A COMPOUND-OPTION MODEL FOR THE VALUATION OF THE MANAGER'S INCENTIVE FEE AND ITS IMPACT ON THE MANAGER'S ADVERSE INCENTIVE.

by

Francesco M. Paris*

*University of Brescia. Department of Quantitative Methods. Contrada S.Chiara, 48/b. 25122 Brescia. Italy. Ph. +39-030-2988501. Fax +39-030-2400925. E-mail: paris@eco.unibs.it.

Key words: compound option; down and out call option, multicontingency option; incentive fees; moral hazard.

JEL classification: G 13, G 31, G 32.

Abstract

The shareholder-manager relationship in a firm traditionally raises a conflict of interests whose solution is costly and the costs, referred to as agency costs, are incurred by the shareholder.

Among many possible devices aimed to solve the aforementioned conflict, we concentrate on those related to the manager's compensation, in particular on the accounting-based bonus, otherwise known as incentive fee. Margrabe [1978] originally showed that an incentive fee can be priced as a call exchange option written on the realized manager's performance with respect to a benchmark assumed to be the strike price of the option itself. Kritzman-Rich [1998], with respect to an investment-manager, show that the Margrabe's model implies an adverse incentive for the manager to arbitrarily increase the risk of the investment portfolio; such an incentive can be substantially reduced by modelling the incentive fee as a multicontingency option accounting for a relative and an absolute performance measure at the same time.

We extend the Kritzman-Rich model to the case of a firm-manager and propose to transform it into a compound option model in order to adequately account for the option-like feature of the firm-capital, assumed to be our performance parameter. Our model allows for a separate analysis of the shareholder's and manager's incentives. We implement numerical simulations unambiguously showing that even a multiconditional incentive fee is unable to solve completely the shareholder-manager conflict of interests.

The seminal work by Jensen-Meckling [1976] focuses, among other things, on the shareholder-manager relationship in a firm and defines it as an agency relationship where the principal (the shareholder) must waste resources to align the agent's (the manager) behaviour with his own interests. The two subjects are usually characterized by different utility functions leading them to pursue alternative objectives (i.e. maximization of the firm-capital vs. maximization of the firm-value). There are many ways to enforce the alignment of the managers' actions with the shareholders' interests; all of them are costly and the enforcement costs are what Jensen-Meckling call "agency costs of capital". The minimization of the agency costs is one of the main goals of the firm-shareholders and is the result of a substantial solution of their conflict of interests with management.

The mechanisms aimed to remove the aforementioned conflict can be grouped into four main categories: a) management-participation to the firm-capital: as a shareholder, the manager is expected to have objectives converging with those of the other shareholders, b) management-control by the executive board: its effectiveness depends on the shareholders' power in the decision process implemented by the board itself, c) firm-acquisition and management-substitution: usually occurring when managers' behaviour has substantially eroded shareholders' wealth, d) management compensation. Within the last category fall three different alternatives, at least: i) wages' flexibility, allowing to reward good managers and to punish the bad ones; ii) stock options, which are exercised by managers if and only if the shares' value is sufficiently high; iii) accounting-based bonus which is a compensation indexed to some prespecified measure of performance and is the main objective of our study.

If the manager's incentive-fee is simply related to the difference between the realized firm-performance and an assigned benchmark (what we'll refer to as the relative performance), its value is given by the premium of a standard European exchange call option (see Margrabe [1978]) whose value is indefinitely increased by increasing the volatility of the realized performance-measure. This fact implies an adverse incentive (i.e. moral hazard) for the manager to arbitrary increase the riskiness of his investment choices. More recently Kritzman-Rich [1998] show that an incentive fee based on a double measure of performance, a relative performance together with an absolute performance (i.e. the realized performance must be at least equal to an assigned threshold), helps to mitigate the moral hazard problem. Such a compensation is called multiconditional incentive fee and can be priced as a multicontingency option whose value is related in many ways to the underlying's volatility. A variation of such a volatility, in fact, has a direct and ambiguous effect on the option-value, through the probability of the realized performance being higher than the threshold value, and two indirect effects through the volatility of the relative performance and the correlation between relative and absolute performance.

Kritzman-Rich consider the multiconditional incentive fee paid to an investment-manager; we extend this model to the case of a firm manager identifying the performance measure with the market value of the firm capital, which can be regarded as a part of the firm shareholders' wealth. The extended model leads to the same conclusions as the original one; we argue, however, that the option-like feature of the firm capital suggests a more appropriate way to price the incentive fee. We compute it as the premium of a compound call option written on a European down and out call whose underlying and strike price are, respectively, the current value of the firm assets and the face value of the firm debt. The barrier option represents the current market value of the firm-capital. The new approach to the fee-pricing problem enables us to study the incentives of the firm-shareholders and managers brought about by variations of three decision-variables which are the firm-assets' value, the firm debt's value and the volatility of the firm assets. While the incentives turn out to be almost perfectly aligned with respect to the first two variables, with respect to the firm-assets' volatility they are not. In particular, they are consistent with the traditional assumptions of risk-neutrality for the shareholder and risk-aversion for the manager, implying that a multiconditional incentive fee, if correctly priced, is not able to completely solve the shareholder-manager conflict of interests within a firm.

