TOTAL VENTURE CAPITAL DIVESTMENTS AS ABANDONMENT OPTIONS AND ASYMMETRIC INFORMATION

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ABSTRACT

This paper is focused on venture capital shareholding in companies with high uncertainty due to their sector, the stage of their activities or owing to the lack of historical data. In particular, we explain the problem of early shareholding disinvestment, analyzing the way asymmetric information becomes the key element of the value of above-mentioned possibility. We employ real option methodology to the implementation of the analysis assuming three different hypotheses.

Keywords: Venture capital, abandonment option, asymmetric information
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1. INTRODUCTION

The valuation of investments is in practice generally made with methodologies, which are recognized as classics, like, for example, the discounted cash flow (DCF) valuation, which determines the value of a company discounting its future cash flows. The valuation of companies for minority or majority acquisitions, mergers or negotiations about a new financing round, are examples of the practical use of those methodologies. Models like discounted cash flow valuation or comparable company analysis are abundantly employed to valuate companies in practice.

Nevertheless, in numerous occasions, those models are not free of problems, which can lead to inexact values of the target. With a general and not complete character, the following problems can be pointed out:

a) Use of general and in many cases unrealistic hypotheses about the valuation of risk. The discounted cash flow valuation employs a discount rate, which is adjusted to the risk of the investment project, but assumed to be constant over the investment's lifetime. In most cases, this is unrealistic, due to the existence of different risk levels in each life cycle of the investment, evolution of the environment, etc.
b) The value of all new information the investors receive over time is not considered, but it can help to rectify the decisions initially planned.
c) In line with the problem previously mentioned, the traditional investment valuation models generally do not consider the flexibility investment projects usually have, although in different degrees.
d) The classic models do not take into account the discretion of the management team, chairman or other decision makers on making adequate decisions according to the characteristics of the investment in a changing environment.

The real option valuation approaches employed in investment projects constitute a step forward in the claim to more reliability and realism in comparison with the traditional valuation methods used in practice. They measure the potential flexibility of a project as a function of the uncertainty, which characterize its future evolution and the path the management could adopt to respond adequately. Authors like Dixit and Pindyck (1994)

show that the investment decision making should consider the implicit options or path the company's decision maker can use in the future. Therefore, high risk projects seem to be ideal for the application of those methodologies, fundamentally given the existent difficulty to employ the classic models and the high value a corrective action in the future can have for the global evolution of the investment.

Venture capitalists have become important financial intermediaries, contributing capital to companies, which could have difficulties to get any other kind of financing. Therefore, this paper focuses on the valuation of venture capital investments in companies with high uncertainties; risks caused by the sector, the activity or the lack of historical financial data of the target company and big differences between the information the management and the venture capital investors have access to. In the existing financial literature we can find contributions like from Cochrane (2005), in which the venture capital investments' expected performances, standard deviations, alphas and betas are analyzed to confirm if those kinds of investments behave in the same way as the negotiated assets. Nevertheless, it has to be pointed out that it is logical for the venture capitalists to require higher expected performances to compensate the illiquid nature of this kind of investments. In this sense, Cochrane (2005) underlines the existence of high average performances, in his opinion justifiable by the consideration of the divestment probabilities in any secondary market. In his opinion, this is closely related to the high project volatility. Also Chen *et al.* (2002), Kaplan and Schoar (2005), Cumming and Walz (2004), Gompers and Lerner (1997) or Ljungqvist and Richardson (2003) analyze the high rates of return of the venture capital investments. The volatility of venture capital performance has been studied by Moskowitz and Vissing-Jorgenson (2002), Cheng *et al*. (2002) or Long (1999). Cochrane (2005) shows that the investment risk decreases from one financing round to the next.

In the framework of venture capital, the attractiveness of high rates of return and the low correlation with the capital markets is difficult to verify, due to the lack of unbiased and realistic data. Databases such as VentureOne or VentureXpert are built on the cash flow information voluntarily reported by the venture capital investors. Studies like Cheng *et al*. (2002) or Cochrane (2005) suggest certain measures to adjust some of those biases. Likewise, in this kind of investments, where the venture capitalist constantly monitors and controls the company, real options he could have on future economic and financial

decisions become crucial for the valuation. Although this value added is in practice considered in an implicit and intuitive way, it is convenient to have models, which give an objective and quantitative character to those valuations, especially if we consider that an important part of those projects present high risk adjusted discount rates and clearly negative net present values (Dixit y Pindyck, 1994). Smith and Smith (2000) review numerous studies in which the discount rates oscillate between 35% and 50%. Nevertheless, it would be necessary to analyze in which measure the expected cash flows, on which those discount rates are applied, are too optimistic. However, it has to be mentioned that the differences between the high discount rates applied by venture capitalists and the tendency to gradually reduce the risk over time is a topic that is still studied in the literature.

