Valuing a leveraged buy-out

The expansion of the *Adjusted Present Value*
by means of the *Real Options Approach*.

Francesco Baldi

M.Sc. in Finance
Faculty of Statistics, University of Rome "La Sapienza"
PhD in Management
Faculty of Economics, University of Rome III

e-mail: francescobaldi@tiscali.it

1. Introduction

The expression *leveraged buy-out* (LBO) means a financial technique that consists in the acquisition of the majority stake of a firm by a group of buyers endowed with entrepreneurship, composed of private investors or institutional investors or merchant banks or by all three subjects together, that is mostly financed by debt, destined to be paid back by using the financial resources produced by the firm itself in the form of operating cash flows or divestments of non-strategic activities, as well as assets and shares as side guarantee to obtain the loan.

The fundamental characteristic of a *leveraged buy-out* is given by the fact that the acquiring of the shares or assets of the so-called target firm or of a subsidiary or of a part of it, is effected by utilizing a significant amount of debt and a very low quantity of equity capital. Then, in a wider meaning, a *leveraged buy-out* may be also defined as every acquisition that leaves the acquired firm with a leverage ratio higher than it was before the acquisition.

The main economic principle the *leveraged buy-out* technique relies on is the exploitation of a capital market inefficiency: the presence of taxation. According to the Modigliani-Miller's intuition, if there was not taxation in the economy the choice of a given financial structure for a firm would have an indifference effect on its value. Taxes, instead, contribute to the imperfection of the valuation mechanism in use in the financial markets, as an unlevered and a levered firm are differently valued. Taxes perform a specific role in the economy of a firm that consists of making interests related to debt act as a shield towards operating profits to be destined to tax payment. The fiscal deductibility of financial interests expands the *Free Cash Flows from Operations* by preventing a part of them from being paid out and that allows for an increase of the firm value. Such a capital market inefficiency produces a misalignment in

the risk perception between debt and equity market in the sense that bondholders attribute a lower degree of riskiness to the firm if levered than equity investors do as to the same one if totally unlevered. Such a misalignment may be exploited by turning to a greater portion of debt instead of equity in order to increase the overall value of the firm.

The goal of a *leveraged buy-out* can be of a dual nature: a strategic-industrial nature and a financial-speculative nature.

In the first case, the potential buyers look at the industrial features of the deal and rely on their capacity of improving the static and the dynamic efficiency of the management of the core-business, namely the technical way of performing production operations and the capability of adapting to changing external conditions such as market conditions, in order to enhance the target firm's profitability. Besides the growth of operating profits, a fixed capital reduction is also performed by means of a non-core assets divestment process (asset stripping) and/or a lease-back process so that the ROI of the target firm is improved. Such a beneficial improvement should favour value creation, if the difference between the ROI and the cost of debt is positive and hence, generate extra *Free Cash Flows from Operations* in order to pay interests related to the greater amount of debt contracted. Additionally, the resort to debt can complement the enhanced operating cash flows with the further cash trap that is based on the fiscal deductibility of financial interests (leverage effect). The evidence of such a cash trapping mechanism is the gradual increase of the net income component of the target firm's ROE.

The structuring of a *leveraged buy-out* can also be merely motivated by the attainment of a financial-speculative objective. In this case, the expediency of the deal derives from the chance of taking advantage of another form of capital market inefficiency which is not properly exploited and, once again, lies in the valuation mechanism. This imperfection consists in a market myopia that

leads to valuing the single parts of a conglomerate at prices whose sum is greater than the value of the whole firm. An acquisition premium can be easily gained, if the control of a diversified group is acquired by resorting to a *leveraged buy-out* technique and the debt is repaid through a process of divesting separate business units.

The paper is organized as follows. First, we describe the main characteristics of a *leveraged buy-out* structuring process, as well as the traditional approach usually applied to perform the valuation of the target firm: the Adjusted Present Value method. Second, we propose the expansion of the target firm's Adjusted Present Value on its equity side, namely the equity value, by means of the integrative use of the Real Options Approach. In particular, we identify two real options that may be considered inherent in a *leveraged buy-out* technique: a financial default option and an operating default option. The expansion of the firm equity value is accomplished by relying on the common roots existing between the Net Present Value analysis and the Discounted Cash Flow method. Finally, a business case is reported in order to illustrate our reasonings.

2. The structuring of a *leveraged buy-out* and its valuation by means of the Adjusted Present Value method

Let us imagine that a team of subjects in their capacities as "buyers-investors" intends to start a *leveraged buy-out* for the acquisition of a firm chosen as a target. The framework, upon which the deal is based, is the Kolberg Kravis Roberts's (KKR), a classic planning of the cash merger type in which the acquisition of the control stake of the target firm by the potential buyer is made through the establishment of an *ad hoc* company **(Newco),** which often gets funds by giving the stocks held in the target firm at pawn, funds that the firm

resulting from the merger of the two companies will give back by means of the *Free Cash Flows from Operations* produced over the time. Furthermore, let us suppose that the object of the acquisition is the stocks of the target firm and that the latter is not listed on the Stock Exchange.

The aims of the buyers' team are two:

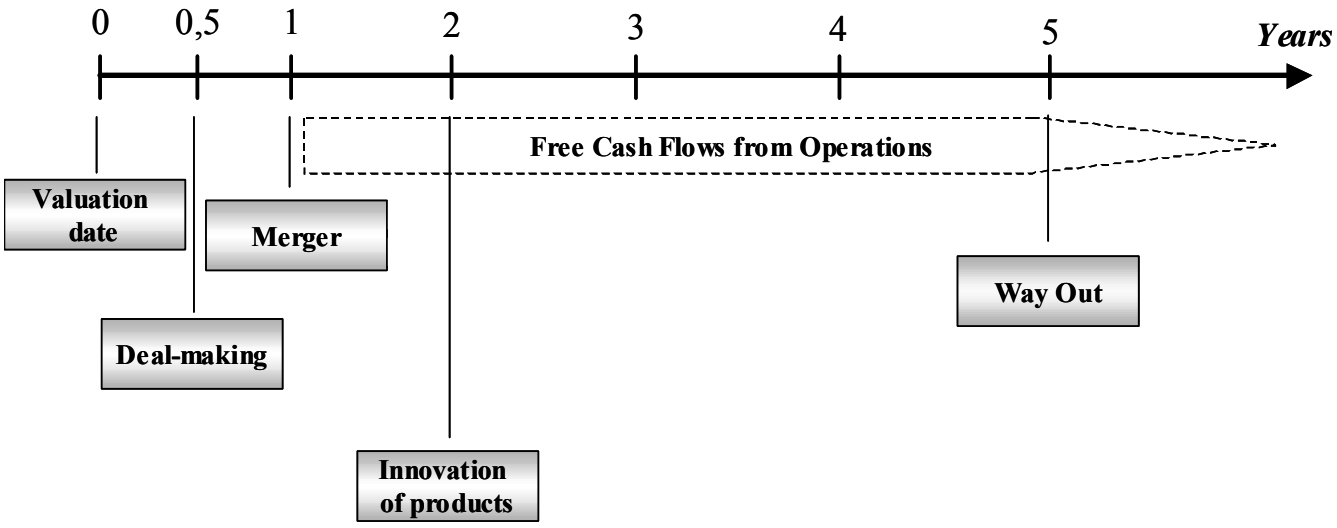
1) value the target firm, that is fix the top price they are willing to pay to the seller in order to buy the firm;
2) examine the options of different nature that shareholders and management will have while running the target firm's business and the interactions that, probably, will be established with each other in order to include them in the determination of the firm's equity value.

These aims shall be reached considering that the problem to be faced may be divided in three steps:

a) organize the **Newco**'s financial structure by getting the amount of debt necessary to carry out the acquisition from banks and bondholders;
b) pay back the contracted debt within the due date, thereby avoiding insolvency;
c) reorganize the target firm's structure in order to improve the business performance and to assure, if not to accelerate, the reimbursement of debt by means of larger *Free Cash Flows from Operations*.

Let us consider the structure of a typical *leveraged buy-out*, whose deal timing may be summarized in the following timeline:

Figure 1



We assume that the valuation horizon stretches over 6 years, being the end of the sixth year the date at which the buyer's initial investment is paid off (way out). Furthermore, we suppose that the merger between the **Newco** and the target firm is executed at the beginning of year 1 and two of the typical post-merger managerial actions (as described in detail later) are performed in order to enhance the business performance: product innovation and commercial relations' improvement.

The firm that may become the target of a *leveraged buy-out* can be described with a few, but significant characteristics. It has to be able to generate large and stable *Free Cash Flow from Operations*, so as to be mainly utilized to face the repayment of greater financial interests. As a result, a few cash will be available to finance an increase in the Net Working Capital, the Capital Expenditure and the Research & Development expenses. It follows that the target firm should preferably operate in a mature market and offer not very

sophisticated product lines. In fact, firms, whose business is characterized by a strong growth rate or high technology products, are not suitable for being acquired by structuring an LBO. The speed of their growth rate would require an excessive increase in the Receivables and the Inventories (and as a result, in the Net Working Capital), as well absorbing capital for the productive capacity enlargement and a raising share of the marketing expenses. Additionally, high technology products are constantly exposed to the obsolescence risk, so requiring considerable Research & Development costs. As to the market position, the target firm should be either a sector leader or located in a niche segment, so that any attempt of attack from a competitor is costly and complicated. In fact, such an attack resulting in an increase of its own sales only derives from taking away others'market shares, which becomes extremely difficult in a mature business. Furthermore, the debt/equity ratio of the optimal target firm must be low in order to allow for the increase in the borrowed capital resulting from the merger with the **Newco** and its asset structure sound in order to use its tangible assets as guarantees for the new debt. Whereas, then, the firm has surplus non-strategic assets available, that would permit to get extra cash through asset stripping. Finally, still referring to the asset structure, a market value of single assets that is higher than the book value make appreciation emerge for the seller and buyer's benefit. The first one is spurred to sell, the second one can rely on appreciations in order to exploit the amortization tax shield resulting in an increase in the operating cash flows. The table below summarizes the just described features of the optimal target firm:

Cash Flows	Strategic Position	Market Position	Debt/Equity Ratio	Asset Structure	Asset Value
Large and Stable	Mature Business/ No High Technology Profile Product Lines/ Low Growth Rate Product Lines	Sector Leader/ Niche Market	Low	Sound/ Prevalence of Tangible Assets/ Surplus Assets (to be stripped)	Market Value higher than Book Value

The valuation of the target firm of a *leveraged buy-out* is usually accomplished by applying the Adjusted Present Value method (APV), which is an hybrid "equity side" discounted cash flow method, as it is a combination of the asset side and equity side approaches of the financial methodology for firm valuation. The APV method, in fact, contains some of the elements that are typical of the asset side and some others pertaining to the equity side. The Adjusted Present Value of a given firm is the sum of two components: 1) the value of the unlevered firm, which is estimated by discounting the *Free Cash Flows from Operations* generated along the explicit forecast period at the unlevered cost of equity (Ke) and adding to it a conveniently discounted Terminal Value for the synthetic part of the forecast period; 2) the present value of the interest tax benefits deriving from the use of a certain amount of debt. As the firm is assumed to be unlevered (only equity-financed), it follows that the value of the unlevered firm is an enterprise value also coinciding with an equity value, since, according to the accounting relation Enterprise Value = W_E + Debt, there is no debt to be added. As a result, the final Adjusted Present Value of the firm still remains an enterprise value, even after computing the present value of the expected fiscal savings. It ends up representing the enterprise value of a levered firm.

