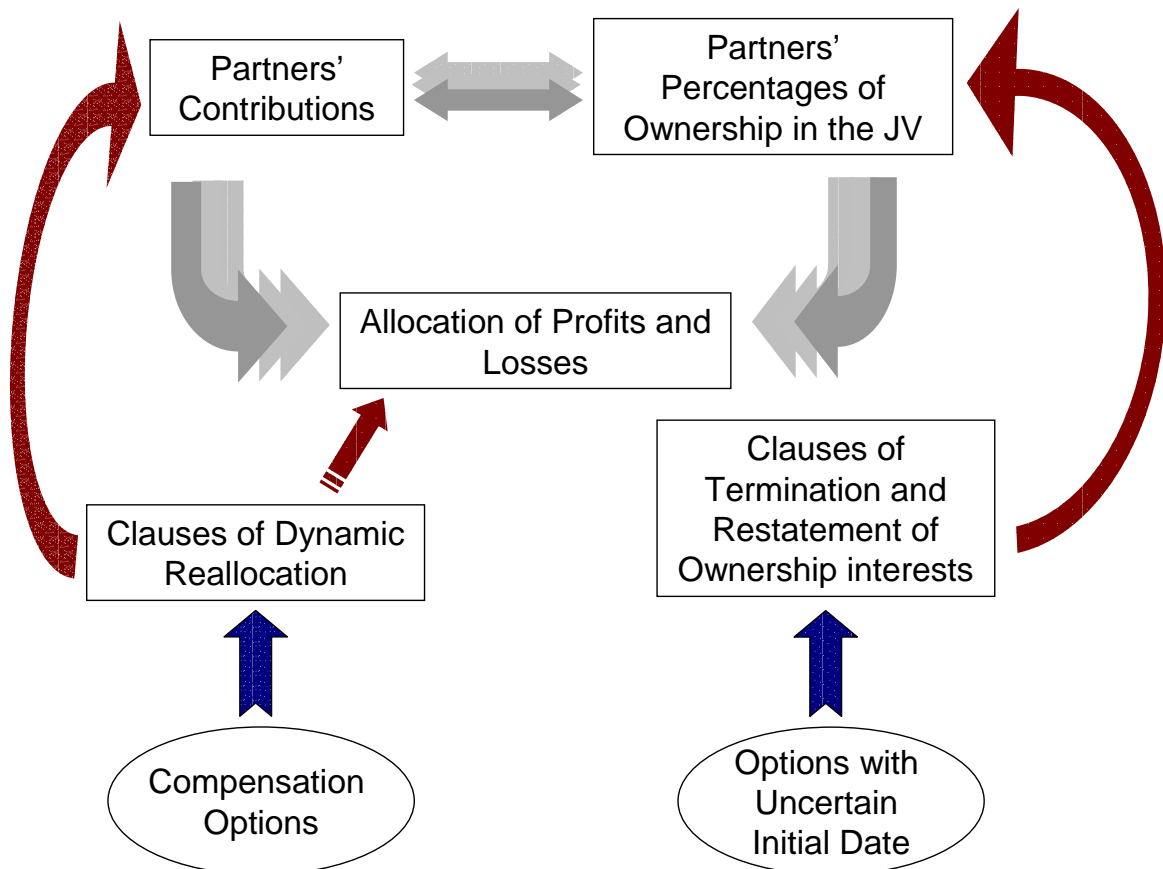


Figure 1

Valuing each parties' contribution in a JV entails the same difficulties as valuation of any other assets but often involves additional difficulty concerning the

valuation of intangible assets (e.g., licenses, intellectual property rights, technology, know-how, human skills). Ground-floor type (see Seth, A., Kim S. M., 2001) or transfer pricing valuation of intangibles using real options (see Faiferlick, C.J. et al., 2004) are just a couple of references in recent research literature. Intangible assets will play an important role in the real options approach that will be developed later on in this paper.

Once an agreement on the two previous issues (parties' contributions and percentage of ownership) is reached, the negotiation will come to the point of deciding the allocation of profits and losses from the JV (the third issue). The interests of the parties in profits and losses and their initial contributions, as well as such interests and their percentages of ownership, may not be the same. The reason for these differences could be explained by noting that unequal initial contributions are sometimes inevitable and thus demand subsequent compensation through uneven allocation of profits and losses (and/or specific clauses), as we will explain later on. In the same way, the percentages of ownership may be previously determined before entering the negotiation, as we have mentioned before, and therefore could not be used as suitable allocation criteria.

The final agreement involving the three issues previously discussed constitutes the core of the JV. In addition to this basic initial structure, a set of clauses guides the details needed for the efficient operation of the new venture. For the purpose of this research we will only point out two groups of clauses: the clauses of dynamic reallocation and the clauses of termination and restatement of ownership interests. The grouping is due to the special features that these clauses share and will play a key role in our research.

The clauses of dynamic reallocation refer to those clauses in the JV agreement that restate the allocation of profits and losses and/or the initial contributions of the parties based on future events. These types of clauses are very useful to avoid complicated negotiation processes and, once the JV is operative, deadlock and impasse situations. This is often the case when intangible assets are involved. As we have mentioned before, valuation of intangible assets is difficult and mostly based on expectations. A reallocation clause allows a partner to compensate, or to be compensated by, the other partner(s) in case of deviations of the actual performance of the intangible asset (or, in general, of the venture) from the expectations. We have called the type of options embedded in such clauses, "Compensation Options" (see Juan, C. et al., 2004), and is the topic of Case-Studies 1 and 2 in Section 3.

The clauses of termination and restatement of ownership interests together represent two groups of clauses with different natures but with some sort of call option on all or part of the other parties' interests. Following Gutterman, A. (2002), the termination provisions determine (i) the duration of the JV, (ii) any event that might trigger a premature termination (operational problems of a partner, partner's change of ownership, material change in partners' business or operational problems of the JV) and (iii) the rules for liquidation and dissolution of the entity. These rules often include options to liquidate, buy-sell options or unilateral purchase rights, as well as precise means for determining the transfer price and value of a departing partner's interest, whether the value is defined as a stated amount, a formula, or by reference to the determination of a third party (Appendix 1 contains an example of conditions for premature termination, purchase options and pricing rules for the case of an IJV between BMW Holding BV & Shenyang JinBei Automotive Industry Holdings Company Limited).

Clauses of restatement of ownership interests may appear in JV agreements separately from termination clauses. They are often used to contemplate situations such as (i) additional capital contributions in response to positive market performance where one partner is not interested in such new commitments, (ii) one partner's desire of acquiring other parties' interest in order to operate the whole JV business on his own (for example, when the IJV has been chosen as a foreign market entry mode) and (iii) other circumstances concerning strategic management expansion decisions (Appendix 2 contains an example of specific purchase rights of type (iii) in the IJV between VaxGen, Inc. & Celltrion, Inc.).

Therefore in both groups of clauses, (purchase or selling) real options can be found, either for expansion and deferral purposes, or forced by liquidation. When the initial date of the option is known (for example, JVs with a fixed duration), they can be valued as American or European options with the standard methodologies (see Copeland, T. (1994), Trigeorgis, L. (1996) and Seth, A., Kim, S.M., (2001). As we can conclude from the examples quoted in the appendices, the precise date when the condition that triggers the exercise of the option is often uncertain. Therefore the initial date of the option, as well as its value, will depend on the probability and timing of occurrence of such condition. We have called these options "Options with Uncertain Initial Date". They require specific valuation methodology and will be illustrated in our Case Study 3 in Section 4.

Before approaching the Case Studies, Section 2 is devoted to an overview of the previous research literature, placing this paper in the context of prior works. Finally, the paper ends with Section 5, containing the conclusions and future research suggestions.

2. Prior Empirical Research and State of Art

The purpose of this section is to focus on those specific fields and works that have motivated this paper, rather than making a comprehensive review of all research literature on JV agreements. We agree with Yan, A. and Zeng, M. on their opinion of how future research on IJVs should be approached: “The real practical value of IJV research rest on providing practitioners with insights regarding how to manage the IJVs evolution, particularly, how to reconfigure its structures and take adaptive actions over time in order to strengthen performance and prevent premature death.” (Yan, A. and Zeng, M., 1999).

Real options concepts and methodologies supply the suitable perspective to look at such “adaptive actions over time”, and moreover to assign a value to the right of being able to actually take those actions. Many examples can be found of how the ideas underlying real options methodology have influenced both empirical and theoretical studies on IJV, but few proper valuations have been done. Most of these examples were developed in studies of IJVs as a foreign market entry mode, and many of them are interlinked with learning and know-how acquisition features in the IJV agreements.