Otherwise, although there are many possible future decisions which could be modeled as real options, and which have been analyzed in the literature in detail. -Kester (1984) and Chung and Charoenwong (1991) analyze time-build option, Ingersoll and Ross (1992) or McDonald and Siegel (1986) investigate options to postpone the start of the investment, Kulatilaka and Trigeorgis (1994) and Margrave (1978) analyze technological change options- the possibility to abandon the investment has been omitted frequently, although it could contribute a significant value in many projects. In the literature we can find studies such as from Aggarwal and Soenen (1989), in which the Exit Net Present Value (ENPV) is presented as a version of the classic Net Present Value approach. In the paper of Robichek and Van Horne (1967) it is shown via decision trees how the net present value and the rate of return are higher when the possibility to abandon is included. In this way, the authors confirm that the non-inclusion of this possibility could lead to an undervaluation of the investment, because the option of abandonment can never lower the value of a project.

Venture capital investments are often characterized by various investment stages, which are an instrument directly comparable with the option to abandon the project. The capital supply in stages allows analyzing the evolution of the company from the prism of the new information. Therefore, if the venture capitalist decides to not make the next financing round, it corresponds to a passive option of abandonment. Sahlman (1990) confirms that the staging of the investment can become one of the most powerful control mechanisms the venture capitalist can employ. Gompers (1995) analyzes the factors that have influence in

the venture capital financing structure by stages. The venture capitalists examine the business plans and elaborate contracts with the aim of minimizing the potential agency costs, especially in young companies. Those agency costs are weighted, because the frequency of reevaluation of the project is determined each time the venture capital investor contributes more capital.

Otherwise, venture capital investments are less liquid and transparent than those traded at the stock markets. Cumming and Walz (2004) find out that there are differences between the quality of the information about non-realized investments given to institutional investors, depending on the degree of asymmetric information existent between the management team of the venture capital-backed companies and the venture capitalists. They also show that in case of newly created venture capital funds or investments in very early stages, the investment tends to be overvalued more frequently. Contrarily, syndication among venture capital funds tends to reduce their incentives to overestimate the unsuccessful investments. Furthermore, the existence of less stringent accounting standards or legal systems facilitate the overvaluation, downgrading the quality of the given information. Precisely, combining this approach with the model elaborated by Myers and Majluf (1984), it can be deduced a direct consequence of the existence of asymmetric information. The emission of the financial assets underwritten by the venture capitalists incorporate frequently high price discounts in concept of a risk premium for the uncertainty derived from those asymmetries. This could justify the high rates of return obtained with the successful investment projects.

The degree of information asymmetry depends on the percentage of shareholders with privileged information about dividends, debt and the relationships with financial entities. In this sense it is interesting to analyze the role of financial intermediaries. Degryse and de Jong (2005) show how banks reduce their impact of asymmetric information in the debt markets and Campbell and Kracaw (1980), Diamond (1984), Chan (1983) or Fama (1985) work out how intermediaries can serve as information generating agents.

Gompers (1995) finds evidence that venture capitalists focus with their investments on young high tech companies with high information asymmetry, analyzing a sample of 794 venture capital transactions made in the US.

In this context, given the differential characteristics of venture capital investments, the

option of abandonment gains special relevance. Therefore, in this paper we will analyze the anticipated total divestment, showing that the existent information asymmetries between the involved parties are a key element in the value of this option.

The rest of the paper is structured as follows: in section 2, the option of abandonment is discussed in detail. In section 3, we expose different valuation models based on distinct contractual design hypotheses, to show in section 4 an applied example. Finally, the main conclusions are presented in section 5.

2. THE DEFINITE ABANDONMENT OF VENTURE CAPITAL INVESTMENTS

Based on the agency theory, venture capitalists supervise investments or strategies, which the managers of the venture capital-backed companies plan. The aim is to detect actions which can prejudice the shareholders' interest. The agency problems can be materialized in the possibility that those owners do not desire to liquidate a project in some cases although having a negative net present value. As Gompers (1995) shows, information generated by the venture capitalists has a high value in this case. Consequently, venture capitalists weight the agency costs when they determine how frequently they should re-evaluate their projects to decide if they go on with the next financing round or abandon the investment. Therefore, in case of a bad evolution of a project or an agreement to sell the shares to a third party, the venture capitalist can divest, finalizing his relationship with the company. Stringently, this usually implies the sale of the participation to another agent, who in practice would be:

a) The original owner of the company: This way, the owner recovers the complete control of his company, i.e. the same proportion of control he had before the venture capital investment. In some situations, this repurchase is established in the moment of investment, the venture capitalist ensures a possibility of divestment and the owner obtains temporary financing in a moment in which he plans to expand the company.
b) Another venture capital fund: Also frequently, the participation is acquired by another venture capitalist fund, which enters the group of shareholders or increases his participation in the company in case the first investment was made in syndication.