According to the known formula, the Adjusted Present Value of the firm is computed as follows:

$$\mathbf{W_{assets} = W_U + W_{TS}}$$

where:

$\mathbf{W_{assets}}$ = enterprise value (value of operating assets);

$\mathbf{W_U}$ = value of the unlevered firm;

$\mathbf{W_{TS}}$ = value of the fiscal benefits referred to borrowing (G, tax shield).

More specifically, the value of the levered firm (W_L) can be unbundled in the following parts:

$$W_L = W_{assets} = \sum_{t=1}^{n} \frac{FCFO_t}{(1+K_e)^t} + \frac{TV_n}{(1+K_e)^n} + \sum_{t=1}^{n} \frac{K_d \times D_t \times t_c}{(1+K_d)^t} + \frac{TV\,(G)_n}{(1+K_d)^t}$$

W_U = Enterprise Value

G = Present Value of Tax Shield

where:

$FCFO_t$ = free cash flows from operations at each time t;

K_e = unlevered cost of equity;

TV_n = terminal value of the firm at time n;

K_d = cost of debt;

D_t = debt amount;

t_c = tax rate;

$TV\,(G)_n$ = terminal value of the interest tax benefits.

The Adjusted Present Value becomes an equity value, when the present value of debt (D) is subtracted from the enterprise value (W_{assets}):

$$W_{equity} = \text{Enterprise Value } (W_{assets}) - D$$

With regard to the Terminal Value, it expresses the value of the firm at the end of the period of explicit forecast of cash flows. The methodologies that may be used for its determination are those typical of the Analytic Financial Methods with Terminal Value*:* Perpetual Growth Rate Method and Exit Multiples' Method[1]. The former uses the Gordon's synthetic formula, under the hypothesis that the firm which is being valued, once reached a definite capacity of producing cash flows, can grow indefinitely at the rate **g**. In the case of an acquisition with a *leveraged buy-out*, the recourse to the variation of this method, which assumes that the firm is in a situation of equilibrium characterized by absence of growth, is excluded, since the firm in question has become the target of the deal just because of its capacity of stable growth over the time. The latter method, instead, bases the calculation of the Terminal Value on the use of market multiples such as the EV\EBIT (Enterprise Value\Earnings Before Interests and Taxes) in the assets side approach, assuming that the Terminal Value, being a fraction of the firm's value, may likewise be expressed in function of the multiples which are implicit in comparable firms. Hence, let us illustrate how to compute the Terminal Value with the Perpetual Growth Rate Model, since such a method will be later applied in the proposed business case. The Terminal Values that are involved in the Adjusted Present Value, TV_n and $TV\ (G)_n$, are calculated as follows:

[1] Given the reduced, if not almost inexistent, probability of a pay-off of the target firm's assets in the operating context of a LBO, the recourse to the liquidation value method , as a means for the estimate of the *Terminal Value,* seems not to be admitted.

$$TV_n = \frac{FCFO_n}{(K_e - g)}$$

$$TV\,(G)_n = \frac{FCFO_n}{(K_d - g)}$$

where:

$FCFO_n$ = normalized average free cash flow from operations (to be considered "in force" over the synthetic forecast period);

g = growth rate of the free cash flow from operations (namely, the firm's growth) over the synthetic forecast period.

It can be noticed that the cost of debt (K_d) is used to discount all the cash flows related to the fiscal benefits (interest tax shield and Terminal Value). Such a choice is attributed to the consideration that the riskiness of those cash flows is well reflected in the average cost of debt, as tax shields are as uncertain as principal and interest payments. Nevertheless, some others regard the use of such a discount rate for the estimate of the present value of the interest tax savings as being a significant drawback of the method, besides the computation of the shareholders' rate of return for the cash flows of the unlevered firm (the

unlevered cost of equity), since the APV does not find a solution to one of the main disadvantages of the Adjusted WACC approach[2].

The Adjusted Present Value method presents two important virtues:

1. it provides disaggregated information about the factors that share in creating the firm's value;
2. it permits a detailed analysis of the value deriving from the choice of a particular financial structure by isolating the contribution of fiscal benefits to the corporate value creation.

With regard to the latter beneficial feature, the APV can rely on the law of preservation of, according to which the irrelevance of fiscal benefits connected to the use of debt is equivalent to the absence of taxation within the first part of the valuation leading to the determination of the value of the unlevered firm. Hence - thanks to the transmission effects that operate from the asset value to the discount rate – it follows the independence of the Weighted Average Cost of Capital, which is applied to discount back the operating cash flows, from the firm's financial structure and the connected possibility of utilizing it in the place of the unlevered cost of equity without distinction. That accounts for the use of the cost of equity in the discounting process related to the unlevered firm valuation.

[2] The Adjusted WACC approach is the discounted cash flow method that is used alternatively to APV when the main goal is to put in evidence the value creation deriving from the exploitation of fiscal benefits. As to the main disadvantages of the Adjusted WACC approach, they are specifically referred to the miscalculation of the Weighted Average Cost of Capital. The errors usually made are the recourse to the targeted capital structure instead of the outstanding debt/equity ratio in the cost of equity's computation and to book values instead of market values in the determination of the weights.

3. The expansion of the Adjusted Present Value of the target firm: the valuation of a *leveraged buy-out* by means of the Real Options Approach

We have described how the equity value of the target firm can be found by applying the Adjusted Present Value method. Such an equity value may be compared to a passive Net Present Value (NPV), since the theoretical roots are common between the NPV analysis and the Discount Cash Flow methodology. As a result, we can name such an equity value as the "passive equity value" (Passive W_{equity}) of the target firm. The conventional valuation does not capture the flexibility of the managerial actions that can be performed in order to influence the dynamics of the firm value. The informative set that the decision-making rule of the Discounted Cash Flow methodology typically incorporates is a static one, as both the business plan's projections and the discounting process rely on the information available at time zero. The passive equity value the APV user gets to is a precommitted value which does not exploit the benefits of managing and properly reacting to uncertainty. Such an uncertainty is, instead, taken into account by the Real Options Analysis. What we intend to suggest is, therefore, the expansion of the traditional valuation of a *leveraged buy-out*'s target firm by applying Real Options. To accomplish this, we expand the Adjusted Present Value as the equity value of the levered firm by integrating such a passive equity value with the pricing of two real options that characterize the operating context within which a *leveraged buy-out* is carried out. So it is possible to convert the passive equity value into an equivalent expanded value and transform the valuation of the firm that is being acquired from passive to dynamic through the merger, in the process of managerial choices and thus, also in the estimative process, of real options. The result of the suggested integration is called *Expanded Equity Value* and may be got in the following way:

Expanded Equity Value (Expanded W_{equity}) =

= Passive W_{equity} + Real Option Value

Then, the *Expanded Equity Value* deriving from the Real Options Analysis of a *leveraged buy-out* can be compared to the equity value of the target firm that is obtained by means of the Adjusted Present Value method in order to appreciate the value enhancement power incorporated in the former approach.

In detail, the subjects that carry out a *leveraged buy-out* have two real options at their disposal in structuring the deal: a financial default option and an operating default option. They are two options inherent in a LBO technique itself that, considered together, form a compound option, since, as we are going to see, only the exercise of the former gives the possibility to exercise the latter. Particularly, such a compound option belongs to the category of the sequential compound options, as the second option is created only when the first option is exercised.

The financial default option permits to value an investment project or a firm characterized by the recourse to borrowing by incorporating the possibility of the financial default of debt into the valuation. Let us consider a firm that borrows over the equity whose value must be determined. An obligation for the shareholders of such a firm is paying back the contracted debt on pain of default and the possibility for creditors of attacking the shareholders' assets. The chance of resorting to bankruptcy transforms the shareholders' obligation into an option. According to the Black-Scholes 1973' seminal paper, such an option is represented by the equity of the levered firm itself. The firm's equity, in fact, can be regarded as a call option on the value of the firm, whose exercise price is the face value of the firm's debt (including principal and interest) and whose maturity is the maturity of the debt. The value of such a call

option must give the value of the firm's equity. Provided that the considered firm is the target of an LBO, it is therefore leveraged and thus relying on the accounting relation between enterprise value (EV) and equity value (W_E) according to which:

$$W_{equity} = \text{Enterprise Value} - \text{Debt}$$

the underlying risky asset is represented by the enterprise value of the levered firm, that may be calculated via the Adjusted Present Value method, as:

$$W_{assets} = EV = \sum_{t=1}^{n} \frac{FCFO_t}{(1 + Ke)^t} + \frac{TV_n}{(1 + K_e)^n} + \sum_{t=1}^{n} \frac{K_d \times D_t \times t_c}{(1 + K_d)^t} + \frac{TV\,(G)_n}{(1 + K_d)^t}$$

Hence, the payoff of the call option replicates the above mentioned accounting relation and its value gives the Adjusted Present Value of the firm computed as its equity value (W_{equity}).