The JV value drivers as identified by Kogut, B. (1988) [(1) reduction of the transaction cost that would have to be born by the partner companies without the joint venture, (2) improvement of strategic positioning, and (3) learning effects created through the cooperation], are seen by Chi, T. and Seth, A. (2002) and Seth, A., Kim, S.M. (2001) through the lens of real options theory. They become then explicit and implicit real options embedded in the JV agreement between the partners and can be exercised by either party in the future.

In a subsequent work, Kogut, B. (1991) argued that JVs could be considered as real options when firms contemplate expanding their foreign operations in response to anticipated market and technological developments. Acquisition of the venture by a partner will be the exercise of such options. Using real options concepts to state his hypothesis on JV performance in the face of an acquisition, he studied a sample of 92 manufacturing JVs and concluded that unexpected growth in the product market

enhances the probability of acquisition (exercise of the option to buy out) among the JV partners, while adverse behavior of the market does not lead to dissolution.

Sometimes, the real options perspective contradicts previous results on the topic considered. For example, the real options view of market entry suggests that market uncertainty can increase the likelihood of JV formation against its alternatives such as direct investment due to embedded options in a JV agreement (Folta, T.B., 1998; Seth, A. and Kim, S.M., 2001). On the contrary, the transaction cost economics as proposed by Williamson (1991) suggests that market uncertainty is likely to intensify contractual hazards and thus diminish the probability of JV formation.

The real options approach has also proved to be useful when assessing issues concerning market volatility and JVs' termination by acquisition. Buckley and Casson (1998), using a deterministic rather than stochastic model, argued that since in a volatile market environment flexibility is essential, using a JV as a mode of market entry, compared with other modes, will provide an option to expand (buying the partner out) or contract (withdrawal by selling out to partner) the capacity based on unexpected market conditions. The remaining partner is, in effect, a ready customer for the interest of the outgoing partner.

This point was also argued by Nanda, A. and Williamson, P.J. (1995) who stated that a better way for restructuring an unwanted business is setting up a JV with a potential buyer instead of an outright sale. Additionally, Chi, T. & McGuire, D.J. (1996) and Chi, T. (2000) utilized quantitative models to capture the real option value in JVs. They discovered that the option value is likely to be higher as the partners' growth and volatility assessments of the JV assets are deviating and less correlated, and/or as the partner that anticipate a higher growth rate, initially, holds a lower share of the JV's equity.

Finally we would like to focus on those issues concerning know-how transfers and knowledge acquisition through JV agreements, as well as the new insights that a real options approach can provide into the learning option.

Findings by Contractor, F.J. and Lorange, P. (1987) and Kogut, B. (1988) point to JVs as a mechanism for inter-firm learning and know-how transfer. Blodgett, L.L. (1992) in identifying the factors that guide a JV partner to increase its involvement in a joint venture, argues that companies that contribute technology to an international joint venture are more likely to increase their commitment in the venture. These companies

acquire a genuine acquisition option that could be exercised after obtaining local knowledge from their partner(s).

Studies by Kester, W.C. (1984), Rivoli, P. and Salorio, E. (1996), and Miller, K.B. and Folta, T.B. (2002) found the influence of market competition on timing of the exercise of real options so that the firm can benefit from first mover advantages while preempting competitors' threats. In the absence of such market competition the exercise of real options could be deferred until more knowledge regarding the operating environment of the firm, to facilitate the timing and the magnitude (how much to invest) of the market entry, could be gathered. The role of know-how acquisition in the formation and duration of JVs is studied by Habib, M. and Mella-Barral, P. (2003). They explicitly model the learning that is implicit in the Kogut, B. (1991) empirical analysis but avoid the real options perspective of the former.

Regardless of the variety of approaches, topics and conclusions, the research literature quoted in this section could be considered more academic than practitioner-oriented. The purpose of our work is twofold. On one hand, we will try to contribute to the field of study of JVs through promulgating a practical application. Avoiding the general issue of JV design, we illustrate the application of real options methodology by valuing specific clauses in JV agreements extracted from actual JV agreements. On the other hand, we attempt to contribute to the real options field by designing valuation methodologies for options embedded in the JV agreements with certain nonstandard features, as described in the previous section.

3. Valuation of Compensation Options.

3.1 Case of Study 1: Terra Networks, S.A. & IDT Corporation

In this case study we analyze a compensation option embedded in a dynamic reallocation clause included in the IJV between Terra Networks, S.A. (TI) & IDT Corporation (IDT). The main features of this option could be summed up by saying that TI should pay 30 million dollars (initial contribution to the JV) for the right of accessing IDT's client market, an intangible asset transfer valued according to certain criterion (see footnote 1 in section 3.1.2 below). If after 6 months, the actual business volume from IDT's clients is lower than the initial expectations, TI has the right to be compensated by IDT in an amount proportional to such value decline.

The amount of the compensation will be calculated depending on whether IDT owns TI stock, which also depends on whether TI has been able to successfully issue an

IPO before or after a certain date (see section 3.1.2 and 3.1.3 for a full description of the mechanism and formulas).

Therefore the compensation option considered is an option of the European type whose payoff function depends (i) on two underlying assets (the revenues from IDT clients and the TI stock price), and (ii) on the probability of the event of IDT being owner of TI stock. The valuation model is a specifically designed numerical algorithm that uses Monte Carlo simulation combined with a probability distribution modeling.

Let us describe in detail how this option is stated in the JV agreement. The original text of the clauses involved can be found in Appendix 3.

3.1.1 General description of the Parties in the JV

On October 5, 1999 TI a Spanish company, formerly known as Telefonica Interactive, S.A., agreed to form a JV with IDT an American corporation. The objective of the JV would be to pool resources to develop a portfolio of Internet product and services for delivery to hispanic customers in the U.S.

To achieve this objective, TI and IDT would form a new company called TI USA ISP. Through TI USA ISP, IDT would provide its marketing and operational expertise and infrastructure. TI would provide its global brand name and access to its well-developed global relationships (especially in Spanish and Portugues-speaking countries).

3.1.2 Ownership and Capital Contributions of the Parties

Based on JV agreement TI and IDT will own 51% and 49% of equity voting interest of TI USA ISP repectively.

Per the JV agreement, TI would contribute a total of US \$30,000,000¹; in installment payments. As the extent and timing of TI capital contribution is contingent upon the IDT revenues (as explained below), then TI's capital contribution is a stochastic variable.

IDT's rights and obligations to purchase TI Shares are as follows:

¹ This number was determined by multiplying the annualized revenues from IDT customers for August 1999 by he "Customer revenue Multiple"

1. If TI issues IPO² in the U.S. on or prior to March 31, 2000, IDT is **obligated** to buy TI IPO shares for an amount equal to U.S. \$15,000,000 (IDT Purchase Amount)³.
2. If TI IPO were not issued on the above date, but between April 1, 2000 and June 30, 2000, IDT would have the **option**⁴ to purchase TI IPO shares for an amount equal to U.S. \$15,000,000 (IDT Purchase Amount).
3. If TI IPO were not issued by June 30, 2000, IDT would have the **option**, exercisable within 10 business days after the final valuation (see subsection 3.1.3 below), to buy shares of common stock of TI (as a non-public company). The value of these shares to be determined on or before June 30, 2000 by an acceptable investment banking firm.

3.1.3 Description of the Option

If after 6 months of the signing of the JV contract by the partners, the annualized revenues from the IDT customers was less than the annualized revenues estimated based on the revenues for August 1999, IDT should return to TI a portion (equal to percentage decline in annualized revenues) of the TI IPO shares it purchased.

If after 6 months of the signing of the JV contract by the partners, the TI IPO was not issued the TI shares, that IDT has the option to buy, would be reduced by the percentage decline in annualized revenues as stated in number 4 above. If IDT elects not to purchase the TI common stock (see number 3 above), TI Capital Contribution would be reduced by the amount of decline in annualized revenues multiplied by “Customer Revenue Multiple” and then multiplied by 51%.

3.1.4 Valuation Model

The valuation model has been implemented in Excel and the simulations have been run using Crystal Ball[®]. The model has the following inputs:

- Underlying Asset: Daily TI stock prices between January 1st, 2000 and June 30th, 2000.

² Initial Public Offering

³ This number was calculated by multiplying the annualized revenues from IDT customers for August 1999 by the “Customer revenue Multiple”, and further multiplied by 51%.

⁴ Notice that the word “option” used in the original statement of the stipulation should not be on a par with a “financial option” as the purchase would be done in the spot market without any previously recognized right.

The underlying asset has been modelled using a geometric brownian motion with parameters adjusted using data time series of the behaviour of TI stock prices.

- Expiry date: June 30th, 2000.
- Percentages of ownership: 51% (TI); 49% (IDT)
- Initial capital contributions: \$US 30,000,000 (TI); \$US 15,000,000 (DTI) subject to a successful IPO by TI during the first 3 months and to the option to buy hold by IDT during the next three months, including the possibility of no purchase of TI stocks by IDT in the case of unsuccessful IPO⁵.