In section I we extend the Kritzman-Rich model to the case of a firm-manager; in section II we rephrase the fee's pricing problem in terms of a compound option model; in section III we analyze the shareholder's and manager's incentive according to the model developed in section II; section IV concludes.

I. ADAPTING THE KRITZMAN-RICH MODEL TO THE CASE OF THE FIRM MANAGER

In this section the model developed by Kritzman-Rich [1998] to compute the economic value of the state-contingent part of the investment-manager's fees is extended to the case of a firm-manager. As it will be shown, the main changes involve the variables employed in the model.

In this case the market values of the firm capital[1] are selected as the relative and absolute performance indicators. In particular $C_i(t)$ is the market value of the firm *i*'s capital at time *t*, $t \in [0, T]$, while $C^*(t)$ is the capital parameter[2] working as a benchmark.

The firm manager's incentive fee is set as a proportion, α, of the firm capital value exceding the benchmark $C^*(T)$ observed at time *T* (this is what we refer to as "relative performance"). The manager's compensation, however, is subject to the further condition that the market value of the firm capital at time *T* must be at least equal to a threshold *H* (such a condition is the one imposed on the "absolute performance" of the firm). In other words the value of the incentive fee, $F(T)$, at the expiration of the observed time interval, is as follows:

$$F(T) = \begin{cases} \alpha \max[C_i(T) - C^*(T), 0] & if \quad C_i(T) \geq H \\ 0 & if \quad C_i(T) < H \end{cases} \tag{1}$$

according to Kritzman-Rich [1998] the current economic value of the manager's compensation is the expected present value of (1) under the risk-neutral probability measure, which is:

$$F(t) = \alpha C_i(t) D_i^{-(T-t)} N_2(x_1, x_2, \rho) - \alpha C^*(t) D_i^{-(T-t)} N_2\left(x_1 - \sigma\sqrt{T-t}, x_3, \rho\right)$$

(2)

---

1 The choice of capital is based on the observed positive relationship of its market value with the economic performance realized by the firm-managers, other things being equal. Furthermore, the market value of capital is a significant measure of the firm-shareholders' wealth, therefore, an explicit analysis of the shareholder-manager conflict of interests can be developed by relating the shareholders' wealth to the managerial performance.

2 If $C_i(0) = C_i$ is the initial market vaue of capital, the benchmark can be defined as $C^*(t) = C_i(1+g)^t$, where *g* is the instantaneous average growth rate of the firm's industry.

where D_i is equal to 1+the payout rate of the shares underlying the firm capital, $N_2(c_1, c_{2,}\rho)$ is the bivariate standard cumulative normal distribution function with upper limits of integration c_1 and c_2 and correlation coefficient ρ, $x_1 = \frac{\ln[C_i(t)/C^*(t)] + \ln[1 + 1/2\sigma^2](T-t)}{\sigma\sqrt{T-t}}$, $x_2 = \frac{\ln[C_i(t)/H] + [\ln(R/D_i) + 1/2\sigma_i^2](T-t)}{\sigma_i\sqrt{T-t}}$, $x_3 = \frac{\ln[C_i(t)/H] + [\ln(R/D_i) + 1/2\sigma_i^2 + \sigma_i\sigma\overline{\rho}](T-t)}{\sigma_i\sqrt{T-t}}$, R is equal to 1+the risk-free rate and $\sigma^2 = \sigma_i^2 + \sigma^{*2} - 2\sigma_i\sigma^*\rho_{i,*}$ is the variance of the relative performance, while $\overline{\rho} = (\sigma_i - \sigma^*\rho_{i,*}/\sigma)$ is the correlation coefficient between absolute and relative performance.

Based on the thorough discussion and the formal proof developed by Kritzman-Rich in their appendix B, we conclude that the multicontingency device mitigates the adverse incentive of the manager to increase the capital volatility by choosing more risky investment projects. The reason is that the increase in σ_i related to this strategy has an impact on the value of the incentive fee which is unpredictable ex-ante[3].

II. MODELLING THE COMPOUND FEATURE OF THE INCENTIVE FEE

In our opinion, extending the Kritzman-Rich model to the case of the firm manager involves some peculiarities whose analysis allowes us to substantially improve the result reached in the previous section. First of all, the opportunity of expressing the market value of the firm capital as the premium of a barrier option, particularly a down and out call (see Chesney-Gibson [1994]), written on the firm-assets whose strike is the face value of the firm debt, must be recognized. This fact transforms the economic value of the incentive fee into the premium of an option that, even preserving the nature of an exchange option (see Margrabe [1978]), becomes a compound option (i.e. an option written on another option). This kind of analysis will give us the chance to capture the effect of changes in critical variables, such as the firm assets' value, the firm debt and the firm-

[3] Notice that the increase of the capital volatility has a direct effect on the value of the incentive fee, depending on the changed probability of the capital value exceding the threshold H, whose direction is ambiguous and, simultaneously, has two indirect effects through its impact on σ, the volatility of the relative performance, and on $\rho_{i,*}$, the correlation coefficient between absolute and relative performance. The indirect effects, sometimes offset the direct effect and sometimes magnify the direct effect.

assets' volatility, on the incentives related to the firm shareholders and to the firm managers, respectively, by exploiting the power of numerical simulations.