If we analyse a LBO structure, we can understand how the just described option framework perfectly follows the managerial process that those who carry out a leveraged buy-out have to face. At the very moment in which the buyer-investor sets up a **Newco** and negotiates the debt with the banks (or issues subordinated bonds on the financial market) he acquires the faculty of paying back the contracted debt or – when the management of the business does not permit the production over the time of *Free Cash Flows from Operations* sufficient to a complete reimbursement - of declaring his own default. It is, of course, an undesirable event, but nevertheless possible during the lifetime of a

leveraged buy-out, whose uncertainty can be managed with flexibility in order to exploit the connected larger value creation.

Then, it is possible to write, on the enterprise value of the target levered firm as underlying risky asset, a financial default call option of American type whose payoff at T maturity date is:

$$\mathbf{E_T = max\ [EV_T - D_T;\ 0\ ]}$$

Default is declared

Debt is reimbursed

where:

Variable of state: enterprise value of the target levered firm;
Strike price*:* present (face) value of debt (including principal and interest);
Maturity date: T (coincident with the payoff date of debt).

Over the course of a LBO post-merger phase until reaching time T, the financial default American call option written on the firm's enterprise value, which is in the hands of the buyer - the current shareholder of the firm, and of his management, is *in the money* if the *Free Cash Flows from Operations* are large enough to assure at least the profitable remuneration of debt-holders each year, which translates into an enterprise value of the target firm higher than the face value of debt included the interests accrued during all its lifetime. Debt plays the role of the option strike price, since it is a contractually known quantity that may be defined on the negotiation of the borrowing soon after the

setting up of the **Newco**. The consideration of the present value of debt (principal and interest), under the hypothesis of the call option being *in the money*, implies the firm's capacity of its total reimbursement. It follows the expedience for the shareholder to exercise the option, which is equivalent to have paid over the time the borrowed capital. The financial default option is, on the contrary, *out of the money* if at time T the *Free Cash Flows from Operations* produced by the firm's core-business are not only insufficient to remunerate the shareholders' equity, but they are not even sufficient to pay back the debt. That is reflected in an enterprise value of the levered firm lower than the value of the debt (principal and interest) and compels the shareholder, who holds the option, not to find its exercise profitable and to declare the firm's default. Furthermore, by choosing the enterprise value of the levered firm computed *via* the Adjusted Present Value method as the underlying risky asset of the financial default option, its payoff is allowed to incorporate the value created by the exploitation of the tax shield that is typical of a *leveraged buy-out* deal.

An operating default option is the other real option that comes out in the course of the realization of a *leveraged buy-out* and that, therefore, shall be analysed in the valuation process of the target firm. It is an option that, in the case of an investment project, permits management to differ over the time the repayment of the capital outlay needed for carrying out the project itself in function of the *Free Cash Flows from Operations* gradually generated by the firm's core-business. The operating default option belongs, then, to the category of deferral options.

In structuring an LBO, a wide range of managerial actions can be carried out with the purpose of strengthening the business performance in order to reach a more certain and rapid reimbursement of the borrowed capital. These managerial actions, that are usually performed after the merger between the **Newco** and the target firm, may be divided in extraordinary and ordinary

management interventions. The first ones are related to the dismissal of non-strategic assets (asset stripping), while the second ones embrace the firm's key functional areas. Particularly, they can be concerned with the improvement of the performance of the firm's management and personnel, the production structure, the commercial relations' area (clients and providers), the product strategy and the financial management. All these post-merger restructuring actions require financial resources in order to be carried out.

Let us assume that after the merger the buyer-investor intends to perform two ordinary management interventions: the innovation of the target firm's products and the improvement of commercial relations. More specifically, the first intervention aims at influencing the characteristics of the firm's offer. It is not just a question of increasing the production capacity, but above all of improving the characteristics of desirability of the product. The elevation of the technological content of the offer, the reduction of the time threshold of the product obsolescence or, more generally, any interventions aimed at acting on the dimension of the firm's product mix may contribute to it. In fact, a firm's product mix presents four principal dimensions: width, length, depth, and consistency. They constitute the tools to define the corporate product strategy. The width of the *product mix* measures the number of the different product lines[3] existing in the firm and put up for sale. Management can decide to add new lines, widening the product mix. Instead, the product mix length is referred to the total number of the products offered by the firm. Management can decide to lengthen the lines of products in order to attract customers with different tastes and needs. The product mix depth is its size with regard to the versions of every product of the line. New versions may be added to every product and, in this way, making the product mix deeper. Finally, the consistency of the product

[3] A *product mix* is composed of different lines. A product line is a group of products closely connected, since they carry out the same function, they are sold to the same customer category through the same commercial outlets or they belong to the same price class.

mix measures the correlation degree among the different lines of products with reference to their final use, the characteristics of the production process, distribution channels etc.. Management can make the product mix more or less consistent according to the aim of acquiring a strong reputation in a single sector (for example, the historical one of the firm) or rather of entering a multiplicity of sectors.

Let us assume that, besides the debt used to compose the financial structure of the **Newco**, management resorts to a further borrowing to be repaid in two different tranches (as explained later, the first of the tranches must be paid at year 1 and the second one at year 2) in order to carry out the intervention of product strategy (being the action related to commercial relations an indirect cash-free effect of product innovation). Whatever the form taken by the latter, the target firm's management may need to regulate over the time the financial outlay connected to its implementation waiting for the examination of the cash flows from operations that the core business will be able to generate. This task will be performed by the operating default call option, that, being of American type, presents the following payoff at the maturity date T_1 and can be exercised at any time (as we will explain later, at predetermined decision nodes) during its life:

$$\mathbf{E_{T1} = max\ [EV_{T1} - I_{T1}; 0]}$$

Operating default is declared

Investment payment is completed

where:
Variable of state: enterprise value of the target levered firm;
Exercise price: value of the second tranche of the borrowed capital necessary for the carrying out of the investment project;
Maturity date: T_1 (preceding T and coinciding with the maturity of the second tranche of the borrowed capital).

At date T_1 the exercise of the operating default call option suits the target firm's shareholders if it is *in the money,* that is if the *Free Cash Flows from Operations* are produced in a quantity sufficient to assure the continuation of the intervention of product innovation, which is reflected on the enterprise value of the target firm higher than the debt share that has still to be paid. If, on the contrary, the *Free Cash Flows from Operations* have finished their capacity of reimbursement, being the target firm's enterprise value lower than the value of the debt share that is still to be paid, the option is *out of the money*, and its exercise is not profitable for the shareholder of the target firm. The latter, then, is compelled to declare the firm's operating default, which equates to exercising the right of definitely interrupting the project of improving the offer. It means that the project in question has operationally failed, and the firm must be content with the product or the product mix already existing. The product strategy project yet played an important role in recovering the steadiness of growth of the target firm's cash flows and assuring the repayment of the financial debt originally related to the **Newco**'s capital structure. Its operating failure turns into a financial failure as well. It follows that, if the operating default option is left unexercised, the buyer cannot aim at continuing the firm's activity because all the value creation initiatives originally targeted cannot operate. As a result, the *Free Cash Flows from Operations*, that would have allowed to reimburse the

financial debt, will not be sufficient. If, instead, the operating default option is exercised, the value, that will be creating over the years until the buyer's way out, may contribute to the final repayment of the financial debt and, therefore, to repeatedly exercising the related financial default option. That would mean a successful way out for the buyer-investor. Then, we understand how the operating default comes before the possible financial default, leaves it aside and does not exclude it.

A *leveraged buy-out* has in itself the two rights allowed to the shareholder of which we said above. A financial default and an operating default are two possible events in a firm's lifetime and the consideration of the two categories of options that are contingent on them accounts for the managerial flexibility, which creates value only owing to the fact of permitting to make correct choices and to take the relative decisions in the right moment. That eliminates the passive and static quality peculiar to traditional valuation and makes it dynamic, in keeping with the possible sources of value offered by the reality of firm management.

Let us suppose that the setting up of the **Newco** necessary to carry out the LBO needs an initial investment equal to $I0^E + I0^D$, that is equivalent to the composition of its financial structure. The equity brought-in by the team of buyers-investors (the new shareholders) is equal to $I0^E$ and the borrowed capital negotiated with the banks and\or placed with the investors on the financial market (bondholders) is equal to $I0^D$.

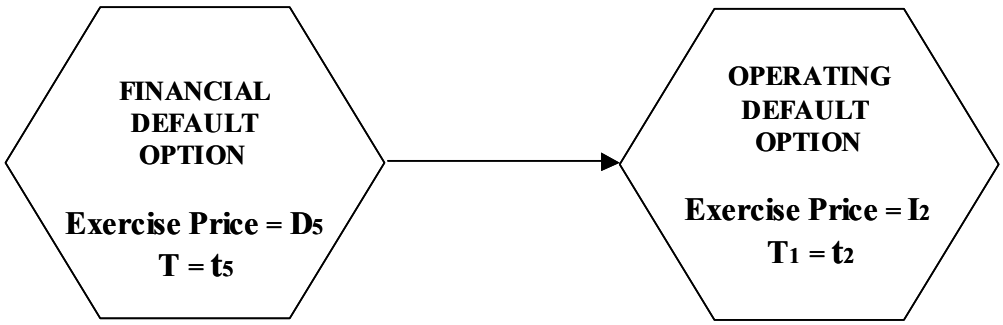
The financial structure of the vehicle company destined to merge the target firm is composed as follows:

