Stock Options and Managers' Incentives to Cheat

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Abstract

In this paper, we use a continuous-time contingent claims framework to study managers' incentives to cheat in the presence of equity-based compensation policies. When we consider a fully predictable legal process, we observe that managers will always have incentives to engage in illicit activities. The exercise of the option to cheat will be postponed if the corruption costs or if the manager's reputational loss increases.We further show that managers incentives to cheat are delayed and can even be eliminated when the legal settlement date is non- predictable. An important result is that managers will always cheat sooner with stock options than with a cash equivalent remuneration consisting of stocks. Finally, we propose a new remuneration package that consists of both long calls and short puts written on the firm 's stocks in order to reduce managers incentives to cheat.

JEL Classification: G13, G30

Key words: executive compensation, fraud, incentives, stock options.

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1 Introduction

Recent corporate scandals where firms like Enron,Waste Management Inc,Worldcom, Xerox and others have used various accounting mechanisms and financial engineering strategies to disguise their actual profits or leverage levels have raised doubts about the ethical standards of corporate managers. More specifically, in the case of Enron, managers used off-balance sheet entities to improve the company's results and to hide its debt, overstating its net income by 744 million dollars. In the case of Waste Management Inc., managers falsified and misrepresented the financial results, which led to a restatement of the company's earnings of about 1.7 billion dollars. Even more dramatic is the case of Worlcom which led to falsified earnings of almost 10 billion dollars. Finally, by prematurely recognizing its revenues, Xerox ovestated its pre-tax earnings by 1.5 billion dollars. The popular press has often related this behavior to managers compensation policies especially when they consist of stock or stock option compensation plans. Indeed, under such remuneration policies, the manager has a strong incentive to see the stock price of the firm increase and, depending on the length of the vesting period, the manager may have a direct interest in a short - term stock price increase.These recent corporate scandals history suggests that some managers are willing to cheat about the true financial health of the firm in order to boost their firms' performance figures. Is this tendency exacerbated when managers receive stock option rather than pure stock compensation policies ? This is the main question addressed in this study.

We rely on a contingent claims continuous - time framework to examine the impact of stock and stock option based - remuneration policies on managers incentives to cheat. Contrarily to the remaining literature in the field, we do not attempt to model the influence of performance - based remuneration policies on managers effort levels and risk-taking behavior since these are widely explored research areas. We concentrate on firms where managers receive equity or stock options based compensations. We start by studying the manager's incentives to cheat and characterize his decision to engage in illicit -for instance, accounting - activities as an option to cheat. We then value this option and examine the manager's optimal exercise policy. In our model, we assume that the illicit activity of the manager will lead to an increase in the stock expected returns. However, engaging in that illicit activity is not free since we consider corruption costs as well as the possibility that the manager may lose part or all of his reputation if he is convicted. For pedagocial reasons, we assume in a first stage that the duration of the legal process leading to the manager's conviction is known with certainty.The model is then extended to the more realistic case of a non-fully predictable legal settlement process. This allows us to tackle our main objective, that is, to assess whether the specific form of an equity-based compensation policy does influence the manager's decision to cheat. More precisely, we examine whether stock options increase managers' incentives to cheat relative to stocks and thus induce managers to exercise their option to cheat earlier. Finally, we investigate potential security design mechanisms that could reduce a manager's willingness to cheat while preserving the stock options in the manager's remuneration package for their desirable incentives. For that purpose, we propose an equity-based compensation package that consists of long stock options and of a specific type of puts shorted by the manager. The latter puts, written on the company's stocks, would only be activated when the manager is convicted and their value can be perceived as an "honesty discount".

The question of how to design an efficient remuneration contract that will induce the manager to exercise best efforts and thus maximise the economic value for the shareholders is at the core of the compensation literature. In this context, an important stream of the literature has examined the impact of the form of the compensation contract on the managers' incentives (Holmstrom (1979) and argued that compensation should be linked to corporate performance (Smith (1996)). There is still ample debate as to whether prevailing remuneration contracts are indeed efficient (for an excellent survey on the issue see Core, Guay and Larcker (2003)) and consistent with the classical principal-agent efficient contracting model (see Dittmann and Maug (2003)). Dittmann and Maug have shown that the latter model is unable to explain the high level of stock options in existing executive compensation contracts. Indeed, according to a recent study on 13500 US executives active in all major industrial sectors during the year 2002, Watson Wyatt observe that these managers received a 3 million US dollars average stock option pay in contrast to a 843 000 US dollars average total cash pay.The widespread use of stock options has also been advocated as a manner to add convexity to the manager's remuneration scheme and thus to induce him to behave in a less risk-averse manner (Carpenter, (2000)).This risk steering property of stock option contracts has been corroborated in a study by Guay (1999) but is challenged by the recent theoretical study by Ross (2004) who shows that the risk - taking behavior of the manager is in particular affected by the wealth effect induced by the options. A more technical stream of that literature is devoted to valuation issues and focuses in particular on the correct methodology to use in order to value stock options given that they have hedging restrictions (see Huddart (1994), Marcus and Kulatilaka (1994) and Carpenter (1998)) or that the manager holds an imperfectly diversified portfolio as a consequence of his equity-based remuneration (Ingersoll (2002)). As shown by Lambert and Larcker, and Verrecchia (1991), a manager with a power utility function will, due to the structure of his wealth, value his stock options for less than 50 % of the Black and Scholes predicted value. Finally, as stated by Guay and al (2003), there is presently no theoretical consensus on how managerial compensation might affect firms' performance and the same applies to empirical studies in this area due perhaps to their endogeneity problem.

All these studies have so far assumed that managers are honest and that they would not breach the legal environment in which the firms operate to increase their wealth. However, a more recent stream of the accounting and finance literature focuses on the relationship between managerial compensation and earnings manipulation and more generally, fraud. In this context, we can cite Kedia (2003) who finds that firms with large negative stock price reactions to firms accounting restatements have 50 % greater numbers of options than matched control firms. The empirical study by Johnson, Ryan and Tian (2003) is the most closely related to our problem. These authors examine whether there exist a relationship between equity-based executive compensation and fraud defined as accounting fraud. Their empirical results, based on a sample of 2504 firms and a total of 43 fraud events during the period 1992 to 2001, suggest that managers who commit illegal actions have significantly higher equity-based compensation than managers in control matching firms. Furthermore, they show that managers in those fraudulent firms earn higher compensation by exercising a larger fraction of their vested options during the fraud period. The median fraud year being equal to two years. Interestingly, they also find that these fraudulent firms are concentrated in some specific industries such as prepackaged computer software or catalog and mail order retail that are characterized by higher growth opportunities. This is a serious drawback of equity-based compensation packages given that the latter were originally aimed at aligning managerial interests in firms with high growth opportunities. These new empirical results highlight a new externality associated with equity - based compensation policies, namely their potential to induce managers to behave at the frontiers of the law and even beyond. This is a rather preoccupying statement in light of the significant increase of this type of compensation over the past decade.

The contingent claims model developed in this study aims at filling an important gap in the literature, namely to characterize the relationship between managerial incentives to engage in illicit activities and the form of the manager's remuneration contract. One interesting feature of our framework is that it uses both real and financial options to model the manager's decision making process under stock market risk and under legal uncertainty. Indeed, the decision to cheat is a real option in our framework that influences the way in which the manager will further exercise his stock options. This shows that real options analysis can be extended to value individuals flexibility to engage in illicit financial activities. Another interesting feature of our model is that it allows us to examine the impact of the manager's reputation and of corruption costs on his incentives to cheat. Furthermore, we can discuss the relationship between the legal system's efficiency in handling corporate fraud and the manager's incentives to cheat. Given the lack of observable data on the subject, we rely on numerical simulations to illustrate our model's predictions. The main findings of this study can be summarized as follows: First, when the legal settlement process is not fully predictable, there will be an honesty region - where the manager will never engage in illicit activities. This region is defined with respect to the efficiency of the justice as proxied by the expected length of time it takes to convict the manager.The honesty region corresponds to a legal settlement process with a short average expected duration that we can thus associate to an efficient legal system. When the legal system is inefficient, the manager has incentives to engage in illicit activities and the latter will be higher in the presence of low corruption costs and of a modest reputational loss. Secondly, we show that for an equivalent dollar amount of stock and stock options, the stock options will exacerbate the managers incentives to cheat under a random legal settlement process. This is a very important result since it suggests that proper corporate governance, especially in inefficient jurisdictions should favor the issuance of stocks rather than stock options from the perspective of the shareholders and of society given that ultimately, they both have to bear the costs of managerial fraud. Finally, we examine whether alternative compensation packages can reduce managers' incentives to cheat under a random legal settlement process. We show that the honesty region can be extended by introducing short puts into the stock option based compensation package. The puts that we propose to introduce in the managers' compensation package can thus be viewed as an "honesty discount". Indeed, such a security design mechanism is intended to lower the externalities related to fraud for society by making it more costly for the manager to engage in illicit activities.

The structure of the paper is the following: in section 1, we present the main assumptions used in our framework. In the second section, we derive the manager's optimal decision to engage in illicit activities when his compensation consists of stock options and assuming that the legal settlement process is fully predictable. In section 3, the latter analysis is extended to the case where the manager receives common stocks rather than stock options. Section 4 extends the analysis of the stock option compensation package to a world where the legal settlement process is not fully predictable. In section 5, we compare the managers incentives to cheat under both remuneration policies. Section 6 focuses on security design and on the potential role of short puts defined as "honesty puts " in reducing the managers' incentives to cheat. Finally, we conclude in section 7 by raising potential extensions of the current study.