The uncertainty concerning the purchase of TI stocks by IDT comes from two sources: the probability of a successful IPO by TI in the first 3 months and the probability of whether IDT will decide to purchase if the IPO takes place during the next 3 months. We have chosen a binomial probability distribution (success and failure) to assess an 80% probability to the IDT purchase (either compulsory or optional).

- Revenue from the IDT customers during the first 6 months of the JV: This revenue is expected to be US\$15,000,000. However if, as explained under section 3.1.3 the actual revenues are less than the expected US\$15,000,000 then IDT should compensate TI proportionately⁶.

The uncertainty concerning the value of the accumulated revenues from the IDT customers during the first 6 months has been modelled using a triangular probability distribution with minimum value \$US 12,000,000, maximum value \$US16,000,000 and likeliest \$US 15,000,000.

⁵ Sophisticated models could be designed to model both uncertainties considering information available on strategic behaviour of both companies and expected stock price performance. We have tried to show with this simple modelling how expert information from managers could be translated into a user-friendly stochastic valuation model

⁶ Revenue from IDT customers could also be modelled using a stochastic process and, therefore considered as an underlying asset. In such case, a binomial model is needed. For the sake of simplicity in order to stress other features of the valuation methodologies proposed, we have avoided multinomial models in our case studies.

- Payoff Function: The value of the payoff function is calculated as follows:
 - o If there has been no percentage decline in the revenues from the IDT customers, the value of the payoff function would be 0;
 - o If there has been a percentage decline in the revenues from the IDT customers, we distinguish two situations:
 1. There is no TI stocks purchase by IDT . Then the value of the payoff function is given by:

$$(30,000,000)*(\% \text{ decline})*0.51$$
 2. The TI stocks purchase took place at a certain day during the 6 months period. Then the value of the payoff function is given by:

$$(\text{Number of actions})*(\% \text{ decline})*(\text{Stock price at expiry date})$$

The number of shares purchased is given by 15,000,000 divided by the stock price at the purchase date. Therefore the valuation model has been built assigning a daily probability to the event of the purchase, identifying the date of purchase and using its corresponding stock price to calculate the number of shares. Notice that the compensation payment is calculated using the stock price at expiry date, when the share transfer takes place.

Figure 2 illustrates the combined behavior of all sources of uncertainty in the model for three different trajectories. The trajectory in blue shows the combination of the evolution of the TI stock price with the event of a successfully issued TI IPO on day 59. Therefore, IDT is forced to buy TI stock. At expiry date, IDT had to pay compensation (in stocks) of US\$460,435.20 to TI due to a decline in its clients' revenues of 3.04%.

The trajectory in yellow shows the combination of the evolution of the TI stock price in the event of an unsuccessful TI IPO during the first 3 months, but considering that IDT voluntarily acquires TI options on day 97. A 0.5 % decline allows TI to receive compensation of US\$53,849.53. Finally, the pink trajectory shows the evolution of the TI stock price in the event of neither an IPO issuance nor the purchase of TI stock by IDT. A 16.35% decline results in a decrease of US\$2,364,197.20 in TI's initial contribution.

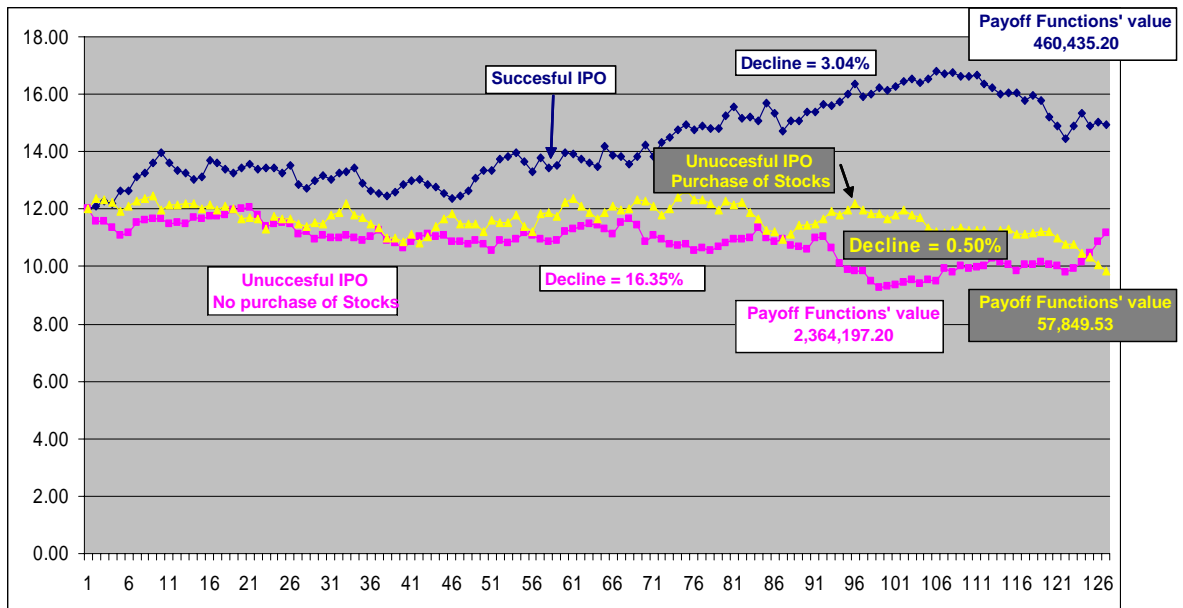


Figure 2

The value of the compensation option is the expected discounted value of the payoff function at expiry. For our case study we obtained a value of US\$735,817.75, which means that the compensation clause included in the JV agreement is worth an expected value of US\$735,817.75. Figure 3 below shows the frequency chart of outcomes of the non-zero payoff function values.

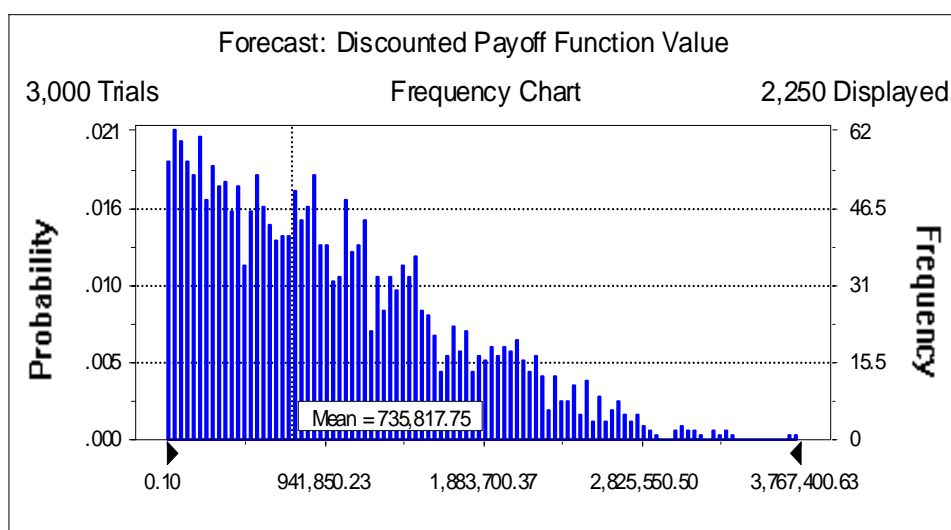


Figure 3

3.2 Case of Study 2: CRA LLC. & ABI LLC.

In this case study we analyze a compensation option embedded in a dynamic reallocation clause included in the JV between CRA LLC (CRA) & ABI LLC (ABI). The main features of this option could be summed up by saying that CRA will absorb losses from the JV until an aggregate amount of US\$300 million dollars, unless four consecutive fiscal quarters with gross profits occur. As compensation, CRA will receive during that period an additional 15%, over the initial 50%, on the profits of the JV, until the aggregate profits equal the aggregate losses.

Therefore, the compensation option considered in the study has as underlying asset, the profits/losses from the JV at the end of each fiscal quarter, and it is compounded by a sequence of European call/put options with expiry dates at the end of each quarter. Each option is path-dependent as the payoff function will depend (i) on the aggregate amount of profits and/or losses, and (ii) on the event of four consecutive quarters of gross profits. Finally, the number of options involved is not fixed as it depends on the final number of quarters with asymmetrical profit/loss allocation. The value of the whole option is the addition of each European option's expected value.

3.2.1 General Description of the Parties in the JV

A joint venture agreement dated April 1, 2001 was entered into by Applera Corporation ("Applera"), the Applied Biosystems Group of Applera ("ABI"), the Celera Genomics Group of Applera ("CRA"), Foster City Holdings, LLC ("ABI LLC"), and Rockville Holdings, LLC ("CRA LLC") with ABI and CRA being the main participants. The name of the JV was to be "Celera Diagnostics, LLC."

The JV was structured as shown in Diagram 1.