Normally, the venture capitalist will be tempted to divest when the accumulated losses are high and/or there are no sign of recovering. Like mentioned before, the high risk of this kind of investments motivates in many cases to make staged investments. This methodology allows the venture capitalist not to invest the whole amount of financial resources needed at the beginning, but to contribute successively, depending on the development of the business plan. This way of financing helps to avoid a concentration of excessive risks in the initial stages, when the risk is highest, and to have new information over time, which is very important to decide about new capital contributions. In many investments, the successive venture capital investments are crucial for the continuity of the company and the non-contribution of new capital leads the company to disappear. Thus, two kinds of total divestments can be distinguished:

1 Transfer of the investment via sale to a third party. Within this kind of divestment we can differentiate between two alternatives in function of the sales price:
   a) Predetermined price: The sales price is predetermined with the potential future buyer from the beginning.
   b) Uncertain price: No agreement on future prices or potential buyers exists at the beginning of the investment.
2 Non-extension of the investment in further stages. In those cases the participations loose their value if there is an absolute dependence on the venture capital financing.

Those possibilities to definitely abandon the investment allow the venture capitalist to cover his position in the participated companies, permitting to totally divest in case of unsatisfactory evolution. Anyway, the temporal character of venture capital participations leads to their transfer also case of success. Gompers and Lerner (2001) show that one of the forms of divestment which usually gives the highest benefits to venture capitalists is the initial public offering (IPO), where the shareholders sell part of their participations at a secondary market.

Those possibilities of anticipated divestment, independently of the version applicable, can have an important value for the investor. Precisely, in situations of growing losses of investment value, negative corrections of the expected growth of the participated company

or in whatever case that recommends a definite abandonment of the investment, this possibility supposes a materialization of the flexible character and gives an active position to the investor. Without any doubt, this adds value. This factor should be considered in the valuation of the investments, because it increases the value.

3. VALUATION OF THE TOTAL DIVESTMENT OPTION: THEORETICAL MODEL

The problem of the abandonment option's valuation varies in function of the conditions and agreements reached at the beginning of the project (Aggarwal, 1989; Dixit 1989). As shown, the initial agreements can be materialized in detailed clauses, such as repurchase agreements at a predetermined price, sale to third parties at a variable price based on certain multiples, etc. It can also happen that the venture capitalist has not ensured any future exercise price, pretending to take advantage of the existing information asymmetries to reach a higher sales price.

In the following, we focus on two possible alternatives: (1) the sales price is predetermined from the beginning and (2) no previous agreement exists with any third party with respect to the participation's sales price.

In both cases, two existing option valuation models will be used: Black-Scholes and the multiplicative binomial method. The latter will be modified with the aim to adapt it to the singularities of the option type to be evaluated. The hypotheses adopted in this analysis will be the same as in the cited models and whatever additional hypothesis will be explained in the description of the model.

3.1 Total divestment at a non-revisable predetermined price

In this section, the cases in which the sales price has been fixed from the beginning, without any possibility of future negotiation nor revision, not even based on any multiple, are analyzed. In this situation, the possibility of sale to a third party is a put option on the venture capital's participation in the company, at an exercise price which equals the predetermined price. This option has been bought by the investor at the moment of establishing the clause and sold by the agent, who agrees to buy the participation.

As evident, this option has a high advantage for the venture capitalist, who fixes a future

price on the optional sale, ensuring a minimum return on investment. The contrary happens to the potential acquirer, who is obligated to buy the participation whatever its price may be. The exercise of the option will take place, when its economic value is inferior to the predetermined sales price, so the seller of the option seems to loose always or, in the best case scenario, never gain anything. To understand the reasons why an agent could accept to sell an option of such characteristics, it has been analyzed the reality of each transaction. The seller of the option can be the previous owner of the company, who gives part of his participation to make the entrance of a new investor possible. An important part of the return on investment the venture capitalist reaches comes from the divestment process, which is an aspect of big uncertainty and the investor can demand the establishment of this kind of anticipated divestment clauses before contributing new financing to the company. Therefore, the original owner of the company and seller of the put option receives a benefit in form of new resources and managerial support from the venture capitalist. This benefit can be assimilated to the value of the option.

Anyway, the problem of the abandonment option's valuation under those assumptions is similar to any real option, which is the estimation of the volatility of the underlying asset. Otherwise, two different possibilities have to be taken into account:

1 It is possible that the agreement has been established the way that it permits to use the option in every moment during the predicted period of investment. In this case, it is an american option.
2 The venture capital-backed company can be in a situation, which permits the periodic payment of dividends to its shareholders, of which one is the venture capitalist. In this case, the put option has the participation in a company, which pays out periodic returns, as underlying asset.

In case of seed-stage investments, where the companies are recently created, the second type of underlying assets is barely possible. Nevertheless, in more mature companies, which incorporate venture capital to finance their expansion, it is possible that periodic dividend payments take place. Intuitively, the abandonment option has more value in the first case. Effectively, in this case exist high possibilities of failure -the put option will be

highly “in the money”, given the reduced current value of its financial returns-. Furthermore, the investment is highly uncertain, which increases the option value, given the high volatility of the underlying asset.

However, both the discrete valuation models such as the binomial model and the continuous models such as Black-Scholes can be adapted in an easy way to underlying assets with periodic payments.