2 Main Assumptions

The purpose of this study is to compare the effects of alternative equity-based remuneration policies on the managers' incentives to engage in illicit activities on behalf of the firm. We will consider two cases. First, the case where the manager is compensated with stock options and secondly the case where he is compensated with common stocks.

We assume in both cases that the firm is run by a single risk - averse manager.

Case A: The manager has already received m stock options at time t_0 that he cannot exercise before date t_1.The idea is that most options compensation plans have a vesting period during which the manager cannot exercise or sell his options. We chose to initiate his decision making period at the end of this vesting period in order to simplify the analysis. These stock options are of the American type, have a strike price equal to K and for simplicity we will assume that they have a perpetual maturity.[1] Until date T_1, this firm undertakes a perfectly licit activity and the value of the firm's stock S_t is characterized by the following dynamics:

$$\frac{dS_t}{S_t} = \mu_1 dt + \sigma dW_t \tag{1}$$

for

$$t \in [t_1, T_1]$$

where $(W_{t,}\ t \geq 0)$ is a P-Brownian motion and P denotes the historical probability. The parameters μ_1 and σ that respectively denote the instantaneous mean and volatility of the stock returns are constant. T_1 denotes the date at which the manager will engage in illicit activities.This random variable will later be modelled as a stopping time.

After date t_1, the manager has the option to engage in an illicit activity that will alter the stochastic process followed by the firm's stream of instantaneous revenues. We will assume that by pursuing an illicit activity, the manager can fool the market by announcing news that lead to an increased drift of the stock price process. Johnson, Ryan and Tian (2003) provide an interesting appendix illustrating the variety of fraudulous accounting mechanisms that US firms in their sample used to artificially inflate their stock prices. Let us just remember a few revealing examples: Enron used special purpose vehicles to improve results and hide debts, leading to an overstated income of 744 million dollars. In the case of Bank of America, the firm incorrectly treated equity investment as a loan, resulting in a write-down of 372 million dollars. Finally, Waste Management falsified and misrepresented its financial results which led to a 1.7 billion dollars restatement of its earnings.

We will thus write the modified stock price process as follows:

$$\begin{aligned} \frac{dS_t}{S_t} &= \mu_2 dt + \sigma dW_t \\ t &\in [T_1, T_1 + \Delta T] \end{aligned} \tag{2}$$

where $\mu_2 \geq \mu_1$ and $T_1 + \Delta T$ denotes the date at which the manager is caught by the legal authorities in his juridiction. Thus, ΔT represents the total length of time it takes for the justice to settle the fraudulous case associated with the manager's behavior and is thus a measure of the inefficiency of the legal system prevailing in a specific country.

In reality, ΔT is not known with certainty. However, in the first part of this study we will assume that ΔT is constant for pedagogical reasons. Indeed, it will allow us to already define the main features of the option to cheat in a simple framework that will be further extended to a non-predictable legal settlement date in section 5.

[1]The reasons for using perpetual options are twofold. First, it makes the model more tractable without affecting our main results. Secondly, we know that longer maturity options are supposed to better align managers and shareholders incentives in the absence of fraud.

There is a cost associated with the exercise of this option to shift in the illicit domain. This cost denoted by C consists of all the corruption costs borne by the manager, that is, costs dedicated to the creation of illegal off-shore SPV's or trusts, costs associated with false communication to the analysts or to the auditors, costs associated with bribery, etc.. We will assume that the discounted stream of all corruption costs denoted by C is a constant.

At date $T_1+\Delta T$, we will assume that the public discovery of the legal settlement of the manager's illicit activity leads to a dramatic drop in the drift of the stock price. Indeed, in their study, Palmrose, Richardson and Scholz (2001) document a two - day excess return of - 20 % following fraud based restatements.We can thus write the modified stock price process when the fraud is publicly discovered as follows:

$$\begin{aligned} \frac{dS_t}{S_t} &= \mu_3 dt + \sigma dW_t \\ t &\in [T_1 + \Delta T, +\infty [\end{aligned} \tag{3}$$

The new drift parameter μ_3 is such that $\mu_2 \geq \mu_1 \geqslant \mu_3$.

The manager is risk averse and his discount factor is denoted by ρ with $\mu_2 \geq \rho \geqslant \mu_1$. His total wealth at date T_1 consists of his stock option in the licit world and of his option to cheat.[2] Since we are interested in studying the manager's incentives to engage in illicit activities, we will consider a reduced - form optimization problem focusing on the maximisation of the expected discounted utility of the payoff generated by the manager's option to cheat. At date $t \in [t_1, T_1]$, the latter can be viewed as a compound exchange call option. Indeed, the compound call option is actually an exchange call option that gives the manager the right to exchange his "licit" stock option for an "illicit"[3] stock option. Thus, the compound option is actually an exchange option that can upon exercise trade a licit underlying stock option for an illicit one. The value of the compound call option at date T_1 depends on the value of the m stock options SOI_{T_1} he will own provided that he engages in illicit activities less the costs of exercising his compound option. These costs consist of three components: first, the value of those m options had he pursued a licit activity $(m \cdot SOL_{T_1})$, second, the total costs of corruption C and finally the expected discounted reputational loss $EDRL$ that he incurs when he will be convicted. More formally at date T_1:

$$U = U(mSOI_{T_1} - (mSOL_{T_1} + C + EDRL\ )) \tag{4}$$

[2]Note that considering other sources of wealth in our model will not change its main results due to the fact that we assume that the manager maximized the expected discounted utility of his wealth differential in order to focus more precisely on the option to cheat ..

[3]The terms "licit" and "illicit" refer respectively to the case where the manager does not engage in a fraudulous activity and the one where he engages in an illegal activity in order to increase the payoff of his stock options.

Theoretically, an individual's reputation is neither a quantifiable nor, in general, a tradable asset (see, in particular,Tadelis (2001))[4]. However, for the purpose of this study, we shall assume that reputation has an agent specific monetary value and that the manager is endowed with a reputational capital A at date t_0.This reputational capital results from his capitalised good behavior in previous jobs and is supposed to be constant thereafter. The reputational loss $EDRL$ that arises if he engages in illicit activities and is convicted is equal to $\eta A e^{-\rho \Delta T}$. In other words he looses a constant fraction of his reputational capital when he is convicted at date $T_1 + \Delta T$.

Thus, we can write:

$$EDRL = \eta A e^{-\rho \Delta T}$$

with $1 \geqslant \eta \geqslant 0$ denoting the reputational cost fraction that reduces his reputational capital when he is convicted. The loss parameter η consists of two components, an external one that is driven by the market for this specific type of managerial positions and a second one which is specific to the agent and determined by his ethical values.

Hence, assuming that the manager has a power utility function with coefficient $\alpha, \alpha \in [0,1]$, we can write his optimisation problem as follows:

$$\sup_{T_1} E_{t_1}[e^{-\rho(T_1-t_1)}(mSOI_{T_1} - (mSOL_{T_1} \ + C + \eta A e^{-\rho \Delta T}))^{\alpha}] \tag{5}$$

Case B: The manager has received x common stocks at date t_0. In this case, we assume that the vesting period of the stocks ends at date t_1.The timing of the events remains the same as before but the manager now maximizes the utility derived by the value of his x stocks at a date T_1 given that he has the option to cheat. More formally, the expected discounted utility function provided by his option to cheat can be written as follows:

$$\sup_{T_1} E_{t_1}[e^{-\rho(T_1-t_1)}(xSI_{T_1} - (xSL_{T_1} \ + C + \eta A e^{-\rho \Delta T})^{\alpha}] \tag{6}$$

where SI_{T_1} and SL_{T_1}respectively denote the values of the manager's stock in the case where he engages in an illicit activity and remains honest.

In the next two sections, we solve the optimisation problem for the manager in the case where he receives stock options and common stock respectively and where the inefficiency of the legal process as measured by ΔT is assumed to be known.

3 The manager's optimal decisions in the presence of stock options

In this section, we study the manager's decision to engage in an illicit activity, that is to exercise his compound option and to subsequently exercise his stock options in the

[4]Tadelis (2001) examines the conditions that guarantee long-term incentives through an active market for reputations.

case where the legal settlement date is known. In the previous section, we defined a random variable T_1 that corresponds to the date where the manager starts to behave illicitly. Since it is an American perpetual option, it corresponds to the first passage time of the underlying value at a level L_1:

$$T_1 = inf\,\{t > 0; S_t \geq L_1\}$$

The manager remains honest as long as the time value of the option is positive. In the latter case, the exercise of the option is delayed.

The options values SOI_{T_1} and SOL_{T_1} in equation (5) cannot by derived in the classical no - arbitrage framework. Indeed, the latter options are manager specific and thus cannot be valued using standard no arbitrage arguments. In a different context, Ingersoll (2003) recognizes and values explicitly the subjective value of stock options to managers who hold sub-optimally diversified portfolios and who exercise their stock options sub-optimally.

3.1 The case where early exercise of the stock option is not optimal in the illicit economy

More specifically, we are interested in defining the optimal decision - making process of the manager in the case where $\mu_2 \geqslant \rho$, that is when there are in principle no incentives for the manager to exercise his perpetual American stock options[5].Indeed, upon taking the decision to cheat, the drift of the stock price process μ_2 is higher than ρ which, in the classical real options literature, would suggest that the owner of the perpetual stock option never exercises his calls. However, due to the fact that the manager will be convicted, the exercise policy of these perpetual stock options is de facto constrained by the fact that the manager faces legal risk. Thus, it is sub-optimal to exercise the option after date $T_1 + \Delta T$. Indeed, after date $T_1 + \Delta T$, that is, once the manager is convicted, the dynamics of the stochastic process characterizing S are altered by the presence of a large decline in the stock's drift. Thus, the optimal exercise date T_2 occurs just an instant before he is convicted, that is to say at $T_2 = T_1 + \Delta T$. The possible exercise date of the stock options is thus assimilated to the date $T_2 = T_1 + \Delta T$.