Let us start defining a compound call option as a call whose underlying is a standard European call option expiring at time *T*. The strike price *k* can be regarded as the premium due to purchase the underlying call at the expiration, τ, of the compound. The condition $\tau \leq T$ must obviously hold. According to the results derived in Geske [1979], the value of a compound call on a European call is given by the following equality:

$$Comp(t) = S_t e^{-d(T-t)} N_2(x, y, \rho) - K e^{-r(T-t)} N_2\left(x - \sigma\sqrt{\tau - t}, y - \sigma\sqrt{T-t}, \rho\right) - k e^{-r(\tau - t)} N\left(x - \sigma\sqrt{\tau - t}\right) \tag{3}$$

where S_t is the current value of the asset underlying the standard European call, *K* is the strike price of the standard European call, *d* is the instantaneous dividend yield of the asset *S*, *r* is the instantaneous risk-free rate of interest, σ is the std. deviation of the assets' return, *N(.)* is the univariate standard cumulative normal distribution function, $x = \frac{\ln\left[S_t e^{-d(\tau-t)} / X e^{-r(\tau-t)}\right]}{\sigma\sqrt{\tau-t}} + \frac{1}{2}\sigma\sqrt{\tau-t}$, $y = \frac{\ln\left[S_t e^{-d(T-t)} / K e^{-r(T-t)}\right]}{\sigma\sqrt{T-t}} + \frac{1}{2}\sigma\sqrt{T-t}$, $\rho = \sqrt{\frac{\tau-t}{T-t}}$ and *X* is the solution of the following equation[4]: $X_\tau e^{-d(T-\tau)} N(z) - K e^{-r(T-\tau)} N\left(z - \sigma\sqrt{T-\tau}\right) - k = 0$, where is $z = \frac{\ln\left[X_\tau e^{-d(T-\tau)} / K e^{-r(T-\tau)}\right]}{\sigma\sqrt{T-\tau}} + \frac{1}{2}\sigma\sqrt{T-\tau}$.

The underlying of the call on a call priced by (3) is the market value of firm *i*'s capital. Chesney-Gibson [1994] show that, under sufficiently standard assumptions, such a value can be expressed as the premium of a down and out call option written on the firm-assets and a strike equal to the face value of the firm debt. The down and out call is a standard European call vanishing as soon as the value of the underlying hits a prespecified floor, conveniently set, in this case, equal to $\hat{H}$, such that the condition $C_i(t) = H$ is met and *H* is the threshold value of the parameter of absolute performance already employed to define the incentive fee in (1)[5]. The current value of this barrier option is expressed by the following formula:

---

[4] X_τ can be interpreted as the value of the asset *S* making the compound call at the money, when expiring.

[5] Such a condition implies that $\hat{H}$ is the value of the firm assets that, given a fixed amount of debt, leads to the capital structure corresponding to the minimum acceptable market value of capital generating a positive incentive fee.

$$C_i(t) = A_i(t)N(x) - Be^{-r(T-t)}N\left(x - \sigma\sqrt{T-t}\right) - \left[A_i(t)\left(A_i(t)/\hat{H}\right)^{-2\xi} N(y) - Be^{-r(T-t)}\left(A_i(t)/\hat{H}\right)^{-2\xi+2} N\left(y - \sigma\sqrt{T-t}\right)\right] \tag{4}$$

where $A_i(t)$ is the current value of the firm *i*'s assets whose dynamic is described by the diffusion process: $dA_i/A_i = \mu dt + \sigma dz$, where *dz* is a standard Wiener process, *B* is the face value of the debt issued by firm *i*, assumed to be in the form of a zero-coupon bond expiring at time *T*[6], σ is the volatility, assumed constant, of the return on the firm *i*'s assets, $\xi = \frac{r}{\sigma^2} + \frac{1}{2}$, $x = \frac{\ln\left[A_i(t)/B\right]}{\sigma\sqrt{T-t}} + \xi\sigma\sqrt{T-t}$ and $y = \frac{\ln\left[\hat{H}^2/A_i(t)B\right]}{\sigma\sqrt{T-t}} + \xi\sigma\sqrt{T-t}$.

It is the case, at this point of the analysis, of pointing out the fact that the lower bound, *H*, imposed on the absolute performance to derive (2), affects the value of the down and out call whose barrier, $\hat{H}$, is set in such a way as to meet the aforementioned limiting value of the firm capital. Moreover, such a condition is more binding than the one on the absolute capital performance assumed by Kritzman-Rich to compute the incentive fee's value. In fact, the Kritzman-Rich condition has to be met just at the upper bound of the time interval, while our condition must be verified at any time $t \in [0,T]$[7]. Therefore, the incentive fee, instead of a multicontingency option, can be priced as a compound call on a European down and out call, preserving the feature of an exchange option[8] in order to capture the effect of the condition related to the relative performance of capital.