All of these models need the following data to proceed valuation:

1 Current value of the underlying asset: Current value of the participation the venture capitalist wants to assume. To calculate this value, any existent valuation methodology, such as discounted cash flow valuation, comparable company analysis, etc. can be used.
2 Exercise price: Sales price contractually preestablished with a third party.
3 Option period: Time in or during which the option can be used. Given that in its original conception, the venture capital investment has a predetermined temporal character, a maturation period is usually established, after which the divestment takes place. Generally, it can be considered that the abandonment option can be used until this moment, being, therefore, the maximum duration of the option.
4 Volatility of the underlying asset: Measured by the standard deviation, it captures the dispersion of the returns derived from the participation of the investor. This variable is the most difficult in the valuation. Given that the venture capital investment focuses on private companies, no market prices are available to calculate the volatility. Therefore, it is necessary to use comparable company methods or simulation techniques, which are not free from difficulties.
5 Risk-free interest rate.

3.2 Total divestment at an open sales price

If the sales price is unknown, this price is a random variable. The value of the option depends on the behaviour of this variable, together with the other influential factors mentioned.

Therefore, a put option with a variable strike price, which is exercisable in any moment of

time during the life of the investment, should be analyzed to estimate the value of the abandonment option.

If the venture capital market was completely efficient, the sales price of the participation would be equal to its authentic economic value. This way, it would be logic that the investments were sold at exactly the value resulting from discounting the remaining net cash flows predicted for the project at a discount rate representative for its risk. This amount is exactly the value of the underlying asset of the abandonment option at every moment of time or spot price, in a way that it has a perfect correlation with the strike price.

In this context it can be shown that the value of the abandonment option equals zero. Given that the participation will always be sold at the same price as its true economic value, the intrinsic value of the option equals zero at expiration date and at any previous moment. Figure 1 shows illustratively the evolution of the option value for two steps, regarding the multiplicative binomial valuation model of options.

[Figure 1]

where:

V : Current value of the venture capitalist's participation.

u : Rate in which the participation value increases in a binomial step, calculated as $e^{\sigma \cdot \frac{n}{steps}}$, where σ is the volatility of the venture capital-investment's return measured by the standard deviation, and n is the period until the option's expiration date.

d : Rate in which the participation value decreases in a binomial step, calculated as $\frac{1}{u}$.

p : Risk-neutral probability of increase in one step, calculated as $\frac{1+r^{*}-d}{u-d}$, where r^{*} is the risk-free interest rate in continuous form.

q : Probability of participation value decrease in a binomial step, calculated as $1-p$.

Given that the strike price equals the value of the participation at any moment in a perfect market, the option's intrinsic value equals zero at any point of the binomial process, so the option value also equals zero:

$$P_0 = \frac{(Strike_1 - V \cdot u^2) \cdot p^2 + (Strike_2 - V) \cdot 2pq + (Strike_3 - V \cdot d^2) \cdot q^2}{(1 + r^*)^2} =$$

$$= \frac{(V \cdot u^2 - V \cdot u^2) \cdot p^2 + (V - V) \cdot 2pq + (V \cdot d^2 - V \cdot d^2) \cdot q^2}{(1 + r^*)^2} = 0$$

where:

P_0 : Current value of the abandonment option.

$Strike_i$: Sales price of the participation for the ith case.

However, the initial assumption of venture capital transactions' efficiency is very different from the reality. These transactions do not take place in any organized market, but isolated between the venture capitalist and, generally, an agent who participates or wants to participate in a private company. As mentioned in the literature review, information does not tend to flow freely in these transactions, which are predominated by a lack of transparency. This is due to the high level of asymmetric information.

It makes that the sales price of the participations, although correlated to their economic value, does not have to coincide exactly with it. As mentioned before, it is usual that the sales price is fixed in function of a multiple on a critical variable, such as revenues. Although this measure can be adequate as a reference, the company value does not have to be perfectly correlated with the critical variable, which can imply the bias that the sales price is different to the true economic value.

Generally, without other restrictions, we can consider that the valuation of the sales price follows a binomial process constructed in function of its own or its critical variable volatility.

In the following, the evolution of the possible future strike prices is detailed based on two assumptions: (1) The sales price follows an evolution independent from the economic value of the investment, and (2) an increase (decrease) of the latter determines an increase (decrease) of the sales price, although not necessarily in the same proportion.

1º. The sales price is not related to the economic value of the participation

Although this assumption does not seem to be very coherent, the resulting value of its application will serve to compare it to the second assumption, more realistic in this kind of

operations.

The projection of the strike price and its probabilities via a binomial model can be done regarding its volatility in the same way as the spot price. To determine the option value, its expected values are discounted in each binomial step, making use of the distribution of the joint probability of both spot and strike price. In this situation, which assumes independence between both prices, the joint probability's distribution is given by the product of both probabilities at each point. Herefore, a european option which does not assume the payment of dividends is shown in figure 2 employing the binomial method with two steps.