Based on the above considerations, SOI_{T_1} in equation (5) can thus be priced as a European option:

$$SOI_{T_1} = E_{t_1}[(S_{T_1+\Delta T} - K)^+ e^{-\rho\Delta T}] = L_1 e^{-(\rho-\mu_2)\Delta T} N(d_1) - Ke^{-\rho\Delta T}\ N(d_2)$$

[5]In Appendix 1, we furthermore develop the case where $\rho \geqslant \mu_2$, that is, in which the manager may be inclined to exercise his stock options before the settlement of the legal procedure by the justice.

where K denotes the exercise price of the stock option and where

$$d_1 = \frac{\ln(L_1/K) + (\mu_2 + \sigma^2/2)\Delta T}{\sigma\sqrt{\Delta T}}$$

and

$$d_2 = \frac{\ln(L_1/K) + (\mu_2 - \sigma^2/2)\Delta T}{\sigma\sqrt{\Delta T}}$$

Similarly, in equation (7), we can value the stock option in the licit environment as follows:

$$SOL_{T_1} = \sup_{L_3} E_{T_1}[e^{-\rho(T_3-T_1)}(L_3 - K)]$$

with:

$$T_3 = inf\,\{t > 0; S_t \geq L_3\}$$

which reduces to:

$$SOL_{T_1} = (L_3^* - K).(L_1^*/L_3^*)^{\theta_1}$$

where L_3^* is the level at which the licit stock option is optimally exercised.

$$L_3^* = \frac{\theta_1}{\theta_1 - 1}K \tag{7}$$

and

$$\theta_1 = \frac{-\nu_1 + \sqrt{\nu_1^2 + 2\rho}}{\sigma} \tag{8}$$

and $\nu_1 = \frac{\mu_1}{\sigma} - \frac{\sigma}{2}$.

and where L_1^* denotes the stock price at which the manager will optimally exercise his option to cheat,

Thus, relying on the definition of the expected reputational loss, we can now rewrite the maximisation problem of the manager in equation (5) as follows:

$$\sup_{L_1}(\frac{S_{t_1}}{L_1})^{\theta_1}[m(L_1e^{-(\rho-\mu_2)\Delta T}N(d_1) - Ke^{-\rho\Delta T}\ N(d_2)) - (m\ (L_3^* - K).(L_1/L_3^*)^{\theta_1})1_{L_1<L_3^*}$$
$$- (m\ (L_1 - K))1_{L_1>L_3^*} - C - \eta Ae^{-\rho\Delta T}\ ]^{\alpha}$$

Indeed, when $L_3^* < L_1$, the value of the licit stock option at time T_1 is simply $(L_1 - K)$ since there would be no more incentives to wait before exercising it.

The latter maximisation problem is solved under the budget constraint imposed by the shareholders. The latter, for accounting purposes, use the standard perpetual American call options valuation framework (the accounting value of the stock options is denoted by $CS_A(S_{t_0})$). This practice is in line with most international accounting standards that rely on specific versions of the Black and Scholes valuation model to value stock options and is here modified in so far that we are dealing with perpetual options.The discount rate used to value the options from the shareholders accounting perspective is the riskless rate r. This constraint thus determines the number of stock options that will be distributed to the manager at date t_0. Knowing that the amount of cash distributed by the shareholders at date t_0 is a constant, D, the maximisation problem of the manager has to be solved under the following budget constraint:

$$mCS_A(S_{t_0}) = D \tag{9}$$

The following proposition summarizes the main results obtained in this section:

Proposition 1:
When ΔT is a constant, the optimal exercise boundary of the option to cheat L_1^* is finite. Thus, when the settlement date of the legal procedure is known with certainty, there are always incentives for the manager to engage in illicit activities. In the case where the maturity of the option to cheat is infinite, the probability to cheat is equal to one.

This result which is numerically verified in the following section follows from the fact that the drift of the stochastic process characterizing the stock price dynamics is strictly positive. It is also worthwhile to mention that, for tractability reasons, we have derived the manager's optimisation problem while assuming the limiting case in which the option to cheat displays a perpetual maturity.

In the following numerical simulations, we analyse the effect of a change in the base case parameters on the date at which the manager's decides to cheat. More precisely, and from a risk management perspective, we are interested in the circumstances that may lead the manager to delay this decision as long as possible.

3.2 Base Case Parameters

This section is intended to examine the sensitivity of the manager's decision to cheat to the key parameters of our model. Before presenting the results, it is important to mention that this model relies on several parameters (such as corruption costs, the reputational capital of the manager) that are hard to observe and are thus subjectively determined.The other parameters were chosen to match empirical data on financial markets.

Stock price at time zero, S_{t_0}	60.65
Stock price at time t_1, S_{t_1}	100
Strike price, K	60.65
Manager's discount factor, ρ	0.15
Manager's risk aversion parameter, α	0.5
Risk-free rate, r	0.05
Stock price drift in the licit world, μ_1	0.10
Stock price drift in the illicit world, μ_2	0.20
Stock price drift after the justice intervenes, μ_3	0.05
Stock return volatility, σ	0.15
Initial reputational capital of the manager in dollars, A	$500'000$
Corruption cost in dollars, C	$100'000$
The remuneration budget constraint in dollars, D	$5'000'000$
The fraction of reputational loss, η	0.2
The reference date (in years after the options issuance date t_0), t_1	5

A few explanations on these base case parameters are required. First, note that the initial stock price S_0 was chosen such that its expected future value at time t_1 when capitalised at the growth rate μ_1 is equal to S_{t_1}. Second, we assume that the stock options are issued at - the -money as is common practice in the industry. The manager's discount rate level ρ was chosen so that it be bounded by the drift rates of the stock price process prevailing respectively before (μ_1) and after (μ_2) the manager engages in illicit activities in order to be consistent with the model setting developed in the previous section. Furthermore, the logic regarding the drift rates is as follows: upon manipulating the financial statements, the manager is able to increase the drift from μ_1 to μ_2 until the point where he is convicted and the stock price is negatively affected, thus growing at a lower expected rate equal to μ_3.The volatility of stock returns is characteristic of the average firm volatility observed on European and U.S. stock markets. The model's implications will be examined mainly for a risk- averse ($\alpha = 0.5$) but also for a risk- neutral manager ($\alpha = 1$). The corruption costs represent an important parameter of the model on which we have only little public information. Thus, the model's predictions will be tested for alternative levels ranging from zero to 1 million dollars with the base case value set at 100'000 dollars. Obviously, this parameter is industry specific, depends on the type of fraud being committed and on the strength of the legal system in place. The reputational loss parameter η has been set at an arbitrary level of 0.2 to illustrate the case of a manager who does only moderately care about his reputation. Finally, the value of the initial reputational capital of the manager has been set at 500'000 dollars so that ηA be of the same order of magnitude as the corruption costs. In light of our limited knowledge about the manager specific reputational parameters, we will examine the predictions of our model for alternative values of the reputational loss ranging from zero to 1 million dollars. The budget constraint of $D = 5$ million allocated to the bonus pool is illustrative of a firm generating a net profit of 50'000'000 dollars and that distributes 10 % of its net profit to its managers. Finally, we assume that the analysis takes place five years after the options or the stocks have been granted to the manager.

3.3 Numerical results

This numerical analysis is intended to shed light on the impact of the key parameters on the decision-making process of the manager. In the case where the efficiency of the justice is fully predictable, let us first note that the manager will, as stated in proposition 1, always have incentives to engage in illicit activities. Indeed, the drift of the stochastic process characterizing S is positive and the numerical simulations show that L_1^* is always finite. Thus, the main issue is to determine how long the manager will wait until he engages in illicit activities for changes in the base case parameters. A useful statistic in this context is the expected time at which he will start to cheat, denoted by $E(T_1 - t_1)$:

$$E(T_1 - t_1) = \frac{\ln(L_1^*/S_{t_1})}{\mu_1 - \sigma^2/2} \text{ for } \mu_1 - \sigma^2/2 > 0 \qquad (10)$$

In figure 1, we examine the impact of the manager's initial reputational capital A on his incentives to cheat. We observe that L_1^* is an increasing function of A and thus that managers with a higher reputational endowment will wait longer before engaging in illicit activities.Yet, it is important to mention that from a corporate governance perspective, reputation is a parameter over which the firm has very little control once a manager has been hired. In figure 2, we show along the same lines that higher corruption costs are reducing the manager's incentives to engage in such activities. The problem is that these costs are often at least partially borne by the shareholders and not only by the manager himself. Like in the the real options literature, we observe in figure 3a that an increase in the stock returns' volatility will induce the manager to wait longer before exercising his option to cheat. This statement is interesting in itself, as it points out that less volatile businesses are more prone to adopt a fraudulent behavior early on, an implication of this model that should be further investigated. Intuitively, this behavior is triggered by the fact that the time value of the option to cheat decreases as the volatility of the stock return decreases. It is also important to mention that this prediction refers to the level of the volatility of the stock return before the manager is convicted. In reality, it is very likely that the volatility - which is assumed to be constant in our model - will increase after the manager is convicted. Regarding, the expected exercise date of the option to cheat, we observe in figure 3b that it increases when the volatility of the stock returns increases. Finally, in figure 4, we examine the impact of the drift differential on the manager's behaviour and observe that the latter will engage in fraudulent activities sooner if this differential is larger. This is a very intuitive result since the payoff of his option to cheat increases with the drift differential. Moreover, the same figure shows that the tendency of the manager to cheat earlier increases when the initial stock price drift decreases. This corroborates the statement made by Johnson and al. (2003) according to which fraud is more likely to occur following declines in the stock's performance. In figure 5, we examine the impact of the degree of the stock option moneyness at date t_1 on the manager's incentives to cheat. Like in the classical real option literature, we find that the incentives to cheat are a decreasing function of the strike price of the option. This is most noticeable in the region where the justice is moderately efficient. The role of the risk aversion coefficient on the decision to engage in illicit activities is displayed in figure 6. We observe that an increase in the manager's risk aversion (lower α) decreases L_1^*. This is a standard effect of risk aversion in the real options literature which shows that the perpetual American call option exercise boundary increases in α (see equation (17), for instance). Intuitively, risk is here defined as the risk of not being able to exercise the option the option to cheat when it is in- the -money, hence the more risk - averse individual will exercise sooner.