Based on (2), (3) and (4) and assuming no dividend distribution to the firm-shareholders (*d=0*), the current economic value of the incentive fee can be expressed as follows:

$$\begin{aligned} F(t) &= \alpha A_i(t)N_2(x_1, x_2, \rho) - \alpha Be^{-r(T-t)}N_2\left(x_1 - \sigma\sqrt{\tau-t}, x_2 - \sigma\sqrt{T-t}, \rho\right) + \\ &- \alpha\left[A_i(t)\left(A_i(t)/\hat{H}\right)^{-2\xi} N_2(y_1, y_2, \rho') - Be^{-r(T-t)}\left(A_i(t)/\hat{H}\right)^{-2\xi+2} N_2\left(y_1 - \sigma\sqrt{\tau-t}, y_2 - \sigma\sqrt{T-t}, \rho'\right)\right] + \\ &- \alpha C * e^{-r(\tau-t)}N\left(x_1 - \sigma\sqrt{\tau-t}\right) \end{aligned}$$

---

[6] Such an unrealistic hypothesis is usually handled by computing the modified duration of the real firm-debt structure and treating it as behaving like the modified duration of an equivalent zero coupon bond.

[7] It is easy to infer that the greater binding power of the modified condition has the effect of reducing the value of the incentive fee.

[8] Notice that the main characteristic of an exchange option (see Margrabe [1978]) is to have a time-varying strike, represented by the price of the asset sold.

(5)

where $x_1 = \frac{\ln\left[A_i(t)/A_i^{'}(t)e^{-r(\tau-t)}\right]}{\sigma\sqrt{\tau-t}} + \frac{1}{2}\sigma\sqrt{\tau-t}$, $x_2 = \frac{\ln\left[A_i(t)/Be^{-r(T-t)}\right]}{\sigma\sqrt{T-t}} + \frac{1}{2}\sigma\sqrt{T-t}$, $A_i^{'}(t)$ is the value of the firm *i*'s assets for which the incentive fee is zero at the time of its payment, τ, $y_1 = \frac{\ln\left[\hat{H}^2/A_i^{'}(t)B\right]}{\sigma\sqrt{\tau-t}} + \xi\sigma\sqrt{\tau-t}$, $y_2 = \frac{\ln\left[\hat{H}^2/A_i(t)B\right]}{\sigma\sqrt{T-t}} + \xi\sigma\sqrt{T-t}$ and $\sigma = \sqrt{\sigma_{A_i}^2 - 2\sigma_{A_i}\sigma_{C*}\rho_{A_i,C*} + \sigma_{C*}^2}$.

Equation (5) has the advantage of capturing the option-feature of the firm capital while accounting for the conditions both on the relative and absolute performance of the capital itself.

III. ANALYSIS OF THE SHAREHOLDER'S AND MANAGER'S INCENTIVES

The valuation of an incentive fee as a multicontingency option has the merit of reducing substantially the managers' adverse incentive to arbitrarily increase the riskiness of their investment choices in order to maximize the value of their compensation. What can we say about our new approach? Is the compound option model as effective as the multicontingency one in keeping under control the moral hazard problem?

First of all, we point out that our model allows for an explicit analysis of the incentives specifically referred to the firm *i*'s shareholders and managers originated by a change in one of the three following variables: the value of the firm assets, the value of the firm debt and the volatility of the firm assets[9].

The partial derivative of wealth, $C_i(t)$ for the shareholder and $F(t)$ for the manager, with respect to each of the aforementioned variables, can be interestingly interpreted as the size of the

[9] These are the main decision variables controlled by the firm-management. In particular, the volatility, as defined in (5), is not exactly the volatility of the firm-assets. It accounts also for the volatility of the time-varying strike of the compound call and the correlation coefficient between the two. Based on our definition of $C^*(t)$, as C_i continuously compounded at the industry's growth rate *g*, we could assume its volatility to be so small relative to the firm *i*'s assets' volatility to consider it equal to *0* (this is the case of the constant growth model). Consequently, $C^*(t)$ turns out to be uncorrelated with $A_i(t)$ and σ is exactly the volatility of firm *i*'s assets.

incentive. More specifically, we'll have an incentive if the partial is positive; if negative, it will measure a negative incentive.

The partials are as follows[10]:

for the shareholder

$$\frac{\partial C_i(t)}{\partial A_i(t)} = N(x) - \left[A_i(t)/\hat{H}\right]^{-2\xi}\left[N'(y)/\sqrt{T-t}\right] + Be^{-r(T-t)}\left[A_i(t)\right]^{-2\xi+1}/\hat{H}^{-2\xi}\left[N\left(y-\sigma\sqrt{T-t}\right)(2-2\xi) + \right.$$
$$\left. + N'\left(y-\sigma\sqrt{T-t}\right)/\sigma\sqrt{T-t}\right] > 0$$