[Figure 2]

where:

E : Sales price which the venture capitalist could currently reach for his participation.

u' : Rate of sales price increase in a binomial step, calculated as $e^{\sigma' \cdot \frac{n}{steps}}$, where σ' is the volatility measured by the standard deviation of the variable with which the sales price is calculated, and *n* is the period until the option's expiration date.

d' : Rate of sales price decrease in a binomial step, calculated as $\frac{1}{u'}$.

p' : Probability of a sales price increase in a binomial step, calculated as $\frac{1+r^{*}-d'}{u'-d'}$, where r^{*} in the risk-free interest rate in continuous form.

q' : Probability of a sales price decrease in a binomial step, calculated as $1 - p'$.

For the valuation of a european abandonment option with independence between spot and strike price, it is sufficient to use the probabilities calculated in the last binomial step, determining the probability of each event corresponding to all and each of the estimated price combinations. This determines the calculation of a number of option values, and, therefore, of the probabilities, at expiration date equal to $(steps+1)^2$ in the following way:

$$p_{1,1} = p^2 \cdot p'^2 ;\ P_{1,1} = E \cdot u'^2 - V \cdot u^2$$

$$p_{1,2} = p^2 \cdot 2p'q' ;\ P_{1,2} = E - V \cdot u^2$$

$$p_{1,3} = p^2 \cdot q'^2;\ P_{1,3} = E \cdot d'^2 - V \cdot u^2$$

$$p_{2,1} = 2pq \cdot p'^2;\ P_{2,1} = E \cdot u'^2 - V$$

$$p_{2,2} = 2pq \cdot 2p'q';\ P_{2,2} = E - V$$

$$p_{2,3} = 2pq \cdot q'^2;\ P_{2,3} = E \cdot d'^2 - V$$

$$p_{3,1} = q^2 \cdot p'^2;\ P_{3,1} = E \cdot u'^2 - V \cdot d^2$$

$$p_{3,2} = q^2 \cdot 2p'q';\ P_{3,2} = E - V \cdot d^2$$

$$p_{3,3} = q^2 \cdot q'^2;\ P_{3,3} = E \cdot d'^2 - V \cdot d^2$$

$$P_0 = \frac{P_{1,1} \cdot p_{1,1} + P_{1,2} \cdot p_{1,2} + P_{1,3} \cdot p_{1,3} + P_{2,1} \cdot p_{2,1} + P_{2,2} \cdot p_{2,2} + P_{2,2} \cdot p_{2,3} + P_{3,1} \cdot p_{3,1} + P_{3,2} \cdot p_{3,2} + P_{3,3} \cdot p_{3,3}}{\left(1 + r^*\right)^2}$$

where:

$p_{i,j}$: Joint probability for the spot price *i* and the strike price *j*.

$P_{i,j}$: Value of the abandonment option at expiration date for the spot price *i* and the strike price *j*.

2º. The sales price is related to the economic value of the participation

As an intermediary proposal between the perfect correlation of the venture capital participation's economic value and its sales price and the total independence between both variables, we elaborate another theoretical model. In this model, the amount of both variables does not have to coincide over time, but we suppose an increase in the investment value implies an increase in its potential sales price, and vice versa.

The potential increases/decreases of spot and strike price are calculated in function of their own volatility, measured by the standard deviation. Meanwhile, the probabilities in each situation, considering the before mentioned, are adopted with the aim of considering the dependence among both values.

This version has been elaborated with the binomial option valuation method, due to its high degree of flexibility and its simplicity of application. It has been based on the hypothesis of neutrality to risk inherent in this valuation method. If a constant exercise price is considered:

$$u \cdot p + d \cdot (1-p) = 1 + r^* \Rightarrow V \cdot u \cdot p + V \cdot d \cdot (1-p) + E \cdot p - E \cdot p - E = V \cdot (1+r^*) - E \Rightarrow$$

$$\Rightarrow (V \cdot u - E) \cdot p + (V \cdot d - E) \cdot (1-p) = V \cdot (1+r^*) - E$$

Assuming a variable exercise price:

$$(V \cdot u - E \cdot u') \cdot p + (V \cdot d - E \cdot d') \cdot (1-p) = V \cdot (1+r^*) - E \Rightarrow$$

$$\Rightarrow p = \frac{[V \cdot (1+r^*) - E] - (V \cdot d - E \cdot d')}{(V \cdot u - E \cdot u') - (V \cdot d - E \cdot d')}$$

which is, as logic, considering a constant strike (u'=d'=1):

$$p = \frac{[V \cdot (1+r^*) - E] - (V \cdot d - E \cdot d')}{(V \cdot u - E \cdot u') - (V \cdot d - E \cdot d')} \Rightarrow p = \frac{1 + r^* - d}{u - d}$$

Evidence shows that, due to this expression applicable to call and put options, the probabilities of each event are function of the initial participation value and the potential initial sales price, as well as the remaining variables employed at a constant strike price.

With all this, considering two binomial steps, the model proposed in the american option case can be adapted to the structure shown in figure 3.