4 The manager's optimal decisions in the presence of common stocks

In this section, we solve for the manager's decisions to engage in an illicit activity and to sell the common stocks when he receives stocks as part of his compensation plan and when the legal settlement date is fully predictable. We will assume that after date t_1, the common stock is not vested anymore.

When maximizing the expected discounted utility of his option to cheat, in the first argument of his utility function, the manager considers the difference between the present values of his stock in the case where he engages in illicit activities and in the one where he remains honest. Thus, we can rewrite equation (6) as follows:

$$\sup_{T_1} E_{t_1}[e^{-\rho(T_1-t_1)}((xE_{T_1}(e^{-\rho\Delta T}SI_{T_1+\Delta T}) - (xSL_{T_1} + C + \eta A e^{-\rho\Delta T}))^{\alpha}] \tag{11}$$

where $SI_{T_1+\Delta T}$ denotes the value of the common stock if the manager has previously engaged in illicit activities as of date T_1 and SL_{T_1} denotes the value of the common stock if instead the manager remains honest at this date. Note that in the case when the manager engages in illicit activities he has incentives to wait for a maximal impact of the drift change, that is to sell his illicit stock just before he is convicted, that is to say just before $T_1 + \Delta T$.This strategy is feasible since the date of the manager's conviction is known with certainty.

At date $t \in [t_1, T_1]$, the manager has the option to engage in illicit activities and thus to sell his stock either in the licit or in the illicit - if he exercises the option -

worlds. Note that if he decided not to exercise his call option - i.e. not to engage in illicit activities -, the manager would still own and could sell his stock. Thus, the call option is actually an exchange call option that gives the manager the right to exchange his stock in the licit environment for a stock in an illicit environment. If he engages in illicit activities, his wealth at date T_1 consists of the discounted expected value of the x stocks he will sell just before date $T_1 + \Delta T$ less the costs of exercising this exchange call option. These costs consist of three components: first, the value of the x stock had he pursued a licit activity (SL_{T_1}), second, the cost of corruption C and finally the reputational loss he incurs (ηA) when he will be convicted.

We can thus rewrite the manager's optimisation problem:

$$\sup_{T_1,} E_{t_1}[e^{-\rho(T_1-t_1)}(xS_{T_1}e^{-(\rho-\mu_2)\Delta T} - (xS_{T_1} + C + \eta A e^{-\rho\Delta T}))^{\alpha}]$$

i.e.

$$\sup_{L_1} E_{t_1}[e^{-\rho(T_1-t_1)}(xL_1 e^{-(\rho-\mu_2)\Delta T} - xL_1 - C - \eta A e^{-\rho\Delta T})^{\alpha}]$$

which can be written as follows:

$$\sup_{L_1} (\frac{S_{t_1}}{L_1})^{\theta_1}(xL_1 e^{-(\rho-\mu_2)\Delta T} - xL_1 - C - \eta A e^{-\rho\Delta T})^{\alpha}$$

which can be simplified as follows:

$$X^{\alpha} \sup_{L_1} (\frac{S_{t_1}}{L_1})^{\theta_1}(L_1 - Y)^{\alpha} \tag{12}$$

with

$$X = x(e^{-(\rho-\mu_2)\Delta T} - 1) \tag{13}$$

and

$$Y = (C + \eta A e^{-\rho\Delta T})/X \tag{14}$$

The analytical solution of the maximisation problem provided in (12) is:

$$X^{\alpha}(\frac{S_{t_1}}{L_1^*})^{\theta_1}(L_1^* - Y)^{\alpha} \tag{15}$$

with

$$L_1^* = \frac{\theta_1}{\theta_1 - \alpha} Y \tag{16}$$

The following proposition summarizes the main results obtained in this section:

Proposition 2:

When ΔT is a constant, the optimal exercise boundary of the option to cheat L_1^* given in equation (16) is finite. Thus, when the settlement date of the legal procedure is known with certainty, the manager who receives stocks always has incentives to engage in illicit activities. In the case where the maturity of the option to cheat is perpetual, the probability that the manager engages in illicit activities is equal to one.

The latter proposition holds as long as $\rho > \mu_1$.

In the empirical study by Johnson and al (2003), the authors do not examine whether stock options or stocks provide managers with greater incentives to cheat. Based on the developments provided in sections 3 and 4, we will be able to analyse numerically whether stocks or stock options are better suited at delaying the manager's incentives to engage in illicit activities. In other words, we will compare the exercise boundaries of the option to cheat that apply when the manager respectively receives stock options and common stocks. Before tackling this issue, in the next section, we first introduce uncertainty with respect to the settlement date of the legal process into our model.

5 The option to cheat under a random legal settlement date

In the previous sections, we have assumed that if the manager cheats, he will be convicted after a given period of time ΔT. This intermediary step was introduced for pedagogical reasons and applies in the limit to a "benchmark" judicial system that is fully predictable.

In reality, it is quite unlikely that the manager who cheats, is simultaneously aware of the date $T_1 + \Delta T$ at which he will be convicted. Indeed, courts are known for engaging in lengthy unpredictable legal procedures whose final settlement dates are not known ex ante. In order to account for these legal impediments, we now introduce randomness in the duration of the legal procedure and thus will from now on assume that ΔT is random. Moreover, we assume that the random variable ΔT is independent from the underlying stock price process. Contrarily to the deterministic case, we now assume that if the manager has not exercised his option before $T_1+\Delta T$, he is precluded from doing so at $T_1 + \Delta T$ due to the uncertainty surrounding the legal settlement date. Furthermore, we still assume, like in the previous sections, that there would be incentives for the manager to wait as long as possible to exercise his stock options since $\mu_2 \geqslant \rho \geqslant \mu_1$ in the absence of any legal threats. We will observe a trade - off in the decision-making process of the cheating manager, on the one side he would like to wait before exercising his stock options in order to increase his expected profit and, on the other side, by waiting, he increases the chances of being convicted and thus of losing the potential gains associated with the exercise of the stock options.

We will only examine the case where the manager receives m stock options as part of his compensation policy.Relying on a similar framework as the one developed in section 2, the manager's optimisation problem can be written as follows:

$$\sup_{T_1} E_{t_1}[e^{-\rho(T_1-t_1)}((mSOI_{T_1}) - mSOL_{T_1} - C - EDRL)^{\alpha}] \tag{17}$$

The stock option's payoff $(mSOI_{T_1})$ is only perceived if the manager can exercise his options before being convicted, that is if T_2, the optimal exercise date of the stock options, is smaller than $T_1 + \Delta T$.

ΔT is now assumed to be a random variable with a uniform distribution[6] and therefore its distribution function is defined as follows:

$$p(\Delta T < u) = \frac{u}{\Pi},\ u \in [0, \Pi] \tag{18}$$

where Π denotes the maximal time it takes to the justice to discover and rule over the criminal case.

Due to the random nature of the justice efficiency, the manager has incentives to exercise the stock options prematurely that is before $T_1+\Pi$. Indeed, if he waits until $T_1+\Pi$, he will be convicted and lose the proceeds from exercising his stock options. Due to legal uncertainty, his stock options thus become American with a maturity $T_1+\Pi$. We therefore need to determine the exercise boundary for the exercise of the American finite maturity stock options and will assume, as in Omberg (1987), that this boundary S^* is a decreasing exponential function of time :

$$S^*_t = \exp(-\gamma(t - T_1))S^*_{T_1},\ t \in [T_1, T_1 + \Pi] \tag{19}$$

Note that the positive coefficient γ is defined in such a way that

$$S^*_{T_1+\Pi} = K$$

Thus,

$$\gamma = \ln(S^*_{T_1}/K)/\Pi$$

We can now rewrite the manager's optimisation problem as:

$$\sup_{L_1}(\frac{S_{t_1}}{L_1})^{\theta_1}\left[m \sup_{S^*_{T_1}} \int_0^{\Pi} \{p(T_2^{'} \in dt)(\exp(-\gamma t)\ S^*_{T_1} - K)(1 - \frac{t}{\Pi})e^{-\rho t}\} \right. \tag{20}$$
$$\left. -(m\ (L_3^* - K)(L_1/L_3^*)^{\theta_1} 1_{L_1 \le L_3^*} + m\ (L_1 - K)1_{L_1 > L_3^*} + C + \frac{\eta A}{\rho \Pi}(1 - e^{-\rho\Pi}))\right]^{\alpha}$$

where

$$T_2 = \inf\{t \ge T_1,\ S_t \ge S^*_t\}, T_2^{'} = T_2 - T_1$$

[6]We would like the distribution of ΔT to be bounded thus we took the simplest possible distribution, namely the uniform one.