$$\frac{\partial C_i(t)}{\partial B} = -e^{-r(T-t)}N\left(x-\sigma\sqrt{T-t}\right) - \left[A_i(t)/\hat{H}\right]^{-2\xi+2}\left[A_i(t)/B\hat{H}^2\, N'(y)/\sigma\sqrt{T-t} + \right.$$
$$\left. - e^{-r(T-t)}\, N'\left(y-\sigma\sqrt{T-t}\right)/\sigma\sqrt{T-t} - e^{-r(T-t)}N\left(y-\sigma\sqrt{T-t}\right)\right] < 0$$

$$\frac{\partial C_i(t)}{\partial \sigma} = A_i(t)N'(x)\sqrt{T-t} - \left\{\left[A_i(t)/\hat{H}\right]^{-2\xi} A_i(t)N'(y)\sqrt{T-t} + \left[A_i(t)/\hat{H}\right]^{-2\xi}\ln\left[A_i(t)/\hat{H}\right]\left(4r/\sigma^3\right)\times\right.$$
$$\left.\times\left[A_i(t)N(y) - Be^{-r(T-t)}\left[A_i(t)/\hat{H}\right]^2 N\left(y-\sigma\sqrt{T-t}\right)\right]\right\} > 0$$

for the manager

---

[10] Notice that the signs of the partial derivatives, both for the shareholder and the manager, are verified within the ranges of values of the independent variables considered by the numerical simulations developed in what follows.

$$\frac{\partial F(t)}{\partial A_i(t)} = N_2(x_1, x_2, \rho) - \left[A_i(t)/\hat{H}\right]^{-2\xi}\left[N'_2(y_1, y_2, \rho')/\sigma\sqrt{\tau - t} + (1-2\xi)N(y_1, y_2, \rho')\right] +$$
$$+ Be^{-r(T-t)}\left[A_i(t)\right]^{-2\xi+1}/\hat{H}^{-2\xi+2}\left[(2-2\xi)N_2\left(y_1 - \sigma\sqrt{\tau - t}, y_2 - \sigma\sqrt{T-t}, \rho'\right) +\right.$$
$$\left.+ N'_2\left(y_1 - \sigma\sqrt{\tau - t}, y_2 - \sigma\sqrt{T-t}, \rho'\right)/\sigma\sqrt{\tau - t}\right] > 0$$

$$\frac{\partial F(t)}{\partial B} = -e^{-r(T-t)}N_2\left(x_1 - \sigma\sqrt{\tau - t}, x_2 - \sigma\sqrt{T-t}, \rho\right) - \left[A_i(t)/\hat{H}\right]^{-2\xi+2}\left[A_i(t)/B\hat{H}^2\, N'_2(y_1, y_2, \rho')/\sigma \times\right.$$
$$\times\left(1/\sqrt{\tau - t} + 1/\sqrt{T-t}\right) - e^{-r(T-t)}N_2\left(y_1 - \sigma\sqrt{\tau - t}, y_2 - \sigma\sqrt{T-t}, \rho'\right) +$$
$$\left.- e^{-r(T-t)}\, N'_2\left(y_1 - \sigma\sqrt{\tau - t}, y_2 - \sigma\sqrt{T-t}, \rho'\right)/\sigma\left(1/\sqrt{\tau - t} + 1/\sqrt{T-t}\right)\right] < 0$$

$$\frac{\partial F(t)}{\partial \sigma} = A_i(t)N'_2(x_1, x_2, \rho)\sqrt{T-t} - \left\{A_i(t)\left[A_i(t)/\hat{H}\right]^{-2\xi} N'_2(y_1, y_2, \rho') + \left[A_i(t)/\hat{H}\right]^{-2\xi}\ln\left[A_i(t)/\hat{H}\right]\left(4r/\sigma^3\right) \times\right.$$
$$\left.\times\left[A_i(t)N_2(y_1, y_2, \rho') - Be^{-r(T-t)}\left[A_i(t)/\hat{H}\right]N_2\left(y_1 - \sigma\sqrt{\tau - t}, y_2 - \sigma\sqrt{T-t}, \rho'\right)\right]\right\} +$$
$$- C_a e^{-r(\tau-t)}N'\left(x_1 - \sigma\sqrt{\tau - t}\right)\ln\left[A_i(t)/A'_i(t) \times e^{-r(\tau-t)}\right]/\sigma\sqrt{\tau - t} - 1/2 \times \sqrt{\tau - t} > 0$$

Our results immediately show that the signs of the incentives are always the same both for shareholders and managers. Nonetheless, such an observation is not sufficient to conclude that there is no conflict of interests between the two. A more credible answer could consider the magnitude of the incentives and, moreover, the relationship between magnitude changes and changes of the decision variables. This is the reason why we proceed to a numerical estimation of the incentives' variations. Here are the values assigned to the exogenous variables: $A_i=100$, $A_i'=90$, $B=80$, $\hat{H}=10$, $\sigma=0.2$, $r=0.1$, $C^*(t)=85$, $T-t=5$, $\tau-t=4$, $\rho=(0.8,0.6,0.3)$ and $\rho'=(0.75,0.55,0.4)$. The results are plotted in figures 1 to 3 and can be easily interpreted.