$I0^E$ = equity

Newco's capital structure

$I0^D$ = financial debt

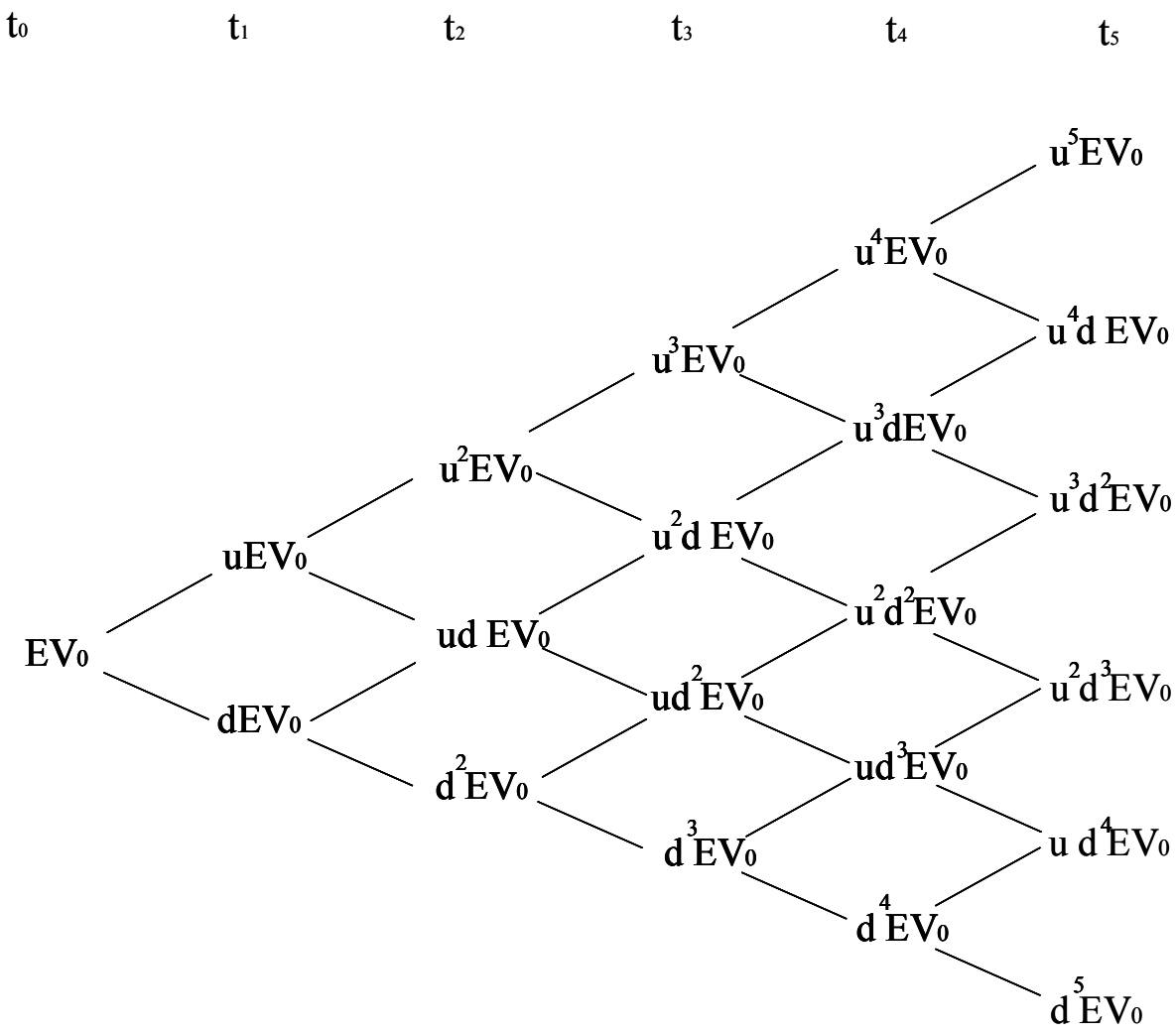
The debt contracted by the firm is risky, so the applied interest rate (K_d) is obtained by adding a risk premium (π_D) to the risk-free rate (r_f) for risk-less investments. The financial debt expiration date is stated in time T_5, coinciding with the time chosen by the team of buyers-investors for the way out. It means that the obligations taken by the firm's new shareholders, that is the debt reimbursement and the payment of relative interests, must be satisfied. If the new shareholders do not fulfil their obligations and do not pay back the debt at time $T = t_5$ [$D_5 = I_0^D \times (1+ K_d)^5$), the firm's default will be declared and the bondholders\banks will take possession of the corporate assets, they will carry out the winding-up by getting the present value at time $T = T_5$ (V_5) and they will pay back their credit, partially or totally, by means of what they obtain from the winding-up. Let us assume, furthermore, that the management team of the target firm, after the merger between the **Newco** and the target, may carry out the product strategy by financing at the valuation date t_0 the relative intervention in two different tranches, the first equal to I_1 to be paid at the end of the merger deal, at the beginning of period t_1 and the second to be disbursed a year later at the beginning of period t_2 and whose value (principal and interest) is equal to I_2. The form of borrowing that management may choose in order to finance the intervention of ordinary management related to the firm's output is a short-term debt. As it was outlined above, the carrying out of a leveraged buy-out and its conduct create intrinsically the two real options of financial and operating default that may be represented with this pattern:



We can easily understand that the two real options form together a compound option, since the decision to proceed to the acquisition by means of a *leveraged buy-out* permits the buyer the discretionary exercise of a financial default option. Still better, we can say that the choice itself of carrying out a *leveraged buy-out* is a financial default option. It follows that, conceptually, the operating default option is acquired by the buyer\shareholder of the target firm only afterwards and because he had acquired the first right: the financial default option. That accounts for compounding. Nevertheless, practically, the operating default option is chronologically antecedent to the financial default option. The type of compounding is sequential, as the time sequence of the real options involved in an LBO is the opposite of their order of economic priority. The first chronological option (the operating default option) is, in fact, the second option from an economical point of view and the option that chronologically comes as second (the financial default option) is the most important one in economical terms.

The valuation process of the sequential compound option starts by building the firm's enterprise value tree. First, in fact, we evaluate the financial default option, whose value in t_0 corresponds to that one of the equity of the levered firm under the APV hypothesis acting as an American call on the enterprise value with its exercise price equal to the face value of debt (principal and interest). Once we model the present enterprise value of the levered target firm and its up and down movements by computing the relative standard deviation, the uncertainty regarding the evolution of the operating cash flows results in a recombining binomial event tree that becomes the underlying risky asset for the financial default call option. The enterprise value tree of the firm is illustrated in the figure 2:

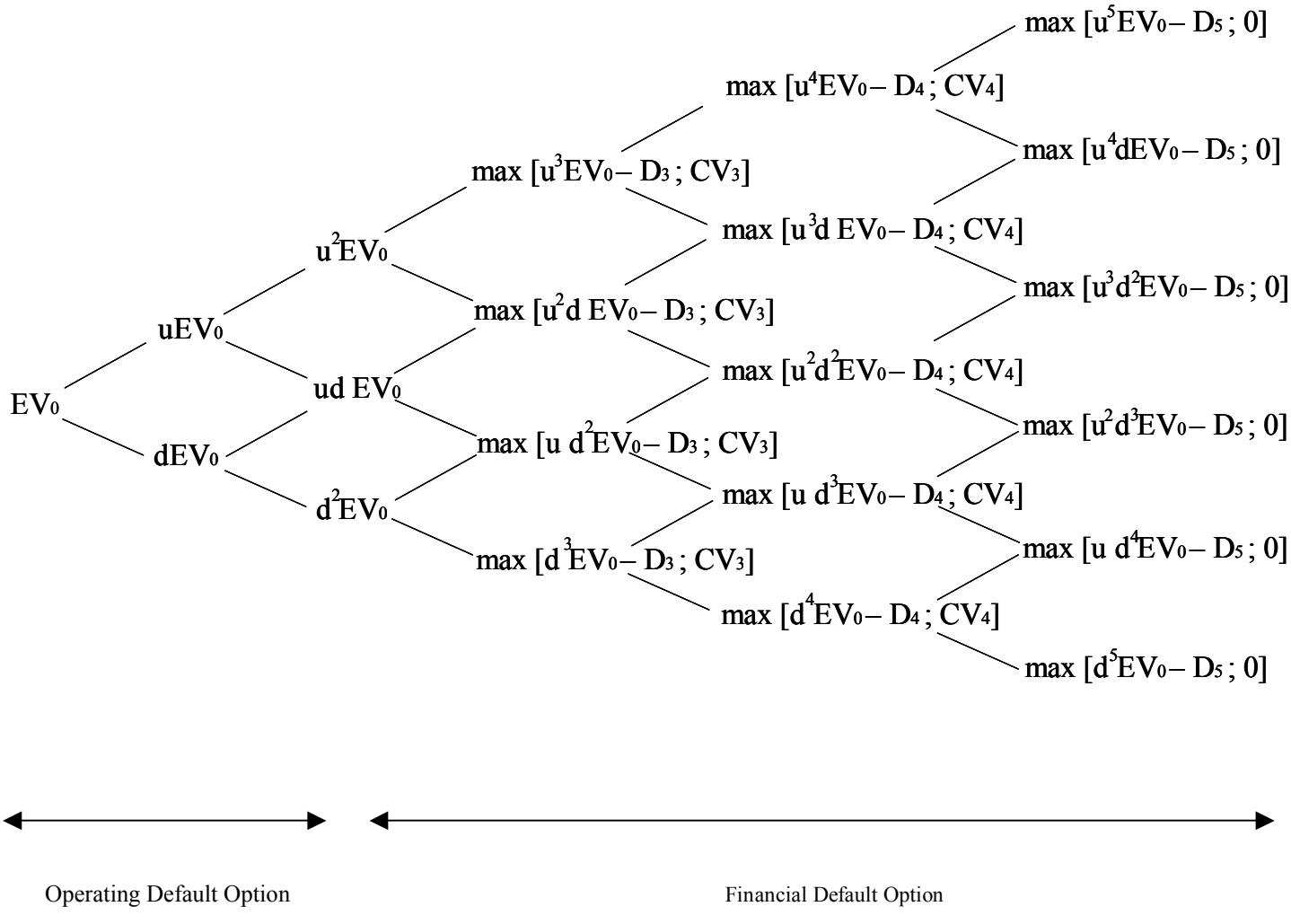
Figure 2



The valuation process proceeds in two steps. As the lifetime of the financial default call option starts at the beginning of year 1 (t_1) until its expiration date, which is the end of year 5 ($T = t_5$, date for the buyers-investors' way out), we first value this option by backward induction so as to reach the decision nodes that coincide with year 2. To calculate the payoffs of the various states of nature over this period and to reason in terms of backward induction, we have to apply the "max" operator to every node at times $T = t_5$, t_4, and t_3

belonging to the binomial tree that draws the dynamics of the value of the underlying (the stochastic process for the levered firm's enterprise value under the APV conditions). That transforms the enterprise value event tree into a decision tree (figure 3).