In this expression, $e^{-\rho t}(\exp(-\gamma t)\ S^*_{T_1} - K)$ represents the illicit stock option's payoff at date T_1+t, discounted at date T_1.This payoff is granted provided that two independent conditions are simultaneously met. First, the exercise of the stock option takes place at date $T_1 + t$, and secondly the manager is not convicted before exercising his stock options.

The density at time T_1 of $T_2^{'}$,the first passage time of S at the exercise boundary is given by:

$$p(T_2^{'} \in dt) = \frac{a}{\sqrt{2\pi t^3}} e^{-\frac{(a-bt)^2}{2t}} dt$$

with

$$a = \frac{\ln(S^*_{T_1}/L_1)}{\sigma}$$

and

$$b = \frac{\mu_2 + \gamma - \sigma^2/2}{\sigma}$$

The maximisation problem of the manager is again solved under the budget constraint of the firms' shareholders. The latter stipulates that the manager receives m stock options at date t_0 such that

$$mCS_A(S_{t_0}) = D$$

Like in the previous section, it is assumed that the shareholders are using the value of the perpetual stock options in the licit world in order to determine, for accounting purposes, the total compensation of the managers D.

We rely on numerical simulations to show the impact of a legal settlement date on the incentives to cheat of the manager.There are two main results: first of all, in the case of legal uncertainty, it can be seen in figure 7, that there is a region in which the manager stays honest. This occurs when the justice is "efficient" that is, for $E(\Delta T)$ smaller than 4.45 years under our set of base case parameters. Hence, if we think that on average justice will take more than 4.45 years to settle the case, then the manager will engage in illicit activities. Second, when the manager is in the illicit region, he will wait longer than under a fully predictable legal system before engaging in illicit activities. This can be seen by comparing the levels of L_1^* in figures 1 and 7 while only considering the illicit region for the latter figure. This leads us to state proposition 3 that relies on numerical simulations in the absence of a known analytical solution to the optimisation problem stated in equation (20):

Proposition 3:

When ΔT is a uniformly distributed random variable, there are two regions characterizing the exercise policy of the manager. In the first region, called the licit region, defined by an efficient legal system (small Π) , L_1^* is infinite and the manager never cheats. In the second region, called the illicit region, characterized by an inefficient *legal system (large* Π*),* L_1^* *is finite and thus the manager will always have incentives to engage in illicit activities. In the case where the maturity of the option to cheat is perpetual, the probability that the manager engages in illicit activities is equal to one in the illicit region. Furthemore, in this region, the exercise boundary is, ceteris paribus, higher than under a fully predictable legal system.*

These results are due to the fact that under legal uncertainty, the manager will, all other things being equal, be inclined to wait longer before engaging in an illicit activity. Like any other real option, the option to cheat will be exercised later when uncertainty increases. The interesting feature is that the source of uncertainty we refer to is the legal uncertainty surrounding the conviction date of the manager.

Figure 8 illustrates the impact of the drift differential on the manager's incentives to cheat. We observe that the licit region increases when the differential in the drift decreases or when the initial level of the drift increases. Like in the fully predictable legal setting, in the illicit region, the manager will wait longer when the drift differential is smaller or when the initial drift increases. This latter observation corroborates the findings by Johnson and al. (2003) who found that managers are more likely to engage in illicit activities in falling stock markets. Figure 9a shows the influence of the stock returns' volatility on the manager's behavior. We observe first that a higher volatility will increase the licit region and secondly that, in the illicit region, it will induce the manager to wait longer. In figure 9b, and along the same lines, we notice that an increase in volatility is accompanied by an increase in the expected time at which the manager will cheat. Figure 10, suggests that an increase in the corruption costs and/or in the reputational initial asset of the manager will first of all increase the licit region and secondly increase the critical level of the stock price at which the manager will engage in fraudulous activities in the illicit region. In figure 11, we plot the two trigger values associated respectively, with the decision to cheat and to exercise the stock options afterwards. We see that when the justice efficiency decreases (i.e. $\Pi/2$ increases), the managers will engage sooner in illicit activities but will wait longer before exercising their stock options. Indeed, a higher value of $\Pi/2$ reduces the manager's probability to be convicted sooner and thus leads him to cheat sooner and to wait longer before exercising his stock option in order to further profit from the differential in the stock return drift.

The main conclusions regarding the results obtained in this section are the following: first, introducing legal uncertainty, that is a legal process with a non- fully predictable maturity date, is beneficial to the shareholders, in that it generates a licit region and also in that it increases the exercise level L_1^* of the option to cheat in the illicit region. Second, and similarly to the deterministic case, an increase in the inefficiency of the justice, as measured by the average length of settlement time $\Pi/2$, is detrimental as it lowers the critical stock price at which the manager will engage in illicit activities. For instance, with the set of base parameters, we can see in figure 7 that if $\Pi/2$ is higher than 5.3 years, the manager will immediately engage in fraudulent activities. Thus, equity-based compensation plans are more likely to trigger dishonest managerial actions in countries where the corporate governance systems are poorly defined and weakly enforced.

6 A Comparison of Both Remuneration Policies

In this section, we will address the main question of this study, namely does the type of equity-based compensation affect the manager's incentives to engage in illicit activities? For that purpose, we compare the impact of both stock and stock options remuneration policies on the managers' incentives to engage in illicit activities under a random maturity legal process. We assume that the allocation rule defined by the shareholders is such that, at date $t_{0,}$ when the options are distributed, shareholders are indifferent between giving x shares or m stock options. Let us denote by y the ratio of m/x . The shareholders would like to distribute a number of stock options such that the value of both compensation packages be equal to D. More precisely, at date t_0, m and x should satisfy:

$$xS_{t_0} = mCS_A(S_{t_0}) = D$$

Thus, y satisfies

$$S_{t_0} = y\ e^{-r(t_1-t_0)}(L_3^* - K)E_{t_0}(\frac{S_{t_1}}{L_3^*})^{\theta_1}$$

where $CS_A(S_{t_0})$ denotes the value of the licit American perpetual option in the standard option valuation framework where the risk free rate is taken as the discount factor. θ_1 is found by relying on equations (7) and (8) using $\rho_s = \rho$ as the shareholders

discount factor.Thus, the above equation reduces to

$$y = S_{t_0}^{-\theta_1+1} L_3^{*\theta_1} e^{r(t_1-t_0)} e^{-(\theta_1\mu_1+\theta_1(\theta_1-1)\sigma^2/2)(t_1-t_0)}/(L_3^* - K) \tag{21}$$

Note that in this cash - neutral comparison, we assume, for budgeting purposes, that the risk-averse shareholders value the newly issued stock options in the licit world.

We now numerically compare the incentives to cheat associated respectively to stock and stock option compensation plans under a random maturity legal process. In figure 12, it is very clearly shown that from the shareholders perspective, stocks are preferable to stock options. Indeed, stocks display a licit region of 10.3 years as opposed to 4.45 years for the stock options and furthermore, in the illicit region, the trigger value for cheating is higher with stocks than with stock options unless the legal system is clearly inefficient (above 12 years....).

These results can be summarized in the following proposition:

Proposition 4:

When the legal settlement date is not fully predictable, and for an equal dollar of initial compensation, the licit region for the stock compensation package is wider than for the stock option compensation package. Furthermore, in the illicit region for the stock, the critical boundary under the stock compensation scheme is higher than the exercise boundary under the stock option compensation scheme.

This comparison thus emphasizes another externality of stock option compensation plans in the case when fraud by managers is explicitly considered, namely that stock options can exacerbate fraudulent incentives of managers operating in inefficient legal systems relative to stocks. According to our results, stock based compensation plans should thus offer more security to the shareholders since they are more likely to reduce managers' incentives to engage in illicit activities for an equal dollar compensation package. This conclusion must however be weighted against the positive impact stock options provide relative to stocks, in enhancing honest managers incentives to develop effort and to take risks (see Core, Guay and Larcker, (2003)) .

7 How can we reduce the managers' incentives to cheat in the presence of stock options?

In the classical agency theory literature, stock options were thought to be an incentive-compatible remuneration instrument that aligns managers and stockholders interests. There has been a wide range of controversy with respect to the validity of this argument especially as far as the asset substitution and more precisely the risk-taking behavior of the manager is concerned (see Lambert, Larcker and Verrecchia (1991) and Ross (2004)) . Other authors, such as Ingersoll (2002) have argued that these incentives might actually be reduced if one accounts for the subjective valuation of the stock options made by the manager who is restricted from holding an optimally diversified portfolio.

According to Holmstrom (1969), Mirrlees (1976) and Von Thadden (2003), it is a rather delicate question to determine whether monetary incentives and monitoring are substitutes or complements. This is acknowledged in the classical principal-agent literature by recognizing that the manager may, due to his monetary incentives, be inclined to take more risks rather than develop more efforts. This feature of equity-based compensation plans is further reinforced in our context if we recognize that besides taking risks, the manager also has the option to engage in illicit activities and will most likely benefit from such a shift if the justice is highly inefficient. Thus, firms internal control mechanisms become even more relevant in the presence of fraud, especially, as suggested by Von Thadden (2003), in areas that are complex and give rise to a high level of managerial discretion.