FIGURES 1,2 and 3

The shareholder's and manager's incentives entailed by an increase of the firm assets and the disincentives (i.e. a negative incentive) related to an increase of the firm debt are substantially aligned. With respect to the volatility of the firm assets the two incentives follow completely different paths. The shareholder's incentive is initially increasing up to a maximum and then decreases while the manager's incentive is smaller and monotonically decreasing. The last result must be carefully considered. It implies that the benefit to the manager coming from an increase of the firm assets' volatility translates into an even greater advantage for the shareholder; this is true up to volatility's values corresponding to a virtually null incentive of the manager. For a larger volatility the manager has no incentive while the shareholder is still interested to push up the riskiness of the firm investments. This fact has two main implications: a) in the case of a firm manager, his attempt to increase the investment-risk does not raise any moral hazard problem because this is the same kind of choice made by the shareholder; b) for sufficiently high volatility values, the risk-taking incentive of the manager vanishes and his investment choice becomes too conservative for the value maximizer shareholder. The last phenomenon is particularly evident in firms engaged in highly risky activities (e.g. project finance, high tech., ecc.). These are firms where a multiconditional incentive fee is unable to solve the shareholder-manager conflict.

Our results seem to be globally consistent with the assumptions, traditionally accepted by the corporate literature, of risk neutrality of the firm-shareholder and risk aversion of the firm-manager.

With respect to the correlation coefficients involved in the bivariate standard cumulative normal distribution functions in (5), they play a marginal role. In all cases their reduction leads to a misalignment of the incentives whose entity is absolutely negligible. A more substantial misalignment can be obviously reached reducing the size of the multiplicative coefficient α (assumed equal to 1 in our simulations), indicating the rate of participation of the manager to the shareholder's gains. In both cases, however, the curves related to the manager's incentive shift, while their slopes remain practically unchanged. This fact implies that neither the correlation coefficients nor the coefficient α can significantly modify the resolution given to the shareholder-manager conflict of interests by the compound option model applied to the computation of the manager's incentive fee.

IV. CONCLUSIONS

The main objective of this paper is to investigate how effective is a compensation scheme based on an incentive fee in solving the conflict of interests characterizing the agency relationship between the firm shareholder and the firm manager.

Our argument is that the model developed to compute the manager's compensation has a substantial impact on the effectivness of the incentive fee as a device to solve the aforementioned conflict.

Kritzman-Rich [1998] present a multicontingency option model and show its ability to mitigate the moral hazard characterized by the behaviour of an investment manager whose objective is to maximize his/her compensation. We extend the same model to the case of a firm manager defining an absolute and relative performance conditions related to the market value of the firm-capital. The option-like feature of the firm-capital suggests us to rephrase the fee's valuation problem into the more appropriate terms of a compound option model: more specifically, a compound call on a down and out call representative of the firm capital. Such a model preserves the exchange option nature of the incentive fee and has the advantage to allow for an explicit and separate analysis of the shareholder's and manager's incentives with respect to three decision variables, at least: the value of the firm assets, the value of the firm debt and the value of the firm assets' volatility. Our results come from numerical simulations run on the variations of the incentives measured by the partial derivatives of the shareholder's and manager's wealth with respect to each of the aforementioned variables.

As to the firm assets and debt values, the compound option model leads to a very good alignment of the respective incentives, substantially solving the agency problem. With respect to the assets' volatility the manager's moral hazard is shown to be non existent, while the manager's investment strategy turns out to be too conservative, in cases of extremely high assets' volatility, to allow the maximization of the market value of the firm capital. This fact leads us back to the traditional agency problem whose solution is still a relevant subject for future research.