Figure 3



At all end nodes of year 5, we calculate the related payoffs and decide whether the firm is able to repay its debt through the *Free Cash Flow from Operations* that will be generated in the future or it will be forced to go bankrupt. At all the five nodes of year 4, the continuation value of the American financial default call option is compared to its present payoff in order to take the optimal exercise decision. If the continuation value of the option is greater than the payoff at the current node (that is, the value of the option unexercised exceeds its value if exercised), then the firm's activity is carried out and no default is declared. It means that the *Free Cash Flow from Operations* still maintain their capacity of debt reimbursement. On the contrary, if the continuation value of the option is lower than the present node's payout, management makes the firm go bankrupt instead of keeping the financial default option open. For the moment, let us leave aside the nodes related to years 0, 1 and 2.

The continuation value of the financial default call option may be calculated by applying either the Replicating Portfolio Approach or the Risk-Neutral Probability Approach (given their equivalence). If we choose to use the latter methodology, we need to compute the risk-neutral probabilities to be utilized in the valuation according to the known formula:

$$q = \frac{1 + r_f - d}{u - d} = \frac{m - d}{u - d}$$

where:

$m = 1 + r_f$

Probability q is the risk-adjusted probability of an upward trend. The probability of the value of the underlying asset going into the low state of nature is simply obtained by calculating the complement to 1 of q. We, then, apply the closed pricing formula derived from the Cox-Ross-Rubinstein model to compute the continuation value:

$$C = \frac{1}{1 + r_f} \left[q\, C_u + (1 - q)\, C_d \right]$$

where:

C = continuation value of the American financial default call option (more in general, value of the option at time 0);

C_u = payoff of the financial default call option in the up-state node;

C_d = payoff of the financial default call option in the down-state node.

Alternatively, we can use the Replicating Portfolio Approach, which is equally derived from the Cox-Ross-Rubinstein model and relies on the law of one price for assets providing the same payouts. Such a method consists in building an hedged portfolio that is composed of one share (Δ) of the underlying risky asset (twin security) and a short position in one or more units (C) of the option that is being priced, so that the capital gain or loss from holding the twin security will be perfectly offset by the correspondent capital loss or gain in the short position created by writing one or more calls on such an underlying risky asset. A simple algebraical inversion operation shows how the so composed portfolio with a resulting hedge ratio is riskless, as its payoff is that one of a risk-free bond (B):

$$\Delta V_0 - C_0 = B_0$$

$$\Delta V_0 + B_0 = C_0$$

Furthermore, we make the *Marketed Asset Disclaimer* assumption[4] that allows for the integrated and simultaneous use of the Replicating Portfolio Approach and the Twin Security Approach, being the latter typically related to the traditional Net Present Value analysis. In fact, such an assumption does permit to avoid the search for a traded twin security by substituting it with the pure NPV of the asset that is being valued, namely "without flexibility".

The Replicating Portfolio Approach consists in equating the end-of-period payoffs of the hedged portfolio in the two considered states of nature and in finding a hedge ratio (Δ), that is chosen so that the portfolio will return the same cash flows in either state of nature. The result will be a riskless portfolio:

$$\begin{cases} \Delta u_t V_{t-1} + (1 + r_f) B = C_u \\ \Delta d_t V_{t-1} + (1 + r_f) B = C_d \end{cases}$$

$$\Delta V_{t-1} (u_t - d_t) = C_u - C_d$$

[4] See Tom Copeland –Vladimir Antikarov, "Real Options. A Practitioner's Guide", 2001.

$$\Delta = \frac{C_u - C_d}{V_{t-1}\,(u_t - d_t)}$$

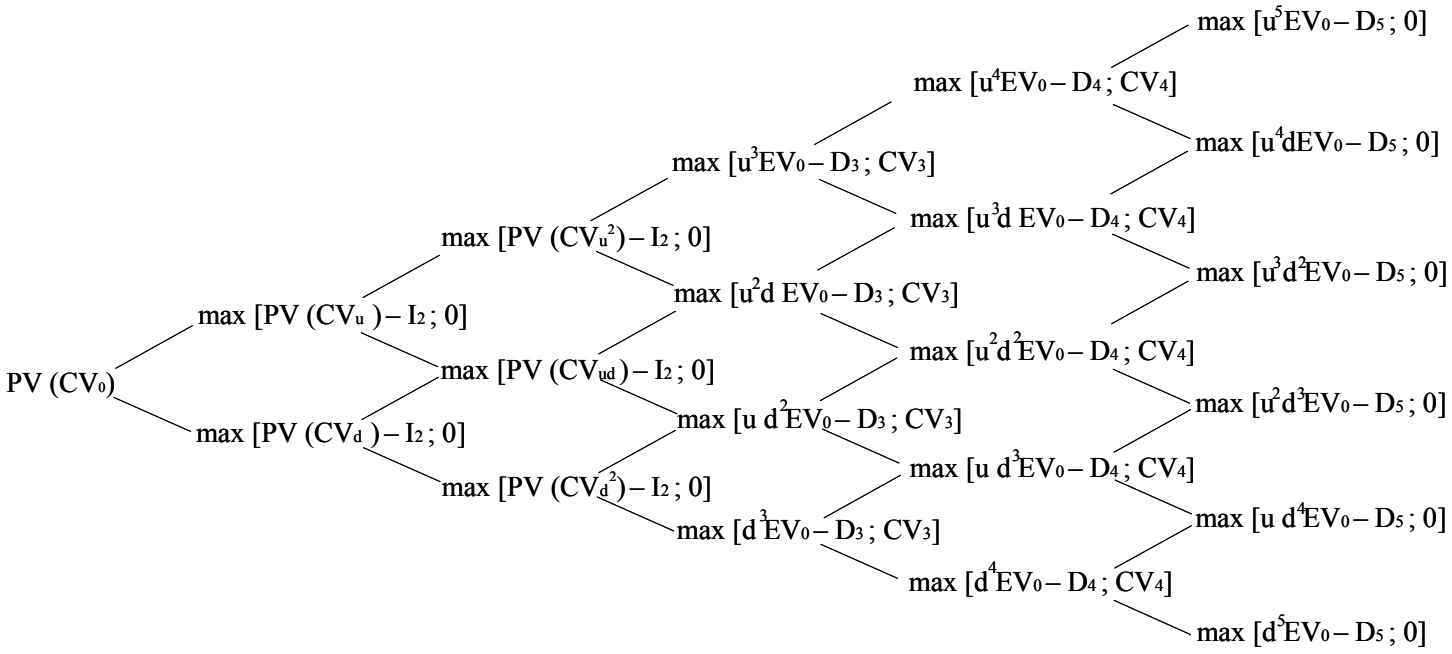
The law of one price allows for the pricing of the hedged portfolio and, hence, of the option at each of the end-of-period nodes of the year before :

$$\Delta\, V_{t-1} + B = C$$

At the end of year 2, the operating default call option, that is written on the enterprise value of the target levered firm and gives the buyer the right to decide whether or not to carry out the product strategy project, expires. As described above, if such an option is not exercised, it does not give the buyer the right to proceed to manage the target firm by repaying the second tranche of the short-term debt which finances the output improvement. That makes the *leveraged buy-out* unsuccessfully terminate beforehand. More important, the operating default option is not merely contingent on the target levered firm's enterprise value, but on the enterprise value incorporating the current value of the financial default option (PV (CV)). Such a "flexible" enterprise value acts as underlying risky asset of the operating default option expiring at year 2 of the post-merger phase of the *leveraged buy-out*. The enterprise value of the target firm, which includes the present value of the American financial default call

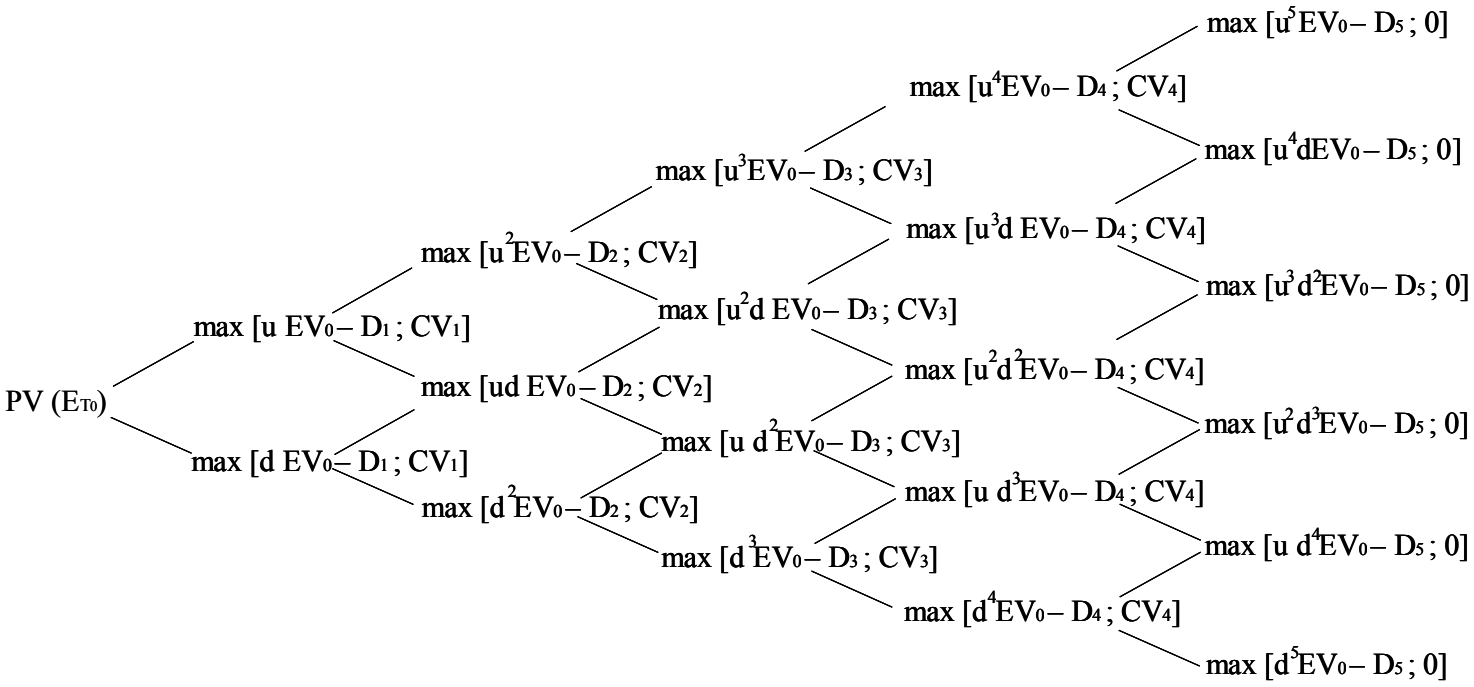
option acting from year 2 (t_2) to year 5 (t_5), is calculated by applying the Replicating Portfolio Approach and needs to be compared to the operating default option's exercise price at the nodes of time t_2. If the "flexible" enterprise value of the firm is greater than the exercise price (I_2), its business operations continue and managers can rely on the gradual production of operational cash flows to monitor the reimbursement of the financial debt. Such a monitoring activity is performed by looking at the continuation value of the American financial default option at the successive nodes of the binomial tree of the underlying. Whereas the payout of the option is negative, the default of the target firm is declared. Otherwise, if the enterprise value of the firm, representing the continuation value of the American option, exceeds the face value of the debt (principal and interests) until reaching the end-of-period nodes of the binomial tree, meaning that the *Free Cash Flows from Operations* are large enough along the predetermined lifetime of the deal to repay the borrowed capital, the buyer can successfully execute the way out. The same backward induction procedure is repeated for the year 1 node (t_1), as the operating default call option is of American type too and its present value is calculated in t_0 (PV (CV_0)) (figure 4).