The business of the Joint Venture shall be limited to the field of Human In Vitro Diagnostics (HIVD). The HIVD field comprises products, technologies, services, and/or processes for use in the measurement, observation, or determination of attributes, characteristics, diseases, traits, or other conditions:

- for medical management of a human being; and/or
- for quality control or testing of human blood or tissue for transfusion or blood banking, bone marrow transplantation or banking, or tissue typing for transplantation.

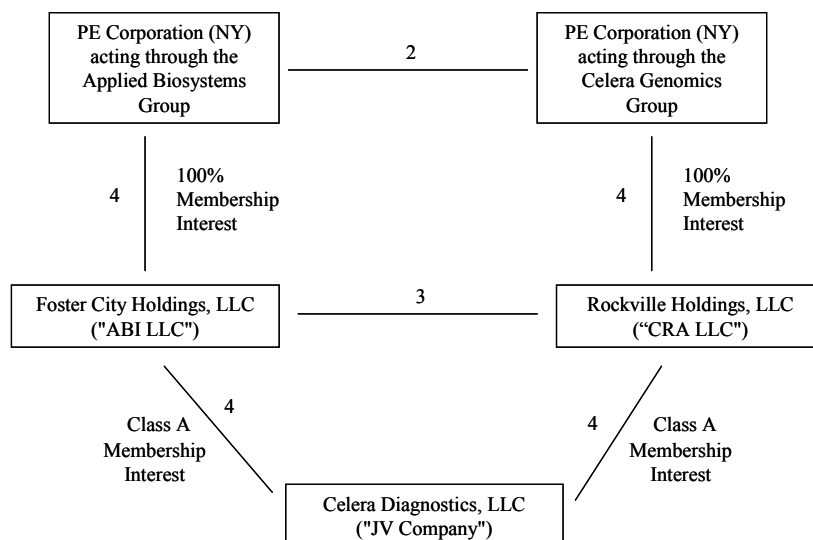


Diagram 1

3.2.2 Ownership and Capital Contributions of the Parties

ABI and CRA both agreed to fund 50% of the working capital and fixed capital requirements of the Joint Venture.

Additionally CRA agreed to fund all of the cash operating losses of the venture up to a maximum of US\$300 million (excluding those amounts required for periodic working and fixed capital contributions which were to be shared equally by ABI and CRA), and to absorb the full operating losses of the JV in the manner specified in the description of the Compensation Option in section 3.2.3.

3.2.3 Description of the Option

JV Company losses shall be for the account of ABI LLC and CRA LLC as follows:

(a) During the *Initial Loss Period*, all operating losses of the JV up to US\$300 million (*Initial Loss Commitment*) shall be allocated to CRA LLC. The aggregate operating losses during the Initial Loss Period will be called *Allocated Initial Losses*.

(b) All operating losses of the JV above the Initial Loss Commitment, or which occur after the Initial Loss Period, shall be allocated 50% for the account of ABI LLC and 50% for the account of CRA LLC.

The JV Company profits shall be allocated as follows:

- i. 65% for the account of CRA LLC, and 35% for the account of ABI LLC until the cumulative profits equal the Allocated Initial Losses.

- ii. 50% for the account of CRA LLC, and 50% for the account of ABI LLC thereafter.

Next the agreement defines the Initial Loss Period:

The Initial Loss Period begins with the formation of the JV and ends on the earliest occurrence of: (i) the Initial Loss Commitment equals the Allocated Initial Losses; or (ii) the last day of any fiscal quarter during which the JV experiences gross operating profits, provided that such fiscal quarter represents the fourth of four consecutive fiscal quarters during which the JV experiences gross operating profits.

3.2.4 Valuation Model

The valuation model has been implemented in Excel and has the following inputs:

- Underlying Asset: Profits at the end of each fiscal quarter. Such profits have been calculated as the difference between the revenues at the end of each quarter and the variable and fixed costs.

The revenues have been modelled using a geometric browning motion whose parameters have been given tentative values.

- Expiry date: At the end of each fiscal quarter. At the end of each fiscal quarter. Note that the number of options to be considered is not fixed as it depends on the number of fiscal quarters involved, which depends on the first to occur of: (i) the Initial Loss Period ending; or (ii) the Allocated Initial Losses equals the cumulative profits.
- Variable costs: 40% as expected value with a variation range between 30% and 50%.
- Payoff Function: Figure 4 illustrates how the value of the payoff function is calculated at the end of each fiscal quarter.

After running a simulation, an expected value of 3.07 was determined, which means that the compensation clause included in the JV agreement is worth an expected value of US\$3,070,000. Figure 5 below shows the frequency chart of outcomes of the global payoff function.

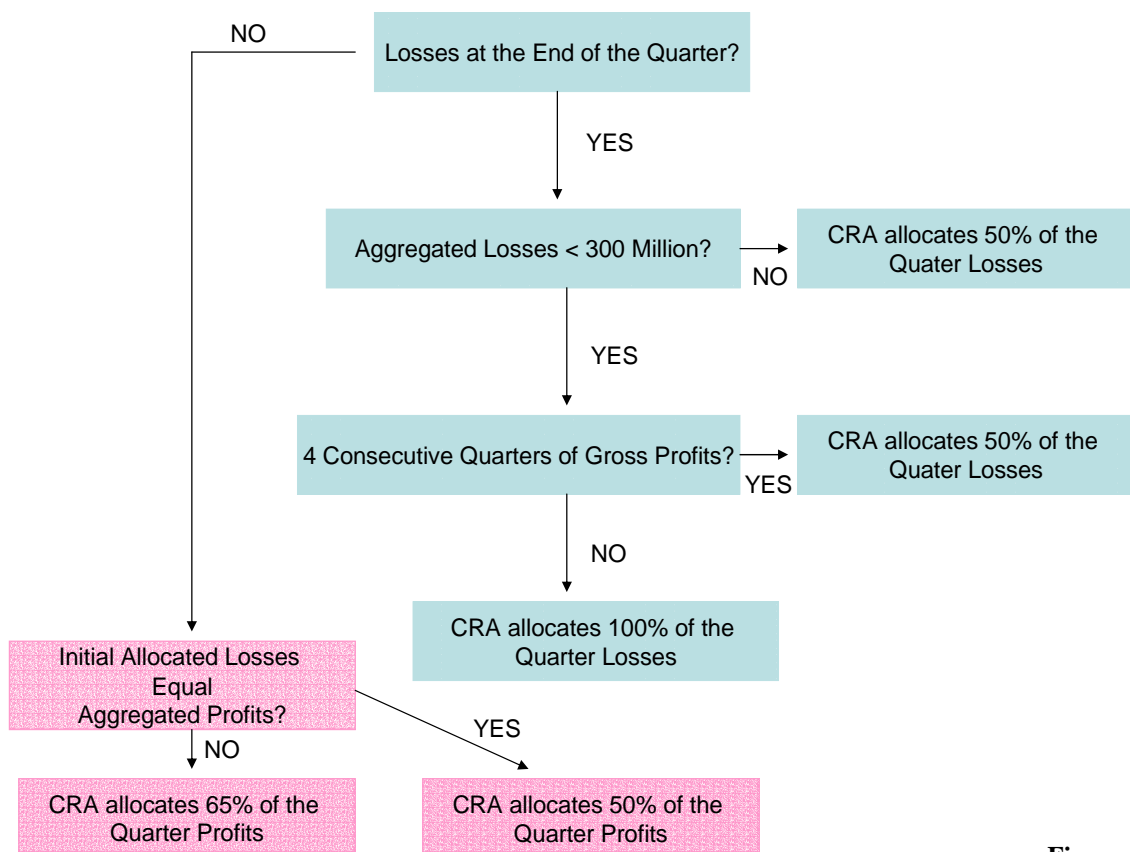


Figure 4

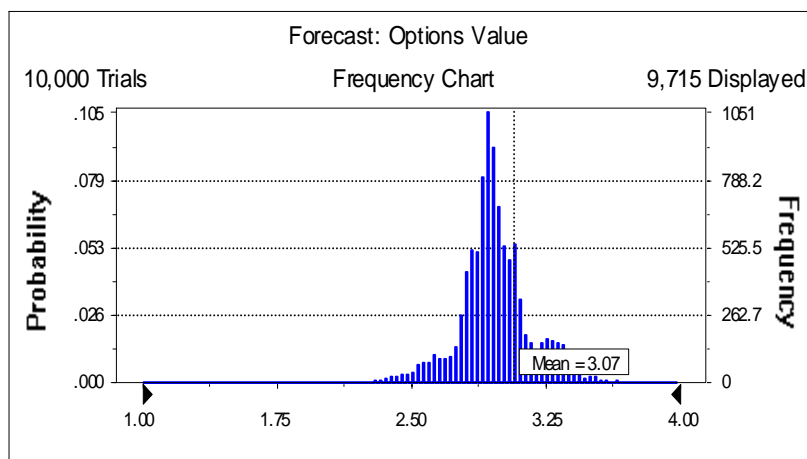


Figure 5

4. Valuation of Real Options with Uncertain Initial Date.

4.1 Case of Study 3: Option to acquire through an IJV

When all the information concerning the structure of the option is known, and there is no other source of uncertainty beside the underlying assets, this type of option, embedded in termination or reallocation of ownership interest clauses, could be valued

as American or European options with the standard methodologies. However, as is the case in the IJVs quoted in Appendices 1 and 2, the initial date of the exercise period of the option is not known in advance because it depends on the occurrence of certain events (such as circumstances stipulated as termination causes in Appendix 1, or the approval from the Food and Drug Administration in Appendix 2).