Shareholder\manager incentive with respect to the firm-assets

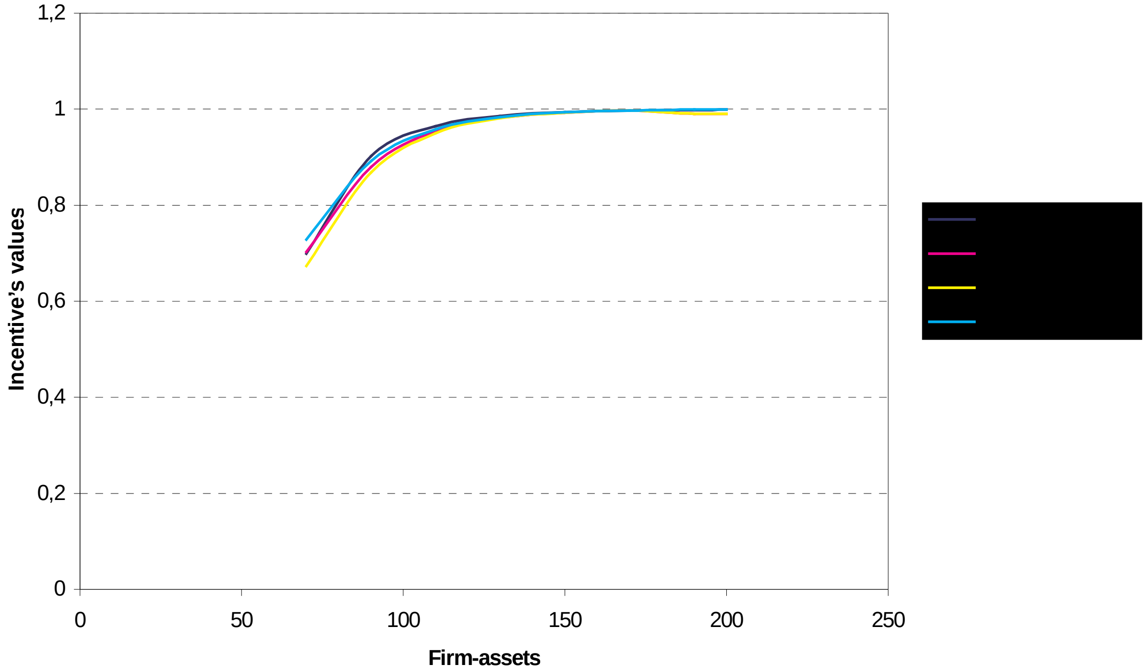

Figure 1

Shareholder\manager incentive with respect to the firm-debt

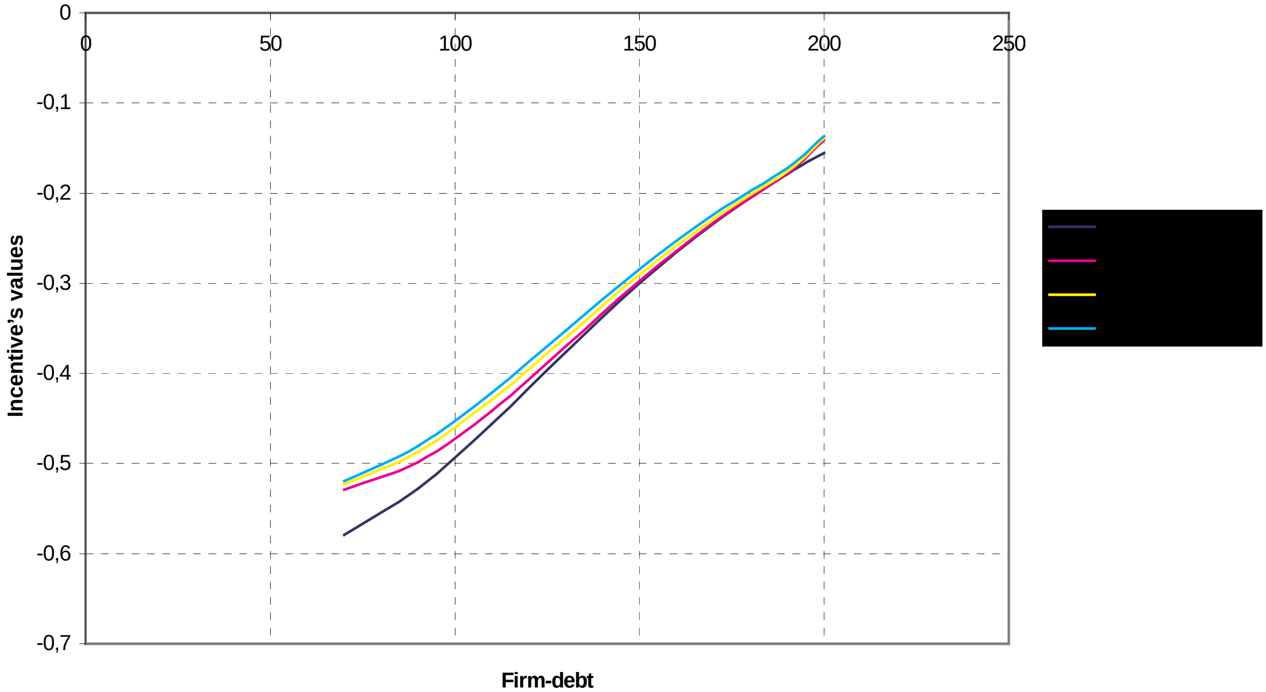

Figure 2

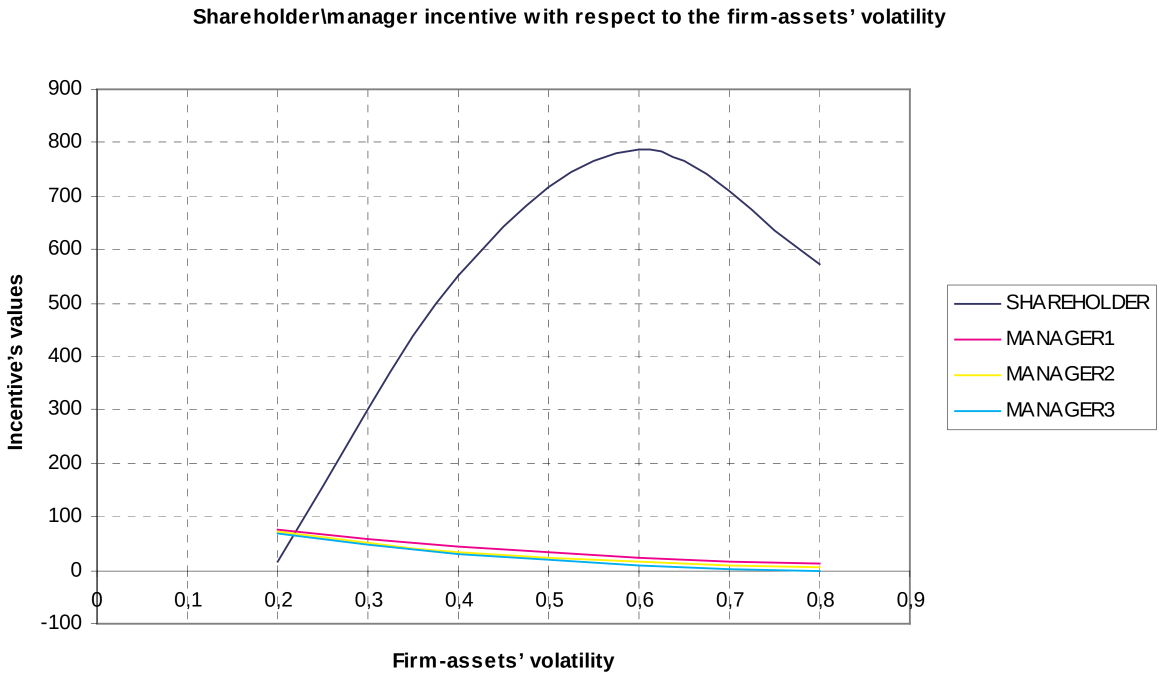
Shareholder\manager incentive with respect to the firm-assets' volatility
900
800
700
600
500
400
300
200
100
0
-100
Incentive's values
0
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
Firm-assets' volatility
SHAREHOLDER
MANAGER1
MANAGER2
MANAGER3

Figure 3

References

Bailey, J. "Some Thoughts on Performance-Based Fees." *Financial Analysts Journal*, July-August 1990, pp.31-40.

Baker, G.P., M.C. Jensen, and K.J. Murphy "Compensation and Incentives: Practice vs. Theory." *The Journal of Finance*, September 1988, pp.593-616.

Black, F., and M. Scholes "The Pricing of Options and Corporate Liabilities." *Journal of Political Economy*, vol.81, pp.637-654.

Byrd, J., R. Parrino, and G. Pritsch "Stockholder-Manager Conflicts and Firm Value." *Financial Analysts Journal*, January-February 1998, pp.14-30.

Chesney, M., and R. Gibson "The Investment Policy and Pricing of Equity in Levered Firms: a Reexamination of the Contingent Claims' Valuation Approach." Working Paper, IBFM, Lausanne University, 1994.

Chesney, M., and R. Gibson "Option Pricing Theory, Security Design and Shareholders' Risk Incentives." Working Paper, IBFM, Lausanne University, 1994.

Geske, R. "The Valuation of Corporate Liabilities as Compound Options." *Journal of Financial and Quantitative Analysis*, November 1977, pp.541-552.

Geske, R. "The Valuation of Compound Options." *Journal of Financial Economics*, vol.7 (1979), pp.63-81.

Grinold, R., and A. Rudd "Incentive Fees: Who Win? Who Loses?" *Financial Analysts Journal*, January-February 1987, pp.27-38.