Figure 4



Even though, in fact, the American financial default call option only operates from the end of the year 2, its lifetime must be considered throughout the deal from time t_0 to time t_5 in order to estimate the present value of the compound option. Therefore, the enterprise value event tree that is illustrated in the figure 4 must be continued until the time 0 (t_0) by computing the continuation value of the American financial default call option and comparing it to its current node's payoff. That gives us the value of the financial default option at the valuation date (figure 5).

Figure 5



By doing so, it is now possible to compare the enterprise value incorporating the current value of the financial default option (PV (CV_0)), acting as the continuation value of the operating default option, to the present value of the financial default option (PV (E_{T0})). The first value, if greater than the second one, corresponds to the profitable continuation of the operating default call option towards the successive nodes, while the second value, if greater than the first one, coincides with the profitable exercise of the operating default option. In the latter case, in fact, the exercise of the operating default option – conceptually - gives an immediate start to the financial default option. Whatever the value is chosen, that is, whether the operating default option is continued or exercised, the value of the compound option, as determined in t_0, identifies what

we are referred to as the *Expanded Equity Value* (Expanded W_{equity}) of the target firm. As already explained, such a value realizes the expansion of the conventional equity value as computed by means of the Adjusted Present Value method, being the payoffs of both the real options involved structured as the difference between the enterprise value of the levered firm and the present value of debt. Thus, the *Expanded Equity Value* of the target firm incorporates the value of the compound option, as sequentially composed by the operating default call option and the financial default call option, that is added to the passive equity value:

Expanded Equity Value (Expanded W_{equity}) =

= Passive W_{equity} + Compound Option Value =

= Passive W_{equity} + Operating Default Option Value +

+ Financial Default Option Value

Having computed the *Expanded Equity Value* of the target firm by means of the Real Options Approach, we can easily extract the value of the compound option by subtracting the passive equity value from the *Expanded Equity Value* itself. Since:

Expanded Equity Value (Expanded W_{equity}) - Passive W_{equity} =

Compound Option Value

Such a calculation permits to estimate the contribution that the integrated use of the Real Options Analysis brings into the valuation of the target firm of an LBO.

We can conclude that the appraisal process of the target firm of a *leveraged buy-out* through the Real Options Analysis, if compared to that one based on the Adjusted Present Value method, presents the following two advantages:

1. it captures the managerial flexibility of the firm value uncertainty, which is not included in the passive and static Adjusted Present Value;
2. it continues to incorporate the extra-value created by the exploitation of the tax shield, as the APV method does, since the underlying risky asset of the compound option is the enterprise value of the levered firm including the present value of the fiscal benefits.

4. Business Case: the valuation of Chemical Brothers SpA

Chemical Brothers SpA is active in the sector of disposal and reconversion of waste products. More specifically, it operates in the following two business segments:

- the recovery, purification and production of organic solvents;
- the production of fine pharmaceutical intermediates.

The first business unit collects any kind of industrial liquid waste product in order to treat and recover it by means of purification processes. By purifying and fractioning heterogeneous mixtures, different types of solvents are extracted, fractionated and dehydrated for re-use in their original processes. All the by-products obtained from processing are analysed for possible commercial use or are treated as waste for later disposal. Chemical Brothers' revenues in this

business segment derive from the solvents' sale to the same main firms from which are originally collected (chemical, petrochemical, pharmaceutical, engineering firms), as well as from the waste collection. The result of the organic solvents' treatment by this business unit of Chemical Brothers is as follows:

- 70% recovered as solvents to be sold to the market;
- 20% transformed in distilled water to be eliminated;
- 10% concentrated waste to be eliminated.

The second business unit exploits the same technological know-how that is employed in the first business unit in order to produce pharmaceutical intermediates through a synthesis process regarding raw materials acquired by third parties.

In the year 2003, Chemical Brothers recorded revenues for € 48.4 million and has a current production capacity of about 150.000 tons per year of industrial solvents with an authorization to treat 98.900 tons of industrial solvents per year. Capital expenditure in the coming years is expected to be limited, since the firm has made significant investments in the past years (its plants are considered among the most technological advanced for organic solvents' treatment).

The current shareholders propose a *family buy-out* through the sale of a majority stake to a financial partner in order to continue the business development and to prepare Chemical Brothers for an IPO/trade sale in the next 5 years. Shareholders will retain a minority stake (30%) in the firm, as well as the management positions. The *leveraged buy-out* is executed in December 2003 and the way out is expected for the year 2008.

The Pro Forma Income Statements and the Pro Forma Balance Sheets resulting from the transaction proposed by the buyer-investor are illustrated in figure 6:

Figure 6

Pro Forma Income Statements	**2003**	**2004E**	**2005E**	**2006E**	**2007E**	**2008E**
(in thousands of Euro)						
EBIT	**6.046**	**11.090**	**16.264**	**17.935**	**19.009**	**19.914**
Interest	- 1.013	- 1.747	- 1.434	- 1.043	- 520	- 5
EBT	5.033	9.343	14.830	16.892	18.489	19.909
Taxes (35%)	- 1.762	- 3.270	- 5.191	- 5.912	- 6.471	- 6.968
Net Income	3.271	6.073	9.640	10.980	12.018	12.941
Supplemental Data						
Depreciation	- 3.451	- 2.874	- 2.126	- 1.738	- 1.847	- 1.908
Capex	- 6.096	- 2.000	- 2.000	- 2.000	- 2.000	- 2.000
Change in NWC	3.480	- 3.038	- 2.835	- 1.145	- 953	- 976
Change in other assets/liabilities	- 3.239	3.130	- 1.456	582	- 130	216

Pro Forma Balance Sheets	**2003**	**2004E**	**2005E**	**2006E**	**2007E**	**2008E**
(in thousands of Euro)						
Net Working Capital	10.720	13.758	16.593	17.738	18.691	19.667
Net Fixed Assets	40.604	39.730	39.604	39.866	40.019	40.111
Other Assets/Liabilities	- 1.351	- 4.481	- 3.025	- 3.607	- 3.477	- 3.693
Net Capital Employed	**49.973**	**49.008**	**53.172**	**53.997**	**55.234**	**56.086**
Overdraft/(Cash)	11.452	10.413	8.938	2.783	- 3.999	- 12.087
Short Term Debt	2.000	-	-	-	-	-
Senior Debt	20.000	16.000	12.000	8.000	4.000	-
Mezzanine Debt	5.000	5.000	5.000	5.000	5.000	5.000
Total debt	38.452	31.413	25.938	15.783	5.001	- 7.087
Equity	11.521	17.595	27.234	38.214	50.232	63.173
Total Sources	**49.973**	**49.008**	**53.172**	**53.997**	**55.234**	**56.086**

The buyer-investor designs the financial strategy that underlies the *leveraged buy-out* so as to have the **Newco**'s capital structure composed by a 77% of debt and a 23% of equity. Particularly, the debt consists of four different forms of borrowing: the revolving credit facility (€ 11.4 million), which is used to finance the Net Working Capital; the short-term debt (€ 2 million, second tranche), which acts as a bridge financing from the LBO'structuring year (2003) to the merger's year in order to fund the proposed intervention of product innovation; the senior debt (€ 20 million), that usually represents the largest portion of the leverage ratio in a *leveraged buy-out* and is amortised in five years through the payment of an annual costant instalment of Euro 4 million; the mezzanine debt (€ 5 million), structured as a bullet bond with an equity kicker, which gives a warrant to its holders for the purchase of an equity stake of the target firm upon the way out. The resulting Net Financial Position is equal to € 38.4 million against a pre-merger one amounting to € 18.7 million, being the shareholders' equity equal to € 31.3 million (equity = 63%; debt = 37%). The figure 7 shows the income statements and the balance sheets that would have been projected over the future life of the firm if it had not been the target of an LBO:

Figure 7

Pro Forma Income Statements	2003	2004E	2005E	2006E	2007E	2008E
(in thousands of Euro)						
EBIT	**6.046**	**6.840**	**12.750**	**14.197**	**15.241**	**15.038**
Interest	- 1.013	- 758	- 492	- 190	- 24	- 69
EBT	5.033	6.082	12.259	14.007	15.217	14.969
Taxes (35%)	- 1.762	- 2.129	- 4.291	- 4.902	- 5.326	- 5.239
Net Income	3.271	3.953	7.968	9.104	9.891	9.730
Supplemental Data						
Depreciation	- 3.451	- 2.874	- 2.126	- 1.738	- 1.847	- 1.908
Capital Expenditure	- 6.096	- 2.000	- 2.000	- 2.000	- 2.000	- 2.000
Change in Net Working Capital	3.480	- 935	- 3.015	- 977	- 896	- 355
Change in other Assets/Liabilities	- 3.239	3.130	- 1.456	582	- 130	216
Pro Forma Balance Sheet						
Net Working Capital	10.720	11.655	14.670	15.647	16.543	16.898
Net Fixed Assets	40.604	39.730	39.604	39.866	40.019	40.111
Other Assets/Liabilities	- 1.351	- 4.481	- 3.025	- 3.607	- 3.477	- 3.693
Net Capital Employed	49.973	46.904	51.250	51.906	53.085	53.316
Net Financial Position	18.669	11.646	8.024	- 424	- 9.136	- 18.635
Equity	31.304	35.258	43.226	52.330	62.221	71.951
Total Sources	49.973	46.904	51.250	51.906	53.085	53.316

To make the structuring of the *leveraged buy-out* profitable and enhance the target firm's performance in terms of generation of *Free Cash Flows from Operations*, the buyer-investor chooses to resort to two different interventions of post-merger ordinary management regarding the product strategy and the commercial relations area. The benefits of the first of these interventions are partially offset by a negative effect on the firm's financial management. Both the value creation initiatives aim at causing an EBIT improvement. The first action, which is financed with a short-term debt, enhances the technological content of the products provided by the organic solvents' business unit. Such an innovation action justifies a price increase and, hence, the Chemical Brothers' revenues are expected to grow because of the two virtuous effects on sales' volumes and prices. Such an intervention also determines an undirect effect on the commercial relations' side. By relying on greater sales' volumes, in fact, management can get a discount on the costs of raw materials from the firm's

main providers. More in detail, the incidence of raw materials' costs on revenues decreases from 24% to 22%. It results that both these actions cause an EBIT increase. Nevertheless, the revenues' growth produces an increase in the Net Working Capital, as, under the same conditions allowed to clients, Receivables and Inventories are also due to grow. The related cash absorption partially counterbalances the positive effects that are determined by an EBIT increase on the production of *Free Cash Flows from Operations*. The calculation of the operating cash flows shows what is mentioned above (figure 8):

Figure 8

Pro Forma Cash Flow	**2003**	**2004E**	**2005E**	**2006E**	**2007E**	**2008E**
(in thousands of Euro)						
EBIT	**6.046**	**11.090**	**16.264**	**17.935**	**19.009**	**19.914**
Taxes	- 1.762	- 3.270	- 5.191	- 5.912	- 6.471	- 6.968
EBIT (1-T)	**4.284**	**7.820**	**11.073**	**12.023**	**12.538**	**12.946**
Depreciation	3.451	2.874	2.126	1.738	1.847	1.908
Operating Cash Flow	**7.735**	**10.694**	**13.199**	**13.761**	**14.385**	**14.854**
Change in Net Working Capital	3.480	- 3.038	- 2.835	- 1.145	- 953	- 976
Capital Expenditure	- 6.096	- 2.000	- 2.000	- 2.000	- 2.000	- 2.000
Other Assets/Liabilities	- 3.239	3.130	- 1.456	582	- 130	216
Free Cash Flows from Operations	**1.880**	**8.785**	**6.909**	**11.198**	**11.301**	**12.094**

We now have to calculate the Adjusted Present Value of the target firm. The estimate is based on the following assumptions and computations regarding the cost of equity and the cost of debt:

Tax Rate	35,0%
Growth Rate	0,0%
Risk Free Rate	4,4%
Target Debt/Equity Ratio	60%
Unlevered Beta	0,56
Equity Risk Premium	5,4%
Unlevered Cost of Equity	9,8%
Cost of Debt	5,0%

The Adjusted Present Value is calculated in two steps. The first step consists in discounting back to 2003 for five years the unlevered operating cash flows and the Terminal Value at the unlevered cost of equity of 9,8%. The value we get to is the enterprise value of the target firm:

Post LBO Valuation	
PV of Free Cash Flows from Operations	34.331
PV of Terminal Value	70.414
Enterprise Value	**104.745**

The second step is concerned with the computation of the present value of the tax shield by discounting back the fiscal benefits and their Terminal Value in the year 2008 at the cost of debt (5,0%):

Interest Tax Shield		**2003**	**2004E**	**2005E**	**2006E**	**2007E**	**2008E**
Interests		1.013	1.747	1.434	1.043	520	5
Tax Shield		355	611	502	365	182	2
Discount Rate	5,0%						
PV of Tax Shield	**1.770**						
PV of Terminal Value	**27**						
Total Present Value of Tax Shield	**1.797**						

By adding the enterprise value and the present value of the interest tax shield, we obtain the Adjusted Present Value of the target firm, which represents the enterprise value of the levered firm itself:

APV	
Enterprise Value of the Levered Firm	104.745
PV of Interest Tax Shield	1.797
Total	**106.542**

If we want to estimate the equity value of the firm in terms of APV, we only need to subtract the present value of debt from the enterprise value, according to the known formula:

$$W_{equity} = \text{Enterprise Value } (W_{assets}) - D$$

$$= 106.542 - 38.452 = 68.090$$

Finally, if we want to highlight the contribution to corporate value creation of the business iniatitives carried out by the buyer-investor, we can start from the valuation of the target firm on the basis of the seller's plan (which does not include the execution of the *leveraged buy-out*) and get to the Adjusted Present Value by providing evidence of the contributive effects of each of the proposed managerial actions (figure 9):

Figure 9

Pro Forma Cash Flow		**2003**	**2004E**	**2005E**	**2006E**	**2007E**	**2008E**
(in thousands of Euro)							
EBIT		**6.046**	**6.840**	**12.750**	**14.197**	**15.241**	**15.038**
Taxes		- 1.762	- 2.129	- 4.291	- 4.902	- 5.326	- 5.239
EBIT (1-T)		**4.284**	**4.711**	**8.460**	**9.294**	**9.915**	**9.799**
Depreciation		3.451	2.874	2.126	1.738	1.847	1.908
Operating Cash Flow		**7.735**	**7.585**	**10.586**	**11.032**	**11.762**	**11.707**
Change in Net Working Capital		3.480	- 935	- 3.015	- 977	- 896	- 355
Capital Expenditure		- 6.096	- 2.000	- 2.000	- 2.000	- 2.000	- 2.000
Other Assets/Liabilities		- 3.239	3.130	- 1.456	582	- 130	216
Free Cash Flows from Operations		**1.880**	**7.780**	**4.115**	**8.638**	**8.736**	**9.568**
PV of Free Cash Flows from Operations	27.414						
PV of Terminal Value	55.574						
Unlevered Firm Value	**82.987**						
Value Creation Initiatives and Negative Effects:							
EBIT improvement							
Incremental EBIT			- 4.250	3.513	3.739	3.768	4.876
Taxes			- 1.487	1.230	1.309	1.319	1.707
Cash increment After Tax			- 2.762	2.284	2.430	2.449	3.169
PV of Annual Cash Increments	9.032						
PV of Terminal Value	18.455						
Total PV	**27.487**						
Net Working Capital Increase			- - 2.103	181	- 168	- 58	- 621
PV of Annual Cash Increments	- 2.114						
PV of Terminal Value	- 3.615						
Total PV	**- 5.729**						
Adjusted Present Value of the Target Firm	**104.745**						

As mentioned above, our aim is to show how the "Discounted Cash Flow" paradigm, which also includes the Adjusted Present Value methodology, is flawed and systematically underestimates the value of firm. We, then, proceed to perform a challenging valuation of the Chemical Brothers SpA by applying the Real Options Approach, as described in the second part of this paper.

First, we start from the Adjusted Present Value of the target levered firm, computed as enterprise value, which has to be subjected to the expansion *via* the use of real options. Such an enterprise value (€ 106.5 million) identifies the starting point of the related binomial event tree.

Second, we draw the dynamics of the enterprise value of the levered firm, acting as the underlying risky asset of the real options to be priced, by calculating the up and down movements along the binomial tree. To accomplish this, we need to identify the driver of uncertainty that makes, through the *Free*

Cash Flows from Operations, the enterprise value of the target levered firm the variable of state of the model. We assume that such an uncertainty driver is only represented by market uncertainty. We, then, exclude technical uncertainty, being such form of riskness the other potential driver of the evolution of a real option's underlying. Market volatility is composed by three different forms of uncertainty which influence the firm's *Earnings Before Interests and Taxes* (EBIT):

- price uncertainty;
- demand uncertainty;
- variable cost uncertainty.

By analysing the Chemical Brothers's business, we decide that, as well as considering variable cost uncertainty, price uncertainty and demand uncertainty can be well reflected and, thereby, consolidated in revenues uncertainty. Then, we decide to apply two different approaches in order to get the volatility of the target firm's enterprise value: a linear regression capturing the influence of revenues and variable costs on EBIT and a management assumption approach. The first one aims at computing volatility by comparing the target firm's results to the overall performance of its economic sector. Therefore, such an approach is constructed as an objective one. On the contrary, the second approach represents a more standard volatility estimation method in the Real Options Analysis and also a more involving one, as it is based on the management's assumptions. By comparing these two approaches, we obtain a very similar result, which supports the use of the volatility figure in our calculations.