In other cases, the structure of the option is fixed and well known but, although the owner of the option has the theoretical right of exercise, in fact, the existence of barriers (e.g., intangible assets to be transferred, cultural or legal barriers) makes it impossible to do so. For example, if the acquisition were done through a JV because the purchasing firm does not possess the know-how of the process that it intends to fully control, the acquisition clauses contained in the JV agreement would only be exercised when the condition of obtaining a sufficient level of know-how were satisfied.

Therefore, we are dealing with options with uncertain initial dates, as the precise dates when barriers may be removed, or prior conditions are satisfied, are uncertain along a venture's life. (Using financial terminology, the closest equivalent would be an up-and-in barrier option with an American type of exercise.)

4.1.1 General Description of the Parties in the JV

In order to better describe the valuation methodology without the complexity of the real cases quoted, we consider a simplified case study. Let us suppose a situation where Partner A and Partner B sign a JV contract. Partner A has the intention of using the JV as a way of acquiring the know-how that Partner B possesses, and then, if the market remains favorable, actually buy out Partner B's share in the joint venture. Partner B, as the selling Partner, is interested in the transfer of know-how as a way of increasing its value since it is facing a potential acquisition by A (see Habib and Mella-Barral (2003)). If the know-how is not acquired, Partner A cannot exercise the option even if the market signals are positive (see Kogut (1991))

4.1.2 Valuation Model

The inputs of the model are the following:

- Percentage of ownership interest of each partner.

The existing percentages of ownership are 60% for the purchasing Partner A, and 40% for the selling Partner (B).

- Underlying Asset: The value of the whole venture as a business unit.

The value is modelled using a geometric Brownian process with 3% growth rate and 12% volatility. The basic growth rate varies between 2% and 5% following a triangular distribution with the most likely point 3%. The volatility varies according to a normal distribution with an expected value of 12% and a standard deviation of 1%.

- The spanning tree, modeling the underlying asset, has been modified with an additional growth of the market of 18.5% in the second year, followed by two subsequent decreases of 8% and 7.5% in the third and fourth years respectively. (This type of tree is based on the spanning trees valuing options on dividend-paying stocks). The situation described models a buying opportunity in the market (see Kogut, 1991) that could gradually disappear due to the presence of competition.

The additional growth rate varies between 15% and 20% following a triangular distribution with the most likely point of 18.5%. The decreasing growth rate in year 3 varies between 6% and 10% following a normal distribution with an expected value of 8% and a standard deviation of 0.8%. The decreasing growth rate in year 4 varies between 5.5% and 9.5% following a normal distribution with an expected value of 8% and a standard deviation of 0.75%.

- Initial value: US\$ 125 millions.
- Time horizon: 5 years with exercise dates each six months
- Cost of Partner A to acquire Partner B: US\$75 million, equal to the 40% of initial value (the percentage of ownership of B)⁷.
- Risk adjusted discount rate: 10%.

⁷ In this simple example we have considered the exercise price fixed along time. However many pricing rules in JVs use the selling and purchasing of shares as a way of transferring ownership. In this case we should then consider a stochastic modeling process of the exercise price, and therefore we would have a multinomial spanning tree.

- Model for the learning variable and the acquisition of know-how: the probability of Partner A having acquired enough know-how from Partner B to approach an acquisition, is modeled at each exercise date using a stochastic variable ξ_t , defined as follows:

$$\xi_t = \begin{cases} 1 & \text{with probability } p_t \\ 0 & \text{with probability } 1-p_t \end{cases}$$

where 1 denotes success in learning with a probability p_t , and 0 denotes that the learning process is not yet finished with probability $1-p_t$. The probabilities increases along time from 0% to 100%. The variables are correlated and will be used when calculating the value of the payoff function.

- Payoff function:
 - o Let V_t^e the value of the venture at date t .
 - o Let K_t^e the exercise price at a given node at date t .

The payoff function at expiry date is given by:

$$\text{Max}(\xi_t (V_t^e - K_t^e); 0)$$

At any intermediate date:

$$\text{Max}(\xi_t (V_t^e - K_t^e); \text{continuation value})$$

Once the know-how is attained ($\xi_t = 1$) at a given date t , then the exercise period of the option starts and we have an American option from that date on ($\xi_{t+s} = 1, s \geq 0$). If the know-how is acquired at the first exercise date ($\xi_t = 1, \forall t$), then we have a standard American option. If the know-how is acquired at the end of the time horizon T ($\xi_T = 1; \xi_{T-s} = 0, s > 0$), then we have a European option.

So we have a non-standard option whose value will be between the ones of a European type option and an American type option.

4.1.3 Numerical Results

If we run a simulation of the model, we obtain the following probability distribution of the value of the option to acquire for Partner A:

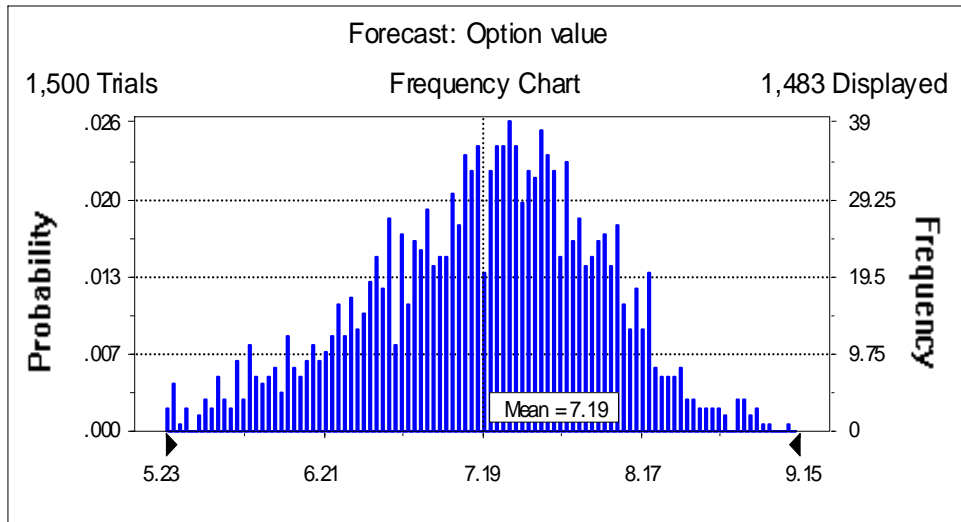


Figure 6

The expected value of the acquisition option is US\$7.19 million.

5. Conclusions

This study attempts to bridge the gap between theory and practice by applying real options valuation models to capture the economic value of the complex clauses embedded in JV agreements. Our study demonstrates that real options models are not only fit to assess the value of tangible assets in JVs, but are suitable to evaluate the intangible assets often present in JV agreements. As valuation of these clauses requires nonstandard option valuation models, a binomial option pricing approach was utilized by the study.

References

¹Blodgett, L.L. (1992). "Factors in the instability of international joint ventures: An event history analysis." *Strategic Management Journal* 13(6), 475-481 (1992).

Buckley, J. P. and M. Casson (1998). "Models of Multinational Enterprise." *Journal of International Business Studies* 29(1): 21-44 (1998).

Chi, T. (2000). "Option to Acquire or Divest a Joint Venture." *Strategic Management Journal* 21(6): 665-687 (2000).

Chi, T. and D. J. McGuire (1996). "Collaborative Ventures and Value of Learning: Integrating the Transaction Cost and Strategic Option Perspectives on the Choice of Market Entry Modes." *Journal of International Business Studies* 27(2): 285-307 (1996).

Chi T, Seth, A. (2002). "Joint ventures through a real options lens." Contractor FJ, Lorange P, eds. *Cooperative Strategies and Alliances: What We Know 15 Years Later*. Elsevier Science, The Netherlands (2002).

Contractor F.J., Lorange P. (1987). "Why should firms cooperate? The strategy and economic basis for cooperate ventures." Contractor F.J., Lorange P, eds. *Cooperative strategies in international business*. Lexington Books, Lexington, MA (1987).

Copeland, T., Antikarov, V. (2001) "Real Options: A practitioners Guide". Texere Publishing, (2001).