While recognizing the importance of internal monitoring, such as the one recently proposed in the Sabanes - Oaxley 404 recommendation on establishing internal financial controls or in its certification requirement for CEO's and CFO's, in this last section of the study, we take another path and examine whether security design mechanisms can reduce managers incentives to engage in illicit activities. This choice does not however imply that we abstract from the important role played by alternative monitoring mechanisms within financial institutions.

We have seen that stock options can provide even more incentives to cheat to the managers than an equal dollar amount of compensation provided in stocks (see section 6).The main question thus becomes: How can one design an incentive - compatible remuneration scheme that simultaneously induces the manager to exercise best effort from the shareholder value maximisation principle and to remain honest?

A solution is to make the pension fund payments made to the former employee contingent upon his honest behavior. The court could withhold part of the managers' pension in order to compensate the shareholders for the damage they incurred due to the manager's fraudulent activities. Such a solution would however raise legal implementation problems in light of the pension fund systems prevailing in most countries and to the fact that managers can change domicile and thus involve several juridictions that do not fully recognize cross-country pension funds' transferability.We have explored alternative mechanisms that maintains homogeneity between the managers remuneration scheme and the potential penalty imposed on him since both remain equity-linked.

An alternative that comes to mind is to raise the strike price of the stock options. The problem is that this solution does not make the manager accountable for his illicit behavior while it may simultaneously induce him to take more risks since he then owns out - of - the money call options.

In this section, we propose a solution that relies on a new equity-based remuneration package. We will show that the stockholders can reduce the manager's incentives to cheat through a remuneration that consists of m stock options and of n American perpetual puts shorted by the manager. In other words, at date t_0, the manager issues n puts on behalf of the shareholders, these puts have an infinite maturity, a strike price of K [7] and can only be exercised once the manager is convicted. More concretely, the possible exercise period of these puts starts at date $T_1+\Delta T$. $PS_A(S_{t_1})$ denotes the value of the put from the manager's perspective. As far as the put is concerned, it will only be activated if the manager engages in illicit activities.[8] Intuitively, the puts' value can be seen as an "honesty discount ". It is a discount insofar as the manager will avoid the costs related to the puts value if he remains honest. Indeed, if the manager cheats, the put can be exercised by the stockholders and can furthermore become highly in - the - money due to the modified stochastic process with a lower drift characterizing the stock returns.

[7] In another version of the remuneration package, one could imagine that the strike price of the puts is only defined when the manager is convicted and set equal to L_1.This case will be considered in our numerical examples under figure 14.

[8] The issuance of this put is rather theoretical in nature but one could assume that a financial intermediary is hired to issue the puts on behalf of the manager.

More generally, the design of this compensation package results from the expected utility maximisation problems simultaneously solved by both agents. In our random maturity case, the problem can be simplified due to the fact that the shareholder knows whether or not he faces an honest manager.

The time sequence of the events is the following: knowing that the amount of cash distributed by the firm shareholders to the manager at date t_0 is a constant, D, the maximisation problem of the shareholders has to be solved under the constraint:

$$mCS_A(S_{t_0}) = D$$

where D denotes the total cash amount that the shareholders are willing to allocate to the remuneration of the managers and where the same mathematical definition of the perpetual US call as in the previous sections applies for accounting reasons. Thus, m is known at time t_0.

In the case where the manager is honest - that is, when he does not cheat - the shareholder maximisation problem is independent of the number of puts since the puts value is zero. Thus, the optimal number of puts n is nil. Indeed, there is no needs to incentives the manager if he is honest. Otherwise, the shareholder's maximisation problem can be written as:

$$EU_S = \sup_a E_{t_1}[e^{-\rho_S(T_1-t_1)}(\ bE_{T_1}(e^{-\rho_S(T^*-T_1)}S_{T^*}) - m(SOI^S(S_{T_1}) - aPS_A^S(S_{T_1}))^{\alpha_s}] \tag{22}$$

where $a = n/m$ denotes the ratio of puts to calls, b denotes the total number of common shares owned by the shareholders and where $SOI^S(S_{T_1})$ and $PS_A^S(S_{T_1})$ denote the prices of the American calls and puts from the shareholders perspective and allowing for the fact that they might have a different dicount rate (ρ_S) and a different risk aversion coefficient (α_s) than the manager.

If the manager might engage in illicit activities, the reference date for the shareholders will be the exercise date of their puts T^*, that satisfies $T^* \geqslant T_1 + \Delta T$. Indeed, it is assumed that the shareholders are long term investors who want to keep their b stocks. Secondly, the shareholders are fully informed, that is, they must be able to incorporate in the stock price valuation the future impact of the manager's behavior. The latter impact, materialized by the final drop in the drift of the stock price process, is only finalized after date $T_1 + \Delta T$.

In this case, the maximisation problem of the shareholder is trivial, a and thus n will take the highest permissible a^* and n^* values where the latter are defined as the highest values that are acceptable from the manager's perspective[9].

As far as the manager's maximisation problem is concerned, we again consider the expected utility maximisation problem with respect to his option to cheat. Indeed,

[9] While we do not model the manager's constraint on the number of puts he is willing to short, note that the latter will in general be defined by his budget constraint, his access to the labour markets and his ethical values.

we are again interested in determining whether the new compensation package may delay his decision to cheat. Thus, his optimisation problem can be written as follows:

$$EU_M = \sup_{T_1} E_{t_1}[e^{-\rho(T_1-t_1)}(m(SOI_{T_1}) - (mSOL_{T_1} + C + +EDRL + nPS_A\ (S_{T_1})))^{\alpha}] \quad (23)$$

We can now rewrite the manager's optimisation problem by relying on the results obtained in section 5 as:

$$\sup_{L_1}(\frac{S_{t_1}}{L_1})^{\theta_1}\Bigg[m \sup_{S^*_{T_1}} \int_0^{\Pi} \{p(T_2^{'} \in dt)(e^{-\gamma t}S^*_{T_1} - K)(1-\frac{t}{\Pi})e^{-\rho t}\} -(m\ (L_3^* - K)(L_1/L_3^*)^{\theta_1}1_{L_1 \leq L_3^*} + m\ (L_1 - K)1_{L_1 > L_3^*} + C + \frac{\eta A}{\rho \Pi}(1-e^{-\rho\Pi}) + nPS_A(S_{T_1})\Bigg]^{\alpha} \quad (24)$$

We can rewrite the put expression in the previous equation as follows:

$$PS_A(S_{T_1}) = E_{T_1}[e^{-\rho\Delta T}PS_A(S_{T_1+\Delta T})]$$

which reduces to:

$$PS_A(S_{T_1}) = E_{T_1}\int_0^{\Pi} e^{-\rho v}\sup_L E_{T_1+v}[(K-L)e^{-\rho(T_L-T_1-v)}]p(\Delta T \in dv)$$

where T_L the exercise date of the put options satisfies:

$$T_L = \inf\{t \geqslant T_1 + \Delta T, S_t \leqslant L\}$$

and where

$$p(\Delta T \in dv) = \frac{1}{\Pi}dv,\ v \in [0,\Pi]$$

$$PS_A\ (S_{T_1}) = E_{T_1}\int_0^{\Pi} e^{-\rho v}\sup_L (K-L)(\frac{S_{T_1+v}}{L})^{\theta_3}\frac{dv}{\Pi}$$

i.e.

$$PS_A\ (S_{T_1}) = \int_0^{\Pi} e^{-\rho v}(K-L^*)(\frac{L_1}{L^*})^{\theta_3}.e^{(\theta_3\mu_2+\theta_3(\theta_3-1)\sigma^2/2)v}\frac{dv}{\Pi} \quad (25)$$

with $\theta_3 = \frac{-\nu_3-\sqrt{\nu_3^2+2\rho}}{\sigma}$, $\nu_3 = \frac{\mu_3}{\sigma} - \frac{\sigma}{2}$ and

$$L^* = \frac{\theta_3}{\theta_3 - 1}K$$

where L^* denotes the stock level at which the stockholders will optimally exercise the puts.

This allows us to rewrite EU_M as follows:

$$
\begin{aligned}
EU_M \;=\; & \sup_{L_1}(\frac{S_{t_1}}{L_1})^{\theta_1}\left[m \sup_{S^*_{T_1}}\int_0^{\Pi}\{p(T_2\in dt)(e^{-\gamma t}S^*_{T_1}-K)(1-\frac{t}{\Pi})e^{-\rho t}\}\right. \\
& -(m\;(L^*_3-K)(L_1/L^*_3)^{\theta_1}1_{L_1\le L^*_3}+m\;(L_1-K)1_{L_1>L^*_3}+C+\frac{\eta A}{\rho\Pi}(1-e^{-\rho\Pi}) \\
& \left.+\,n\int_0^{\Pi}e^{-\rho v}(K-L^*)(\frac{L_1}{L^*})^{\theta_3}e^{(\theta_3\mu_2+\theta_3(\theta_3-1)\sigma^2/2)v}\frac{dv}{\Pi})\right]^{\alpha}
\end{aligned}
\tag{26}
$$

Solving this maximisation problem, we obtain the two trigger values L_1 and $S^*_{T_1}$ that respectively apply to the exercise of the manager's option to cheat and of his stock options under the put-call remuneration package. In the following proposition, we characterize the main result of this section that will also be illustrated numerically.

Proposition 5:

When the legal settlement date is not fully predictable, a compensation package that contains stock options and honesty puts shorted by the manager will decrease the manager's incentives to cheat due to the reduced convexity of his compensation package. This package is mainly attractive for shareholders who want to distribute stock options rather than stocks since, for an equal - dollar compensation amount, the pure stock compensation package still dominates.