With the first approach, we exploit the influence of revenues and variable costs (being these costs represented by raw materials' costs) on EBIT by estimating a regression of the former on the latter. The regression equation is the following:

$$y = \text{revenues } a_1 + \text{raw materials costs } a_2 + \varepsilon$$

The sample of the regression is composed by 60 firms (including the Chemical Brothers SpA) located in Lombardia (Italy) and belonging to the sector of collection and disposal of solid waste. The data used for the regression have been extracted from the 2001 financial reports of the firms. We find that revenues explain the EBIT generation for 99,3% and, as expected, the coefficient sign of raw materials' costs is negative. The table below shows the estimate of the regression equation:

			95% Confidence Interval for Coefficients	
Model	**Coefficients**	**t**	**Lower Bound**	**Upper Bound**
constant	-3,538	-3,828	-5,388	-1,687
a_1	1,127	8,129	0,849	1,404
a_2	-0,117	-1,419	-0,283	0,048

Market volatility has been calculated by taking the arithmetic mean of the upper and lower bounds of the 95% confidence interval of the significant coefficient of the regression (0,849 and 1,404) and this gives a σ equal to 1,1%.

The second approach to estimating volatility also relies on revenues and variable cost uncertainty, but as personally assumed by management. The target firm's management that revenues and variable costs follow an uniform distribution each with a given mean. In addition, management assumes that any expected value of revenues and variable costs over the five years ahead can fluctuate between given maximums and minimums. In other words, as the uniform distribution describes a situation where all the values between the minimum and

maximum are equally likely to occur, management believes that any expected value of revenues and variable costs in the given range has an equal chance of being both the actual revenues and variable costs. Revenue and variable cost streams we refer to are those leading to the expected EBITs as depicted in the Pro Forma Income Statements in figure 6 and are reported as follows (figure 10):

Figure 10

Pro Forma Partial Income Statements	**2003**	**2004E**	**2005E**	**2006E**	**2007E**	**2008E**
(in thousands of Euro)						
Revenues	48.427	61.883	72.417	77.985	82.621	87.340
Variable Costs	- 28.587	- 37.020	- 42.441	- 46.103	- 49.066	- 52.090
Fixed Costs	- 8.914	- 9.749	- 10.515	- 11.161	- 11.845	- 12.716
Leasing Rents	- 1.338	- 1.026	- 926	- 891	- 689	- 536
Depreciation and Amortization	- 3.542	- 2.998	- 2.271	- 1.894	- 2.012	- 2.083
EBIT	**6.046**	**11.090**	**16.264**	**17.935**	**19.009**	**19.914**

Hence, we perform a Monte Carlo simulation on each of the revenue and variable cost figures over the considered period by extracting random numbers from an uniform distribution, thereby obtaining the forecasted EBITs for each of the years involved. The trials used to run the Monte Carlo simulation are 10,000. The volatility estimate (σ) derives from computing the arithmetic mean of the coefficients of variability (standard deviation/mean) related to each of the Monte Carlo simulations performed. Therefore, if the EBIT simulations give the following set of mean, standard deviation and coefficient of variability:

Figure 11

Statistics	**2003 EBIT**	**2004 EBIT**	**2005 EBIT**	**2006 EBIT**	**2007 EBIT**	**2008 EBIT**
Mean	€ 6.300	€ 10.400	€ 16.200	€ 18.300	€ 18.200	€ 19.700
Standard Deviation	€ 6.500	€ 12.700	€ 19.200	€ 25.600	€ 32.400	€ 38.600
Coefficient of Variability	1,03	1,23	1,18	1,40	1,78	1,96

the resulting σ is 1,4%.

As it can be noticed, the two proposed approaches for estimating market volatility give a very similar result. It means that both objectively and subjectively assessed the relevant volatility falls within the given range. To be more conservative, we choose σ = 1,4% as the market volatility of the target firm.

Finally, we can compute the up and down movements by considering that the length of time between the tree nodes is one year:

$$u = e^{\sigma\sqrt{T}} = 4{,}18$$

$$d = 1/u = 0{,}24$$

As we will later apply the Risk-Neutral Probability Approach, we also calculate the risk neutral probabilities q = 0,20 and 1-q = 0,80. Now we are able to build the target firm's enterprise value tree (figure 10). For sake's simplicity, let us express, starting from now, all the data in € million.

Figure 12

2003	2004	2005	2006	2007	2008
					135.692,3
				32.472,4	
			7.770,9		7.770,9
		1.859,7		1.859,7	
	445,0		445,0		445,0
106,5		106,5		106,5	
	25,5		25,5		25,5
		6,1		6,1	
			1,5		1,5
				0,3	
					0,1

In order to estimate the value of the American financial default option, we have to consider the amortisation plan of the total debt contracted by the buyer-investor and exclude the short-term debt (€ 2.0 million), since the latter is borrowed to finance the product innovation project, thereby acting as the exercise price of the operating default option. The present values of the total financial debt are extracted from the resulting amortisation plan (see the table below).

Debt Amortisation Plan					
2003	**2004**	**2005**	**2006**	**2007**	**2008**
36,4	31,4	25,9	15,8	5,0	5,0

We proceed to calculate the value of the American default call option by carrying out a backward induction from the end-of-period nodes until the year 2006 (year 3), as the operating default option expires at year 2005 (year 2) (figure 13).

Figure 13

2003	2004	2005	2006	2007	2008
					max (135.692,3 - 5,0;0)= 135.687,3
				max (32.467,4;32.467,6)= 32.467,6	
			max (7.755,1;7.766,3)= 7.766,3		max (7.770,9 - 5,0;0)= 7.765,9
		1.859,7		max (1.854,7;1.854,8)= 1.854.8	
	445,0		max (429,2;440,4)= 440,4		max (445,0 - 5,0;0)= 440,0
106,5		106,5		max (101,5;101,7)= 101,7	
	25,5		max (9,7;20,9)= 20,9		max (25,5 - 5,0;0)= 20,5
		6,1		max (1,1;1,3)= 1,3	
			max (-14,3;0,3)= 0,3		max (1,5 - 5,0;0)= 0
				max (-4,7;0)= 0	
					max (0,1 - 5,0;0)= 0

We, then, estimate the present value of the American operating default call option in t_0 (PV (CV_0)) in order to assess the target firm's value also incorporating the price of the American financial default option (figure 14).

Figure 14

2003	2004	2005	2006	2007	2008
100,2	max (438,9-2,0;0) = 436,9 max (21,3-2,0;0) = 19,3	max (1.855,2-2,0;0) = 1.853,2 max (102,1-2,0;0) = 100,1 max (4,3-2,0;0) = 2,3	max (7.755,1;7.766,3) = 7.766,3 max (429,2;440,4) = 440,4 max (9,7;20,9) = 20,9 max (-14,3;0,3) = 0,3	max (32.467,4;32.467,6) = 32.467,6 max (1.854,7;1.854,8) = 1.854.8 max (101,5;101,7) = 101,7 max (1,1;1,3) = 1,3 max (-4,7;0) = 0	max (135.692,3 - 5,0;0) = 135.687,3 max (7.770,9 - 5,0;0) = 7.765,9 max (445,0 - 5,0;0) = 440,0 max (25,5 - 5,0;0) = 20,5 max (1,5 - 5,0;0) = 0 max (0,1 - 5,0;0) = 0

Additionally, we compute the value of the financial default option in t_0 (PV (ET_0)) by continuing the event tree illustrated in figure 13. Such a calculation is showed in figure 15.

Figure 15

2003	2004	2005	2006	2007	2008
104,0	max (413,6;440,8) = 440,8 max (-5,9;23,3) = 23,3	max (1.833,8;1.855,2) = 1.855,2 max (80,6;102,1) = 102,1 max (-19,8;4,3) = 4,3	max (7.755,1;7.766,3) = 7.766,3 max (429,2;440,4) = 440,4 max (9,7;20,9) = 20,9 max (-14,3;0,3) = 0,3	max (32.467,4;32.467,6) = 32.467,6 max (1.854,7;1.854,8) = 1.854.8 max (101,5;101,7) = 101,7 max (1,1;1,3) = 1,3 max (-4,7;0) = 0	max (135.692,3 - 5,0;0) = 135.687,3 max (7.770,9 - 5,0;0) = 7.765,9 max (445,0 - 5,0;0) = 440,0 max (25,5 - 5,0;0) = 20,5 max (1,5 - 5,0;0) = 0 max (0,1 - 5,0;0) = 0

Finally, we are able to compare the enterprise value incorporating the current value of the financial default option (PV (CV_0)), acting as the continuation value of the operating default option, to the present value of the financial default option (PV (E_{T0})). We find that PV (E_{T0}) is greater than PV (CV_0), which means that exercising the operating default option in t_0 is worth. That gives us the value of the compound option. In fact, we take the maximum between PV (CV_0) = € 100,2 million and PV (E_{T0}) = € 104,0 million, that is PV (E_{T0}). Such a value represents the *Expanded Equity Value* of the target firm:

Expanded Equity Value (Expanded W_{equity}) =
= Passive W_{equity} + Compound Option Value = € 104,0 mln

It follows that the Expanded Equity Value is greater than the Equity Value calculated by applying the Adjusted Present Value method:

Expanded Equity Value > Adjusted Present Value (W_{equity}) =

= € 104,0 mln > € 68,1 mln

If we want to determine the additional value provided by the adoption of the compound option in order to expand the passive equity value, we can subtract the latter from the resulting Expanded Equity Value:

Compound Option Value =
Expanded W_{equity} - Passive W_{equity} = € 104,0 mln - € 68,1 mln = € 35,9 mln

Therefore, the equity value of the target firm calculated as Adjusted Present Value is remarkably improved if the conventional methodology is integrated by the use of the Real Options Analysis. Value creation is due to the positive contribution of the compound option, whose value benefits from the efficient interaction between the financial default option and the operating default option. More specifically, in this particular case, the result that the buyer-investor has to reach by using the Real Options Approach is represented by a sound judgement about the expedience of the *leveraged buy-out* on the whole since it permits wealth creation, despite the untimely implementation of the product innovation strategy, which is implied by the immediate and too early exercise of the operating default option.

5. Conclusions

We can conclude that the valuation of a *leveraged buy-out* may be strongly enhanced when the flexibility, that the buyer-investor is willing to bring in managing the target firm through the post-merger value creation initiatives, is assessed by integrating the traditional Adjusted Present Value by means of the Real Options Approach. Such an integration results in the expansion of the Adjusted Present Value aiming at dynamically capturing each managerial course of action that leads the target firm towards a successful way out for the buyer-investor through the timely repayment of the financial and operating debt.

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