[Figure 3]

where:

$$P_1 = Max\left[\frac{Max(E \cdot u'^2 - V \cdot u^2; 0) \cdot p^2 + Max(E - V; 0) \cdot 2pq}{1 + r^*}; E \cdot u' - V \cdot u \right]$$

$$P_2 = Max\left[\frac{Max(E - V; 0) \cdot 2pq + Max(E \cdot d'^2 - V \cdot d^2; 0) \cdot q^2}{1 + r^*}; E \cdot d' - V \cdot d \right]$$

$$P_0 = Max\left[\frac{P_1 \cdot p + P_2 \cdot q}{1 + r^*}; E - V \right]$$

4. APPLICATION OF THE PROPOSED MODEL TO A THEORETICAL CASE

To be able to observe the existent relationship between the different assumptions we made, the proposed models have been applied to a theoretical case with the following

characteristics:

a) The economic value of the venture capital participation at the beginning equals 100 monetary units.
b) The volatility of the venture capital-investment's return equals 0.5 in terms of annual standard deviation.
c) The investment's lifetime equals 5 years.
d) Application of 500 binomial steps for each case.

This theoretical case has been elaborated considering different volatilities of the participation's sales price, used in the following applications:

a) Supposing a case of a non-predetermined sales price, which depends on the economic value of the participation, and assuming an american put option.
b) Supposing a case of a non-predetermined sales price which is independent from the economic value of the participation, and assuming an european put option.
c) Supposing a case of a predetermined sales price, and assuming an american put option.

This structure has been applied to three situations:

a) Initial sales price equals the economic value of the participation.
b) Initial sales price is lower than the economic value of the participation.
c) Initial sales price is higher than economic value of the participation.

1º Initial sales price equal to the economic value of the participation

Graph 1 reflects the evolution of the three types of options proposed in case of increasing sales price volatility. As logic, in a situation in which the sales price is predetermined, the option value maintains constant, when the volatility of the strike price changes.

[Graph 1]

The high value of the abandonment option is obvious when the sales price and the participation's economic value are independent, growing in case of a high volatility of the first. In contrast, when dependence between both prices is assumed, the value of the abandonment option shows a reduction in comparison to the previous case, reaching its minimum value when the volatility of both prices is similar. However, the fact that the option value is lower the higher the dependence between the economic value and the sales

price of the participation is coherent with the previously demonstrated about the perfect dependence between prices.

In case of a predetermined sales price, the value of the abandonment option shows an intermediate value between the two values mentioned before.

2º Initial sales price lower than the economic value of the participation

If the estimated value of the venture capital participation is inferior to its economic value, the conclusions do not vary substantially with respect to those shown in the previous paragraph, like observable in graph 2.

[Graph 2]

The value of the abandonment option based on the three assumptions is inferior to the previous case, due to the lower current sales price. This fact implies the step from an "at the money" put option to an "out of the money" put option, which leads to a lower intrinsic value, reflecting a lower value of the abandonment option.

It is interesting, that the option has a lower value when the economic value and the sales price are dependent and very close to zero for high volatilities of the latter.

3º Initial sales price higher than the economic value of the participation

The existent relations between the three assumptions on the abandonment option functioning are shown in graph 3.

[Graph 3]

There are no substantial changes in the evolution of the three option types, but is obvious their higher value for any volatility of the strike price. This is a logic consequence of the higher intrinsic value derived from the step to an "in the money" option with respect to the previous cases.

However, the facts mentioned in the two previous assumptions are applicable to this situation.

5. CONCLUSIONS

In this paper, the inherent question of the possibility of an anticipated venture capital divestment has been analyzed, showing that it can be seen as a put option which influences

the valuation of the investment. Nevertheless, obtaining a representative value for this anticipated abandonment possibility is not easy, given that it depends on the conditions predetermined in each agreement.

Three agreement possibilities with different characteristics of the abandonment option have been analyzed:

1 The future sales price is predetermined in case the venture capitalist wants to abandon the investment. In this case, the option is valued due to the traditional option valuation models, without any further difficulty to those existent in real options valuation.

2 The future sales price is not previously agreed on with any third party and is independent from the economic value of the participation. For its valuation it is necessary to determine the joint distribution function for each of the possible price combinations, considering independence between spot and strike price.

3 The future sales price does not show perfect correlation with the economic value of the participation, although both are dependent on each other to a high degree. It has been assumed that an increase in the latter determines an increase in the first and vice versa.

Analyzing each of those option types and comparing their respective values in function of different assumptions, we can show that the abandonment option has the highest value when the prices are independent from each other, followed by the case in which the sales price is predetermined. The abandonment option has the lowest value when the exercise value depends on the economic value of the participation, without perfect correlation.

Concluding, it can be affirmed that the higher the level of information asymmetry between both contractual parties, induced by the lack of transparency which tends to characterize venture capital investments, the higher the value of an anticipated divestment option.