Feiferlick, C.J., Reichert, T., Andreoli, B., Ackerman, P.C., odden, L. (2004) "Using Real Options to Transfer Price Research-Based Intangibles". *The International Tax Journal*; Summer 2004; 30, 3.

Folta, T. B. (1998). "Governance and Uncertainty: the Tradeoff Between Administrative Control and Commitment." *Strategic Management Journal* 19(11): 1007-1028 (1988)

Gutterman, Alan (2002). "A Short Course in International Joint Ventures : Negotiating, Forming & Operating the International JV. World Trade Press, Novato, CA, USA (2002).

Habib, M. and Mella-Barral, P. (2003) "The Role of Know-How Acquisition in the Formation and Duration of Joint Ventures. EFMA 2004 Basel Meetings Paper.

Hausbald, R., Hege, U. (2003) "Ownership and Control in Joint Ventures: Theory and Evidence". *Discussion Paper Series* N° 4056. Centre for Economic Policy Research, London (2003).

Juan, C., Olmos, F. et al. (2004) "Concesion Agreements in the Shipping Industry". Annual Conference on Real Options. Theory meets Practice. Montreal (2004).

Kester, W. C. (1984). "Today's Options for Tomorrow's Growth." *Harvard Business Review* **62**(2): 153-160 (1984).

Kogut, B. (1988). "Joint ventures: Theoretical and empirical perspectives." *Strategic Management Journal* 9(4), 319-332 (1988).

Kogut, B. (1991). "Ventures and the Option to Expand and Acquire." *Management Science* 37(1): 19-33 (1991).

Miller, K. D. and T. B. Folta (2002). "Option Value and Entry Timing." *Strategic Management Journal* **23**(7): 655-665.

Nanda, A. and P. J. Williamson (1995). "Use Joint Ventures to Ease the Pain of Restructuring." *Harvard Business Review* **73**(6): 119-128 (1995).

Rivoli, P. and E. Salorio (1996). "Direct Investment and Investment Under Uncertainty." *Journal of International Business Studies* **27**(2): 335-354 (1996).

Seth, A., Kim, S.M. (2001) "Valuation of International Joint Ventures: A Real Options Approach". Contractor, F.J. (Editor): *Valuation of Intangible Assets in Global Operations*. Greenwood Publishing Group, Inc., Westport, CT, USA, (2001).

Trigeorgis, L. (1996) "Real Options in Capital Investment: Models, Strategies and Applications". Praeger, Westport, CT, (1996).

Yan, A., Zeng, M. (1999) "International Joint Venture Instability: A Critique of Previous Research, A Reconceptualization, and Directions for Future Research". *Journal of International Business Studies*; Second Quarter, 30, 2 (1999).

Williamson O.E. (1991). Comparative economics organization: The analysis of discrete structural alternatives. *Administrative Science Quarterly* **36** 269-296 (1991).

Appendix 1

Extract from the IJV between BMW Holding BV & Shenyang JinBei Automotive Industry Holdings Company Limited

Article 23: Termination

23.1 Events of Termination

23.1.1 Subject to the approval of the Examination and Approval Authority, either Party shall have the right to terminate this Contract prior to the expiration of the Joint Venture Term by written notice to the other Party, if any of the following events occur:

(i) the other Party materially breaches this Contract or the Articles of Association, and such breach is not cured within thirty (30) days of written notice to the breaching Party;

(ii) the JV Company, after a start-up period of three (3) years from the Establishment Date, has sustained permanent heavy losses exceeding twenty-five percent (25%) of the total registered capital of the JV Company per annum for two (2) consecutive years, or if three (3) years after the Establishment Date the cumulative amount of losses has exceeded fifty percent (50%) of the total registered capital of the JV Company, whichever occurs first;

(iii) the other Party assigns, pledges, or otherwise encumbers any of its interest in the registered capital of the JV Company in violation of this Contract or applicable PRC Laws;

(iv) a Change of Law (exclusive of situations as provided in Article 3.5.3 hereof) has directly or indirectly caused or is clearly foreseeable to cause material adverse consequences to the JV Company or to any Party's benefits under this Contract and the Parties are unable to agree upon necessary adjustments (as provided for in Article 3.5.2) within three (3) months after the Change of Law has occurred;

(v) unforeseen circumstances arise where it is likely that the JV Company, will suffer an overall loss during the entire Joint Venture Term;

(vi) the other Party and/or its Affiliate(s) materially breaches or it will fully causes the JV Company to materially breach any of the Trademark License Agreement, Technology License Agreement, the Parts and Components Supply Agreement or the agreement referred to in Article 14.2 and such breach is not cured within thirty (30) days after receipt of written notice to that causing Party;

(vii) total or partial performance of this Contract is prevented by an Event of Force Majeure for more than one hundred twenty (120) days, and such prevention materially and adversely affects the operation of the JV Company, and the Parties are unable to find an equitable solution;

(viii) both Parties decide to terminate their joint venture cooperation;

(ix) the JV Company or the other Party becomes insolvent for a consecutive period of three (3) months, or it becomes bankrupt, or it dissolves;

(x) the Technology License Agreement or the Trademark License Agreement terminates or expires;

(xi) the Business License is cancelled;

(xii) the Business License is amended, or a license, permit, or authorization which is required by the JV Company is withdrawn, cancelled, or amended in whole or in part, and such amendment, withdrawal or cancellation has directly or indirectly caused or is clearly foreseeable to cause material adverse consequences to the JV Company or to any Party's benefits under this Contract. If the amendment, withdrawal, or cancellation is due to the fault of a Party, such Party shall not have the right to terminate this Contract under this clause;

(xiii) an event of deadlock exists in accordance with Article 8;

(xiv) if a Party loses its powers to appoint one or more of its representatives on the Board or loses its powers to nominate one or more of its representatives in the Management as provided for in this Contract.

(xv) there arises any other reason for termination expressly provided for in this Contract or applicable PRC Laws.

23.1.2 In addition to the provisions of Article 23.1.1, BRILLIANCE shall have the right to terminate this Contract prior to the expiration of the Joint Venture Term, by written notice to BMW, if any of the following events occur:

(i) BMW undergoes a change in Control or twenty-five percent (25%) of its equity capital is directly or indirectly acquired, or it has been directly or indirectly merged with or into another entity, unless BMW has obtained the prior written consent of BRILLIANCE for such change in Control, acquisition, or merger; or if the representation and warranty set out in Article 2.2.3 was incorrect or became incorrect after the Effective Date.

(ii) a BMW Competition Event occurs and it is not cured within thirty (30) days of written notice from BRILLIANCE.

23.1.3 BMW shall have the right to terminate this Contract prior to the expiration of the Joint Venture Term by written notice to BRILLIANCE if any of the following events occur:

(i) BRILLIANCE is in breach of the production capacity guarantee as provided for in Article 11.4.1(xii) of this Contract and such a breach causes a material adverse effect on the operation or the financial results of the JV Company;

(ii) BRILLIANCE undergoes a change in Control or twenty-five percent (25%) of its equity capital is directly or indirectly acquired, or it has been directly or indirectly merged with or into another entity, unless BRILLIANCE has obtained the prior written consent of BMW for such change in Control, acquisition or merger; or if the representation and warranty set out in Article 2.2.2 was incorrect or became incorrect after the Effective Date.

(iii) a BRILLIANCE Competition Event occurs and it is not cured within thirty (30) days of written notice from BMW; or

(iv) the Parties fail to reach an agreement pursuant to Article 11.6.

Article 24: Consequences of Termination

24.1 Buyout

24.1.1 Buyout Option

(i) If, within sixty (60) days of receipt of the notice of termination served pursuant to Article 23, the Parties have not agreed in writing to continue this Contract, then the Parties shall agree to discuss one Party's purchase of all of the other Party's interest in the registered capital of the JV Company ("Buyout"). If, within sixty (60) days of receipt of the notice of termination, the Parties reach an agreement on a Buyout, then the Parties will proceed in accordance with the terms of that agreement.

(ii) If, within sixty (60) days of receipt of the notice of termination, the Parties have not agreed, in writing, to a Buyout, then, BMW shall have the option to purchase BRILLIANCE's interest in the registered capital of the JV Company at a price as determined pursuant to Article 24.1.2 below, multiplied by the percentage of BRILLIANCE's share of the registered capital at the time of the Buyout. BMW shall have ninety (90) days to exercise its option, starting from the date of receipt of the notice of termination. If BMW exercises this option, BRILLIANCE shall not take any actions that might adversely affect BMW's ability to continue the operation of the JV Company as a going concern.