We now introduce n short puts into the base case remuneration package consisting of stock options examined in section 5 and examine the impact of this penalty on the incentives of the manager to engage in illicit activities. In figure 13, we observe that the honesty region increases marginally from 4.45 to 4.5 years when the manager has to short 10 million puts. However, if we now increase the number of puts to equal 1 billion, the impact is much more pronounced since it shifts the honesty region to 5.8 years. As far as the illicit region is concerned, we observe that a higher capitalisation in short puts will dramatically increase the trigger level at which the manager will exercise. When the justice becomes very inefficient, this deterring impact of the short puts is substantially reduced although it remains significant in the case when the manager has issued 1 billion puts. In figure 14, we compare four remuneration packages consisting respectively of stocks only, of stock options only and finally of stock options combined with 1 billion puts held short by the manager. It is interesting to observe that the stocks only package is clearly the most favorable from the shareholders perspective since it leads both to the widest honesty region and to the highest trigger values unless justice is really inefficient. The call - put package is clearly a second best solution that can substantially increase the honesty region (from 4.45 to 5.8 years) and the trigger values in the illicit region as the capitalisation of the puts increases. It can further be seen from figure 14 that an increase in the puts' strike price (from 60.65 to 200) will raise the boundaries of the honesty region and the trigger level in the illicit region substantially.

In practice, shareholders may want to continue granting stock options in order to benefit from their positive externalities on the level of effort produced by the managers. In this case, the consideration of honesty puts can be advised in the presence of potentially dishonest managers. It is important to remember that optimising the security design of equity - based compensation plans should ideally be complemented with efficient internal monitoring in order to prevent fraud and / or to detect it sufficiently early within the corporations.

8 Conclusion

In this study, we have developed a continuous - time contingent claims framework to analyse managers incentives to cheat in the presence of stock and stock option compensation plans. The manager who cheats is modifying the drift of the stock price process in order to benefit from a higher stock valuation. If he decides to cheat, he will face corruption costs as well as a reputational loss when he is convicted. These are all explicit and implicit costs associated with the exercise of the option to cheat. This option is analysed by assuming first that the maturity date of the legal settlement process is fully predictable and secondly by assuming a more realistic setting in which it is random. Numerical simulations show that in our setting, the manager will always engage in illicit activities when the legal settlement process maturity date is fully predictable.

When the maturity of the legal settlement process is not fully predictable, managers will, for specific values of the base case parameters and especially when justice is very efficient, remain honest. Also, if the speed of the justice is too slow (that is, if justice is less efficient), managers will - ceteris paribus - engage in illicit activities later than in the deterministic case. We show that higher reputational costs or higher corruption costs will delay the managers decision to cheat in the illicit region but that a higher drift differential will induce them to cheat sooner in order to profit from a higher payoff associated with their stock options. In light of the recent corporate scandals mentioned in the international press, it is clear that some managers were exploring the limits of accounting standards to hide losses, to reduce excess leverage ratios or to smoothen profits. This study demonstrates that such a behavior can be magnified under stock option remuneration packages or under less efficient legal systems. Indeed, we observe that the manager will always engage in those activities sooner if he owns stock options rather than stocks. Thus, from the perspective of the shareholders, stock compensation plans are preferable since they reduce managers' incentives to alter the drift of the stock returns illicitly.

We also proposed an alternative security design mechanism that mitigates managers incentives to cheat in the presence of stock options. This was done by introducing a penalty in the stock option compensation plan of the manager that aims at deterring him from engaging in illicit activities. This new remuneration package consists of long calls written on the firm's stock and of short perpetual puts that are activated when the manager is convicted. These puts represent an honesty discount. Our numerical simulations show that for the base case parameters, the call-put remuneration package does indeed increase the honesty region and delay the manager's decision to cheat when he is in the illicit region. However, in most cases, stocks remain superior to this new call-put remuneration package for the base case parameter values. Such call-put remuneration contracts could however be introduced by shareholders who want to benefit from the positive impact of stock options on managerial effort while limiting managerial incentives to engage in illicit activities.

This leads us to now state the limitations of our modeling approach. First, we have ignored the impact of alternative remuneration schemes on the manager's willingness to increase his - morally acceptable - efforts. Secondly, our study is cast outside of the optimal remuneration contracts' literature and has thus the less ambitious goal of showing how alternative security design mechanisms affect managers incentives to cheat. The introduction of honesty puts in the managers' remuneration package is still a theoretical construct whose feasibility needs to be further explored and, in any case, supported by efficient internal monitoring within the firms.

In summary, this study provides a first attempt to apply the continuous - time contingent claims approach to analyse and value the impact of managers' remuneration policies on their decisions to engage in illicit activities. The predictions of our theoretical model are supported by a recent study by Johnson and al. (2003) that clearly shows within a sample of US firms subject to accounting fraud that there is a positive relationship between equity-based compensation and corporate fraud. Our model goes one step further in predicting that the form of the equity-based remuneration contract is not neutral in this respect and that performance-based compensation contracts should thus be monitored with respect to their composition.

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10 Appendix 1: The case where early exercise of the stock option may be optimal

More specifically, we now consider the case where $\rho \geq \mu_2 \geqslant \mu_1$, and therefore were early exercise could be optimal. This case implies a second possibility regarding the exercise of the manager's stock options that we treat in the appendix since it does not add economic insight relative to the simpler case treated in the core of the text. Furthermore, this case is more involved in terms of mathematical notations. His perpetual stock options are de facto constrained by the fact that it is sub-optimal to exercise the options after date $T_1 + \Delta T$. Indeed, after date $T_1 + \Delta T$, the dynamics of the stochastic process characterizing S are altered by the presence of a large decline in the stock's drift. Thus, the optimal exercise date T_2 occurs either before the manager is actually condemned by the law or the manager will exercise just an instant before he is caught by the justice that is to say at $T_2 = T_1 + \Delta T$. Thus, if the options were not exercised before $T_1 + \Delta T$, we impose the exercise of the stock options at date $T_2 = T_1 + \Delta T$ providing that their payoff is positive.

In this context, we need to calculate SOI_{T_1} that is now defined as follows:

$$SOI_{T_1} = \sup_{L_2} E_{T_1}[e^{-\rho(T_2-T_1)}(L_2 - K)1_{T_2 \leq\, T_1+\Delta T} + e^{-\rho\Delta T}(S_{T_1+\Delta T} - K)^+ 1_{T_2 = T_1+\Delta T}]$$

where

$$T_2 = \inf\{t \geqslant 0; S_t \geqslant L_2\} \Lambda(T_1 + \Delta T)$$

and K denotes the exercise price of the stock option, and where L_2 is the level at which the illicit stock option is optimally exercised. This expression can be written as:

$$SOI_{T_1} = \sup_{L_2}(L_2 - K)E_{T_1}[e^{-\rho(T_2-T_1)}1_{T_2 \leq\, T_1+\Delta T} + e^{-\rho\Delta T}(S_{T_1+\Delta T} - K)^+ 1_{T_2 =\, T_1+\Delta T}]$$

Note that:

$$E_{T_1}(e^{-\rho(T_2-T_1)}1_{T_2 \leq\, T_1+\Delta T}) = e^{(\nu_2-\xi)\lambda}N(\frac{\xi\Delta T - \lambda}{\sqrt{\Delta T}}) + e^{(\nu_2+\xi)\lambda}N(\frac{-\xi\Delta T - \lambda}{\sqrt{\Delta T}})$$

where

$$\lambda = \frac{\ln(L_2/L_1)}{\sigma};\ \nu_2 = \frac{\mu_2}{\sigma} - \frac{\sigma}{2};\ \xi = \sqrt{2\rho + \nu_2^2}$$

$$\begin{aligned} SOI_{T_1} &= \sup_{L_2}(L_2 - K)[e^{(\nu_2-\xi)\lambda}N(\frac{\xi\Delta T - \lambda}{\sqrt{\Delta T}}) + e^{(\nu_2+\xi)\lambda}N(\frac{-\xi\Delta T - \lambda}{\sqrt{\Delta T}}) + \\ &+ e^{-\rho\Delta T}E_{T_1}((S_{T_1+\Delta T} - K)^+ 1_{T_2 \geq = T_1+\Delta T})] \end{aligned}$$

The stock option in the licit environment has been computed in section 3 and reads as follows:

$$SOL_{T_1} = \begin{cases} (L_3^* - K)(L_1/L_3^*)^{\theta_1} & L_1 \leq L_3^* \\ (L_1 - K) & L_1 > L_3^* \end{cases}$$

where $L_3^* = \frac{\theta_1}{\theta_1 - 1}K$ and

$$\theta_1 = \frac{-\nu_1 + \sqrt{\nu_1^2 + 2\rho}}{\sigma},\ \nu_1 = \frac{\mu_1}{\sigma} - \frac{\sigma}{2}.$$

Thus, relying on equation (**??**), we can now write the expected utility of the manager as follows:

$$\begin{aligned} &\sup_{L_1} E_{t_1}[e^{-\rho(T_1-t_1)}(\sup_{L_2} m(L_2 - K)\{e^{(\nu_2-\xi)\lambda}N(\frac{\xi\Delta T - \lambda}{\sqrt{\Delta T}}) + e^{(\nu_2+\xi)\lambda}N(\frac{-\xi\Delta T - \lambda}{\sqrt{\Delta T}}) + \\ &+ e^{-\rho\Delta T}E_{T_1}((S_{T_1+\Delta T} - K)^+ 1_{T_2 \geq\ T_1+\Delta T}\} - (m\ (L_3^* - K)(L_1/L_3^*)^{\theta_1} 1_{L_1^* \leq L_3^*} + \\ &+ m(L_1 - K)1_{L_1^* > L_3^*} + C + \eta A e^{-\rho\Delta T}))^{\alpha}] \quad (A1) \end{aligned}$$