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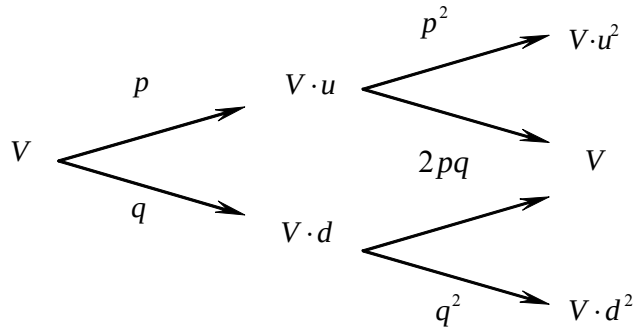
Figure 1: Binomial process of the underlying asset



Source: Cox, J., Ross, S., Rubinstein, M. (1979).

Figure 2: Binomial process of the underlying asset and the strike price

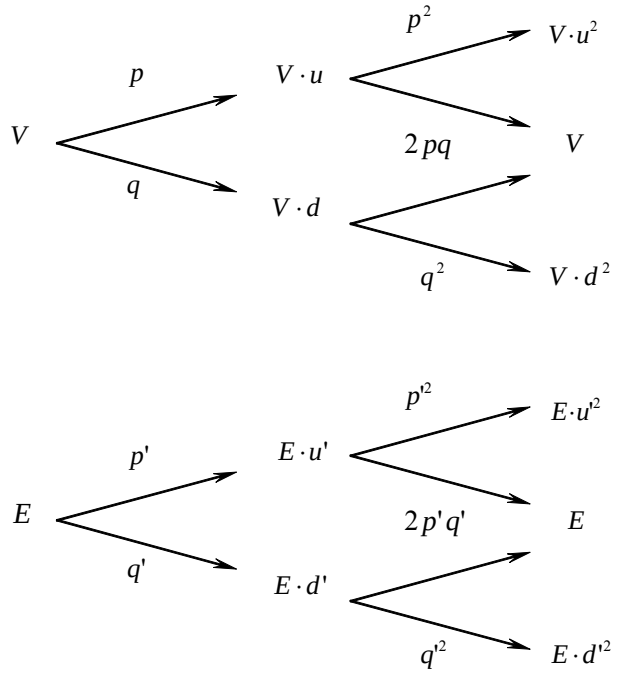
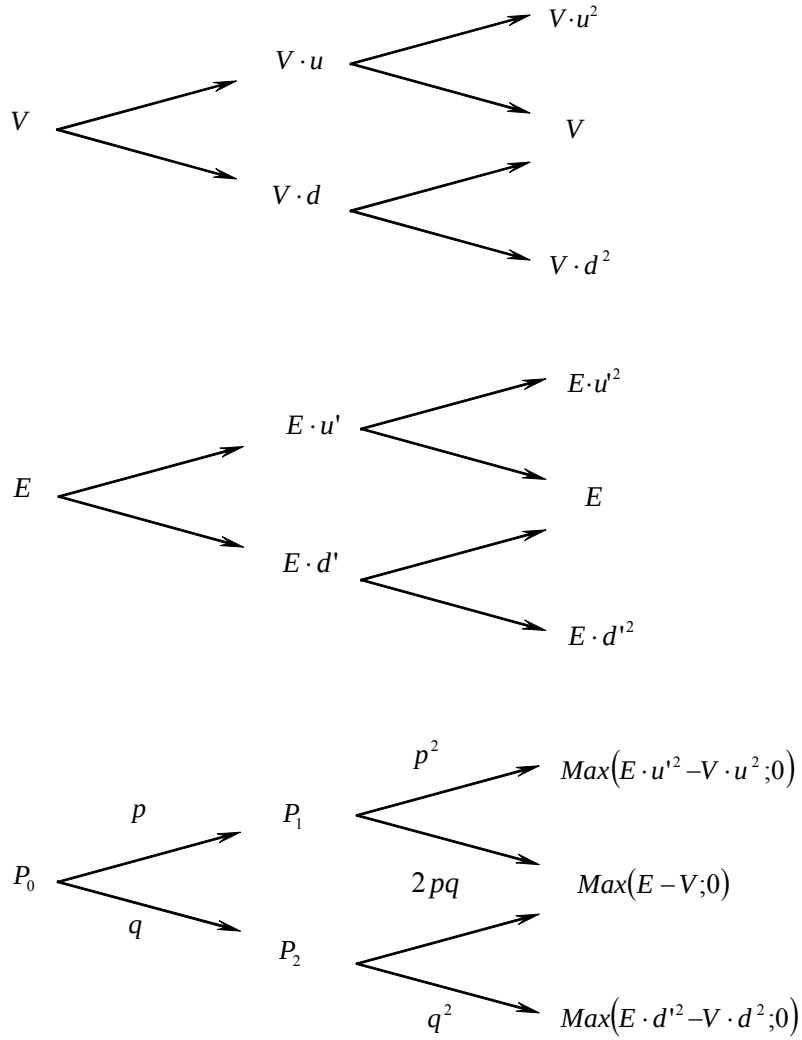
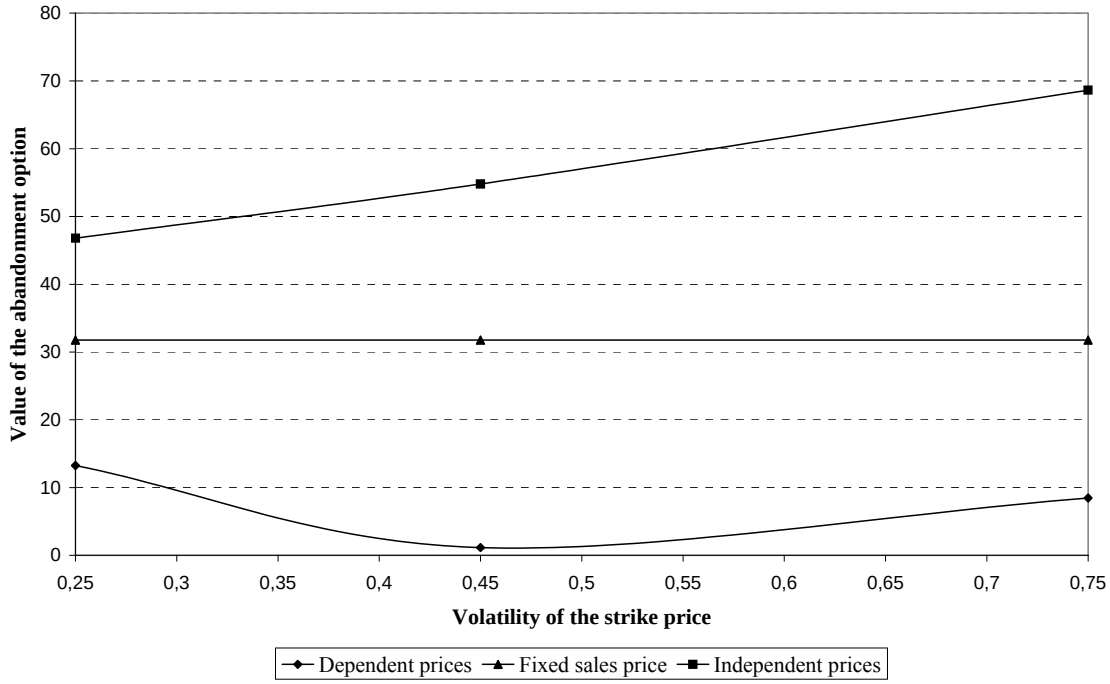