(iii) If BMW fails to exercise its option within ninety (90) days of receipt of the notice of termination or it notifies BRILLIANCE in writing that it will not exercise the option, BRILLIANCE shall have the option to purchase BMW's interest in the registered capital of the JV Company at a price as determined pursuant to Article 24.1.2 below, multiplied by the percentage of BMW's share of the registered capital at the time of Buyout. Such option shall be exercised by BRILLIANCE, in writing, not later than within thirty (30) days from the date the option becomes available to BRILLIANCE.

(iv) The ratio between BRILLIANCE's shareholding in and BMW's shareholding in the registered capital of the JV Company following the Buyout under this Article 24.1.1 shall be in compliance with applicable PRC Laws.

24.1.2 Transfer Price

(i) If the termination of this Contract is caused by a breach of this Contract, the Technology License Agreement, the Trademark License Agreement, the Parts and Components Supply Agreement, the agreement referred to in Article 14.2 or the Articles of Association (a "Breach of Contract") by BMW and BMW exercises its Buyout Option under Article 24.1.1, the Transfer Price shall be the higher of the following two figures:

a) the Net Asset Value of the JV Company at the date when BMW exercises the Buyout Option multiplied by the percentage of BRILLIANCE's share of the registered capital of the JV Company which is to be purchased by BMW; or

b) the result of the formula:

$$\left(\sum_{n=1}^m (X \times En - Dn) \right) \times S + Em \times S$$

where:

En the amount of registered capital held in the JV Company by BRILLIANCE in calendar year n at the beginning of business year n

n indicates each single business year between the Establishment Date until the date when BMW exercises its Buy Out Option (starts with 1)

m indicates the business year when BMW exercises its Buy Out Option

X Agreed rate of Return for BRILLIANCE to be twenty percent (20%) p.a. (first and last year pro rata temporis if necessary);

Dn Absolute amount of dividends paid to BRILLIANCE in Business year n

S BRILLIANCE's share of the JV Company that is purchased by BMW. S is initially defined as 1.0, which represents BRILLIANCE's fifty percent (50%) share of the JV Company.

Em the amount of registered capital held in the JV Company by BRILLIANCE on the date when BMW exercises its Buyout Option

(ii) If the termination of this Contract is caused by a Breach of Contract by BRILLIANCE and BRILLIANCE exercises its Buyout Option under Article 24.1.1, the Transfer Price shall be determined in the same manner as the determination of the Transfer Price according to Article 24.1.2(i).

(iii) If the termination of this Contract is caused by a Breach of Contract by BRILLIANCE and BMW exercises its Buyout Option under Article 24.1.1, the Transfer Price shall be equal to the total value of the assets of the JV Company minus the total liabilities of the JV Company (the "Net Asset Value") multiplied by the percentage of BRILLIANCE's share of the registered capital.

(iv) If the termination of this Contract is caused by a Breach of Contract by BMW and BRILLIANCE exercises its Buyout Option under Article 24.1.1, the Transfer Price shall be equal to the Net Asset Value of the JV Company multiplied by the percentage of BMW's share of the registered capital.

(v) In no event shall the receipt of the Transfer Price by a Party prejudice any rights that Party may have to claim damages under this Contract, the Trademark License Agreement, the Technology License Agreement, the Other Contracts, or PRC Laws.

(vi) If the termination of this Contract is not caused by a Breach of Contract, the Parties shall mutually agree on a Transfer Price, which shall not be greater than the price as calculated under Article 24.1.2(i).

Appendix 2

Extracts from the IJV between VaxGen, Inc. & Celltrion, Inc.

WHEREAS:

- (A) Celltrion is obligated to invest in the construction of the Pilot Plant (as defined in Section 1.4 herein) pursuant to that certain Joint Venture Agreement dated February 25, 2002 by and among VaxGen, Nexol Biotech Co., Ltd., Nexol Co., Ltd., Korea Tobacco & Ginseng Corporation and J. Stephen & Company Ventures Ltd. (the "Celltrion Joint Venture Agreement")
- (B) VaxGen has certain obligations with respect to the Pilot Plant pursuant to the Celltrion Joint Venture Agreement.
- (C) The Parties wish to establish the JVC (as defined in Section 1.3 herein) to fulfill their respective obligations under the Celltrion Joint Venture Agreement.
- (D) The Parties enter into this Agreement to set out the terms governing their investment relationship as shareholders in the JVC and the management and operations of the JVC.

ARTICLE 4

UTILIZATION OF PILOT PLANT

- 4.1 The JVC shall utilize the Pilot Plant to engage in the following activities (listed in order of priority):
- (a) support process development and process validation for the licensure of AIDS-VAX;
 - (b) expedite commercial development and launch of AIDS-VAX;
 - (c) facilitate the technology transfer of AIDS-VAX or other mammalian cell culture manufacturing technology from VaxGen to Celltrion, including the provision of on-site training;
 - (d) to the extent that priorities (a) through (c) above have been satisfied and the Pilot Plant has idle capacity, further utilization of the Pilot Plant shall be discussed by the Parties and shall be prioritized between (i) support of product development and licensure related activities for a non-AIDS-VAX product of VaxGen and (ii) support of other non-AIDS-VAX Celltrion business activities, including, without limitation, process development, technology transfer and/or contract manufacturing; and
 - (e) any and all acts, things, business and activities which are related, incidental or conducive, directly or indirectly, to the attainment of the foregoing objectives.

ARTICLE 7

TRANSFER OF SHARES; PURCHASE OPTION; RIGHT OF REFUSAL

- 7.1 Except as permitted by this Article 7 or with the prior written consent of the other Party, no Party shall:
- (a) transfer any Shares;
 - (b) grant, declare, create or dispose of any right or interest in any Shares; or
 - (c) create or permit to exist any pledge, lien, fixed or floating charge or other encumbrance over any Shares.
- 7.2 VaxGen shall have an exclusive option to purchase all of the Shares held by Celltrion, exercisable upon notice at any time during the five (5)-year period commencing on February 25, 2003 and ending on February 24, 2008; provided, that, VaxGen shall be required to purchase such Shares upon receiving U.S. Food and Drug Administration approval to market any VaxGen product manufactured at the Pilot Plant during such five (5)-year period. In such event, VaxGen shall be obligated to continue to facilitate the transfer of technology to Celltrion and the training of Celltrion employees through the utilization of the Pilot Plant.
- 7.3 Any purchase of Shares made by VaxGen pursuant to Article 7.2 above shall be at the price of one dollar (US\$1.00) per share, plus simple interest at the U.S. prime rate on each Share accruing from the date the selling Party acquired the Shares until the exercise of the option by purchasing Party hereunder.

Appendix 3

Extracts from the IJV between Terra Networks, S.A. & IDT Corporation

JOINT VENTURE AGREEMENT

THIS JOINT VENTURE AGREEMENT ("Agreement") is made and entered into as of October 5, 1999 by and between Terra Networks, S.A., formerly known as Telefonica Interactiva, S.A., a company organized and existing under the laws of Spain ("TI"), and IDT Corporation, a Delaware corporation ("IDT").

RECITALS

A. TI and IDT (together, the "Parties" and each, individually, a "Party") desire to jointly develop a portfolio of internet service products for customers in the United States, mainly targeting and focusing on the Hispanic population in the United States ("Target Market").

B. The Parties desire to jointly form and own a company ("TI USA ISP") to principally provide internet access to customers in the ISP Target Market (as defined herein), which company will provide such access as an internet service provider.

C. The Parties desire to jointly form and own another company ("TI USA Portal") to develop and manage an internet portal that will provide content-based internet services, electronic commerce offerings and various other internet services to customers in the Portal Target Market (as defined herein).

D. IDT is willing and able to provide its current and future product offerings for internet access to the Target Market, its marketing knowledge and its operational expertise and infrastructure to deliver internet products and services through TI USA ISP and TI USA Portal under a global brand selected by TI.

E. TI is willing and able to integrate TI USA ISP and TI USA Portal with TI's global portals in Spanish and Portuguese-speaking countries in order to develop the business of TI USA ISP and TI USA Portal in the Target Market, thereby offering its global brand, its exclusive and global relationships and its marketing and promotional services.

F. In order to implement the objectives set forth in the foregoing Recitals, the Parties desire to enter into this Agreement, on the terms and subject to the conditions set forth herein.

ARTICLE III

CAPITALIZATION OF ISP PROJECT

3.1 Ownership and Initial Capital Structure. TI will own 51% of the equity voting interests of TI USA ISP and IDT will own 49% of the equity voting interests of TI USA ISP. The initial capital structure of TI USA ISP, including the classes of membership interests, the number of membership interests, voting rights, rights to distribution, membership interest transfer rights and other rights and obligations of the Parties, shall be set forth in the ISP Limited Liability Company Agreement.