Holmstrom, B. "Moral Hazard and Observability." *Bell Journal of Economics*, vol.10 (1979), pp.74-91.

Jensen, M.C., and W. Meckling "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure." *Journal of Financial Economics*, vol.4 (1976), pp.305-360.

Jensen, M.C., and K.J. Murphy "Performance Pay and Top Management Incentives." *Journal of Political Economy*, vol.98 (1990), pp.225-264.

Kritzman, M.P. "Incentive Fees: Some Problems and Some Solutions." *Financial Analysts Journal*, January-February 1987, pp.21-26.

Kritzman, M.P., and D. Rich "Risk Containement for Investors with Multivariate Utility Functions." *The Journal of Derivatives*, Spring 1998, pp.28-44.

Main, B. "Top Executive Pay and Performance." *Managerial and Decision Economics*, vol.12, pp.219-229.

Margrabe, W. "The Value of an Option to Exchange One Asset for Another." *The Journal of Finance*, March 1978, pp.177-186.

Merton, R.C. "On the Pricing of Corporate Debt: the Risk Structure of Interest Rates." *The Journal of Finance*, June 1974, pp.449-470.

Merton, R.C. "Theory of Rational Option Pricing." *Bell Journal of Economics and Management Science*, vol.4 (1973), pp.141-183.

Record, E., and M. Tiynan "Incentive Fees: the Basic Issues." *Financial Analysts Journal*, January-February 1987, pp.39-43.

Rich, D., and R. Leipus "Financial Contracting in the Presence of Multiple Indenture Provisions: an Option Pricing Framework." *Advances in Futures and Options Research*, 1997, pp.1-36.

Ross, S. "The Economic Theory of Agency: the Principal's Problem." *American Economic Review*, May 1973, pp.134-139.

Rubinstein, M. "On the Accounting Valuation of Employee Stock Options." *The Journal of Derivatives*, Fall 1995, pp.8-24.

Selby, M., and S. Hodges "On the Evaluation of Compound Options." *Management Science*, March 1987, pp.47-55.