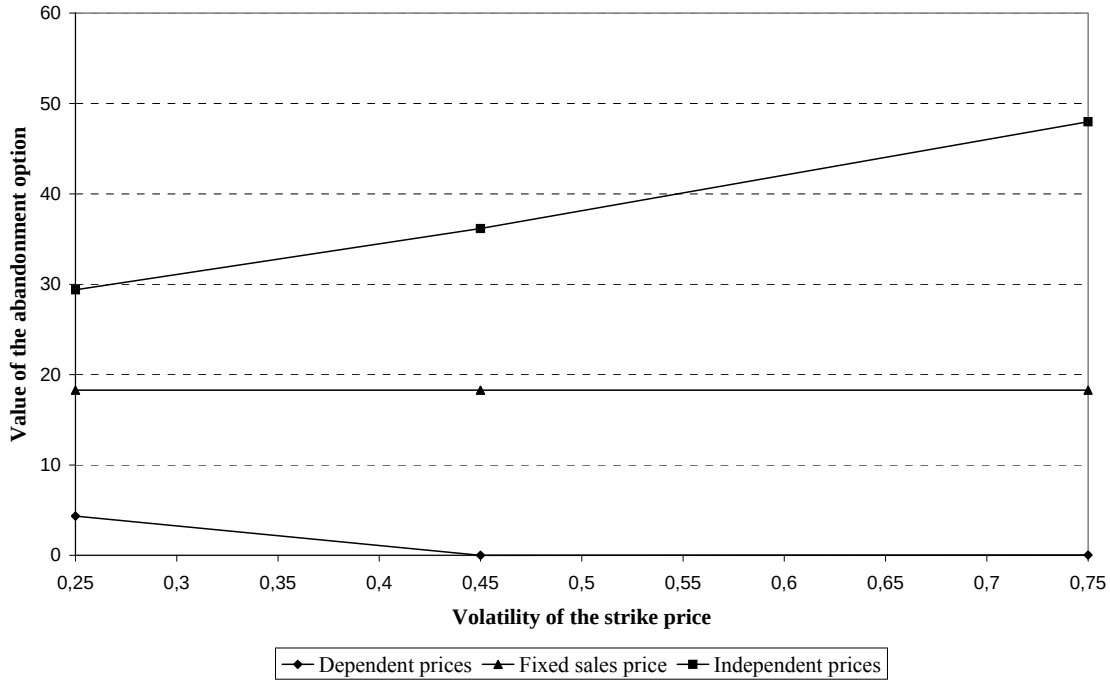
Figure 3: Binomial process supposing dependence between economic value and sales price



Graph 1: Value of the abandonment option supposing initial strike price equals economic value



Graph 2: Value of the abandonment option supposing initial strike price lower than economic value



Graph 3: Value of the abandonment option supposing initial strike price higher than economic value