3.2 Initial Capital Subscriptions. Upon formation of TI USA ISP, each Party shall subscribe to the following ownership interests:

Party	Percentage
-----	-----
TI	51.0%
IDT	49.0%

3.3 Initial Capital Contributions.

(a) On the Closing Date, each of the Parties shall contribute to TI USA ISP their respective initial capital contributions, as set forth in the ISP Business Plan, which include, but may not be limited to, the following:

(i) the IDT Customers and other related intangible assets as described and defined in the ISP Services Agreement;

(ii) each Party's portfolio of current and future products for Internet access (other than those of Net2Phone);

(iii) managerial resources and facilities of IDT, including not less than two (2) full-time senior managers of TI USA ISP;

(iv) brands available to TI to be used or developed in connection with the ISP Business Development Activities and the Internet Services;

(v) beginning on the Effective Date, the right to participate in TI stock options developed for TI USA ISP's senior management in accordance with TI's customary policies and practices, or if, in TI's discretion, the granting of such options would result in adverse tax consequences to TI, other benefits of equivalent value; and

(vi) such amount of cash necessary to commence operations.

(b) IDT Purchase of TI Shares. IDT's rights and obligations to purchase TI Shares are as follows:

(i) in the event that the TI IPO occurs on or prior to March 31, 2000, IDT shall be obligated to purchase, on the date of the TI IPO, TI IPO Shares for a purchase price in an amount equal to the annualized revenues of the IDT Customers for August 1999 multiplied by the Customer Revenue Multiple and further multiplied by 51% (the "IDT Purchase Amount"), which results in U.S. \$15,000,000,

(ii) if the TI IPO has not occurred on or prior to March 31, 2000, then between April 1, 2000 and June 30, 2000, IDT shall have the option to acquire TI IPO Shares on the date of the TI IPO occurring during such period in an amount equal to the IDT Purchase Amount, or (iii) in the event that the TI IPO has not occurred by June 30, 2000, IDT shall have the option, to be exercised within ten (10) business days after the final valuation as described below, to purchase shares of common stock of TI (as a non-public company) in an amount equal to the IDT Purchase Amount, which shares shall be valued on or before June 30, 2000 by a globally recognized, mutually acceptable investment banking firm. The TI Shares acquired by IDT shall have such registration rights as are set forth in Annex A hereto. If on the date which is six (6) months from the Effective Date, the annualized revenue from the IDT Customers for the sixth month after the Effective Date shall be less than the annualized revenue for the same IDT Customers determined in the ISP Due Diligence Investigation, IDT shall deliver to TI a percentage of the TI Shares purchased by IDT in the TI IPO equal to such percentage decline in annualized revenues. If the TI IPO has not occurred six months after the Effective Date, the TI Shares that IDT may purchase pursuant to this Section 3.3(b) shall be reduced by the percentage decline in annualized revenues described in the previous sentence or, if IDT elects not to purchase shares of TI common stock pursuant to this Section

3.3(b), the TI Capital Contribution shall be reduced by the amount of such decline in annualized revenues multiplied by the Customer Revenue Multiple and then multiplied by 51%.

Appendix 4

Extracts from the IJV between Applera Corporation & Applied Biosystems Group of Applera & Celera Genomics Group of Applera & Foster City Holdings, LLC & Rockville Holdings, LLC

JOINT VENTURE AGREEMENT

JOINT VENTURE AGREEMENT (this "Agreement"), dated as of the 1st day of April, 2001, by and among Applera Corporation ("Applera"), the Applied Biosystems Group of Applera ("ABI"), the Celera Genomics Group of Applera ("CRA"), Foster City Holdings, LLC ("ABI LLC"), and Rockville Holdings, LLC ("CRA LLC").

RECITALS

WHEREAS, effective as of December 1, 2000, Applera hired Kathy Ordonez to lead a major initiative in diagnostics, with the expectation that such initiative, although commenced within ABI, would be conducted with the active participation of CRA; and

WHEREAS, the Board of Directors of Applera has determined that it is appropriate and in the best interest of Applera and its stockholders that such joint initiative be carried out in the form of a joint venture between ABI and CRA on the terms and subject to the conditions set forth in this Agreement (the "Joint Venture").

NOW, THEREFORE, the parties hereto hereby agree as follows:

1. Formation. ABI and CRA hereby agree to the legal formation of the Joint Venture, which Joint Venture shall be structured in the manner described in Annex A attached hereto.
2. Name. The name of the Joint Venture shall be "Celera Diagnostics, LLC." The Joint Venture shall be referred to as a joint venture with Applied Biosystems.

INITIAL ABI CONTRIBUTION TO JOINT VENTURE

The Initial ABI Contribution shall consist of the following:

1. The ongoing commitment by ABI to pursue all opportunities within the JV Field exclusively through the Joint Venture, pursuant to the terms of this Agreement.
2. ABI's existing molecular diagnostics business unit headed by Katy Ordonez;
3. ABI's existing diagnostic sequencing business headed by Eric Shulse;
4. Rights under license with Roche to use PCR and ABI's instrumentation platform in the human diagnostics field for the exclusive use by the JV Company in the JV Field; as well as exclusive rights to all other existing and future ABI patents, technology, and know-how in the JV Field as more fully described in, and subject to the terms and conditions of, Section 3.1(b) of Annex E to this Agreement;
5. On-going royalties payable to ABI under the terms of the License Agreement between Visible Genetics and ABI;
6. ABI's agreement to fund 50% of the working capital and fixed capital requirements of the Joint Venture as specified in Sections 2.3 and 7.3 of Annex E to this Agreement; and
7. ABI's agreement to reimburse CRA for tax benefits resulting from losses generated by the JV Company as specified in Section 7.4 of Annex E to this Agreement.

INITIAL CRA CONTRIBUTION TO JOINT VENTURE

The Initial CRA Contribution shall consist of the following:

1. The ongoing commitment by CRA to pursue all opportunities within the JV Field exclusively through the Joint Venture, pursuant to the terms of this Agreement.
2. Access to the Celera Discovery System and all databases, including databases developed after the date hereof and during the term of the Joint Venture; as well as exclusive rights to all existing and future CRA patents, technology, and know-how in the JV Field as more fully described in, and subject to the terms and conditions of, Section 3.1(b) of Annex E to this Agreement;
3. CRA's payment of certain amounts relating to the molecular diagnostics initiative (primarily salaries) incurred from January 1, 2001, to March 31, 2001) under the terms of that certain Agreement dated as of March 30, 2001 between CRA and ABI (the "Prior Payment");
4. CRA's agreement to fund 50% of the working capital and fixed capital requirements of the Joint Venture as specified in Sections 2.3 and 7.3 of Annex E to this Agreement; and

5. CRA's agreement to fund all of the cash operating losses of the Joint Venture up to a maximum of \$300 million (excluding those amounts required for periodic working and fixed capital contributions which are to be shared equally by ABI and CRA) and to absorb the full operating losses of the Joint Venture in the manner specified in Sections 7.1(a) and 7.3(a) of Annex E to this Agreement, subject to a credit for the Prior Payment as specified in such Sections.

Annex E-8

7. Tax/Accounting Matters

7.1 Joint Venture Losses. JV Company losses shall be for the account of ABI LLC, as the Class A member of the JV Company, and CRA LLC, as the Class B member of the JV Company (and accordingly recorded by ABI or CRA, as applicable, on their books), as follows:

(a) During the Initial Loss Period (as defined below), all operating losses of the JV Company up to an aggregate amount equal to \$300 million (the "Initial Loss Commitment") shall be allocated to CRA LLC, provided that CRA LLC shall receive a credit under this clause against the Initial Loss Commitment for the Prior Payment (the aggregate operating losses allocated to CRA LLC from time to time under this clause, including the credit for the Prior Payment, is referred to herein as the "Allocated Initial Losses"); and

Annex E-9

(b) All operating losses of the JV Company above the Initial Loss Commitment, or which occur after the Initial Loss Period, shall be allocated 50% for the account of ABI LLC and 50% for the account of CRA LLC (as the Class A and Class B members, respectively, of the JV Company).

The "Initial Loss Period" shall mean the period beginning with the formation of the Joint Venture and ending on the earliest to occur of (i) the time at which Allocated Initial Losses equal the Initial Loss Commitment, (ii) the last day of any fiscal quarter during which the JV Company experiences gross operating profits, if such fiscal quarter represents the fourth of four consecutive fiscal quarters during which the JV Company experiences gross operating profits. For these purposes, the JV Company's operating results shall include all items, except those deemed to be non-recurring in nature as determined by the JV Board.

7.2 Joint Venture Profits. JV Company profits shall be for the account of ABI LLC, as the Class A member of the JV Company, and CRA LLC as the Class B member of the JV Company (and accordingly recorded by ABI or CRA, as applicable, on their books), as follows:

(a) All profits of the JV Company shall be allocated 65% for the account of CRA LLC and 35% for the account of ABI LLC until the cumulative profits of the JV Company equal the Allocated Initial Losses; and

(b) All profits of the JV Company above the amount referred to in clause (a) above shall be allocated to ABI LLC and CRA LLC equally.