This expression can be further simplified by noting that the term

$$e^{-\rho\Delta T}E_{T_1}((S_{T_1+\Delta T} - K)^+ 1_{T_2 = T_1+\Delta T})$$

denotes the value of an up- and - out call option $(CUO)_{T_1}$ with a barrier level equal to L_2 whose closed -form valuation formula is given by:

$$CUO_{T_1} = e^{-\rho\Delta T}E_{T_1}((S_{T_1+\Delta T} - K)^+ 1_{T_2 =\ T_1+\Delta T})$$

with

$$\begin{aligned} &CUO_t = C_{BS}(\ S_t, K) - C_{BS}(\ S_t, L_2) + (L_2 - K)e^{-\rho(t+\Delta T)}N\ [d_{BS}(S_t, L_2)] - \\ &-(\tfrac{L_2}{S_t})^{2b^2/\sigma^2}[C_{BS}((L_2^2/S_t), K) - C_{BS}((L_2^2/S_t), L_2) - (\ L_2 - K)e^{-\rho(t+\Delta T)}N\ [d_{BS}(L_2, S_t)] \end{aligned}$$

and $b = \mu - \sigma^2/2$.

Since

$$E_{t_1}[e^{-\rho(T_1-t_1)}] = (\frac{S_{t_1}}{L_1})^{\theta_1}$$

Equation (A1) reduces to:

$$\begin{aligned} &\sup_{L_1}(\frac{S_{t_1}}{L_1})^{\theta_1}[\sup_{L_2} m(L_2 - K)\{(e^{(\nu_2-\xi)\lambda}N(\frac{\xi\Delta T - \lambda}{\sqrt{\Delta T}}) + e^{(\nu_2+\xi)\lambda}N(\frac{-\xi\Delta T - \lambda}{\sqrt{\Delta T}}) + \\ &CUO_{T_1}\} - (m\ (L_3^* - K)(L_1/L_3^*)^{\theta_1} 1_{L_1 \leq L_3^*} + m\ (L_1 - K)1_{L_1 > L_3^*} + C + \eta A e^{-\rho\Delta T})]^{\alpha} \end{aligned}$$

This maximisation problem can be computed analytically. In the core of the paper, we treat a simpler case.

In the case where $\Delta T \rightharpoonup \infty$ this expression can be simplified. That is, for the case where the manager never gets caught by the justice, the maximisation problem of the manager reduces to :

$$\sup_{L_1} E_{t_1}[e^{-\rho(T_1-t_1)}(m(L_2^*-K)(L_1/L_2^*)^{\theta_2}-(m\ (L_3^*-K)(L_1/L_3^*)^{\theta_1}1_{L_1\leq L_3^*}+$$
$$+m\ (L_1-K)1_{L_1>L_3^*}+C+\eta A e^{-\rho\Delta T}))^{\alpha}]$$

where $L_2^* = \frac{\theta_2}{\theta_2-1}K$ and

$$\theta_2 = \frac{-\nu_2+\sqrt{\nu_2^2+2\rho}}{\sigma}$$

The above expression reduces to:

$$\sup_{L_1}(\frac{S_{t_1}}{L_1})^{\theta_1}[m(L_2^*-K)(L_1/L_2^*)^{\theta_2}-(m\ (L_3^*-K)(L_1/L_3^*)^{\theta_1}1_{L_1\leq L_3^*}+$$
$$+m\ (L_1-K)1_{L_1>L_3^*}+C+\eta A e^{-\rho\Delta T})]^{\alpha}$$

which can easily be computed analytically.

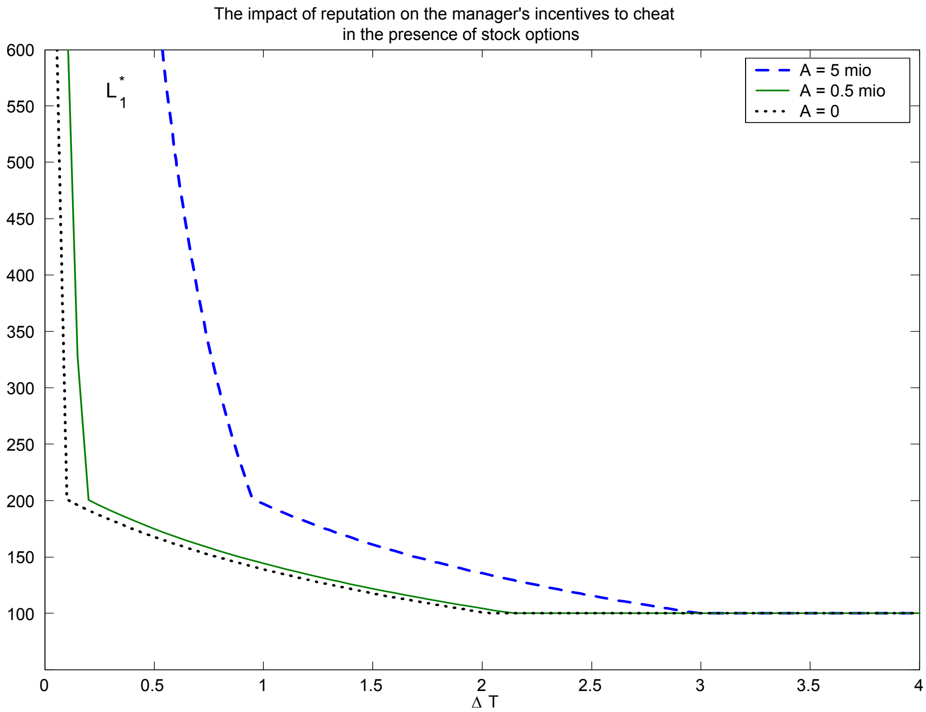

Figure 1. The level of the stock price at which the manager will engage in illicit activities (L_1^*) as a function of ΔT for different values of the initial reputational capital A when the manager receives stock options and when the length of the legal procedure ΔT is deterministic. The other parameters are: $S_{t_0} = K = 60.65$, $S_{t_1} = 100$, $\rho = 0.15$, $\alpha = 0.5$, $r = 0.05$, $\mu_1 = 0.10$, $\mu_2 = 0.20$, $\mu_3 = 0.05$, $\sigma = 0.15$, $C = 100'000$, $D = 5'000'000$, $\eta = 0.2$, $t_1 = 5$.

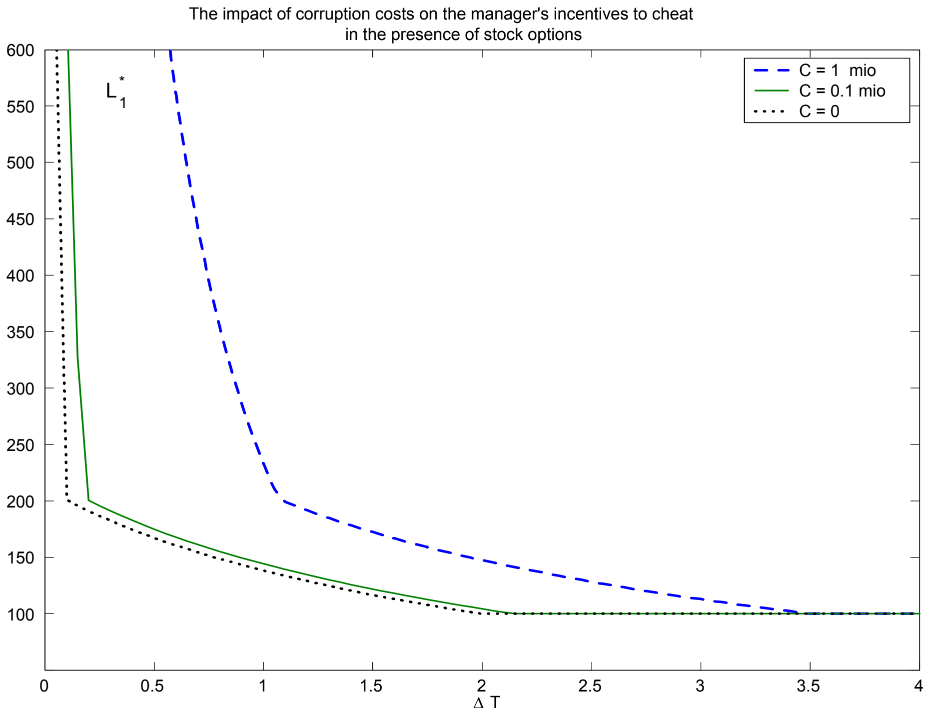

Figure 2. The level of the stock price at which the manager will engage in illicit activities (L_1^*) as a function of ΔT for different values of the corruption cost C when the manager receives stock options and when the length of the legal procedure ΔT is deterministic. The other parameters are: $S_{t_0} = K = 60.65$, $S_{t_1} = 100$, $\rho = 0.15$, $\alpha = 0.5$, $r = 0.05$, $\mu_1 = 0.10$, $\mu_2 = 0.20$, $\mu_3 = 0.05$, $\sigma = 0.15$, $A = 500'000$, $D = 5'000'000$, $\eta = 0.2$, $t_1 = 5$.

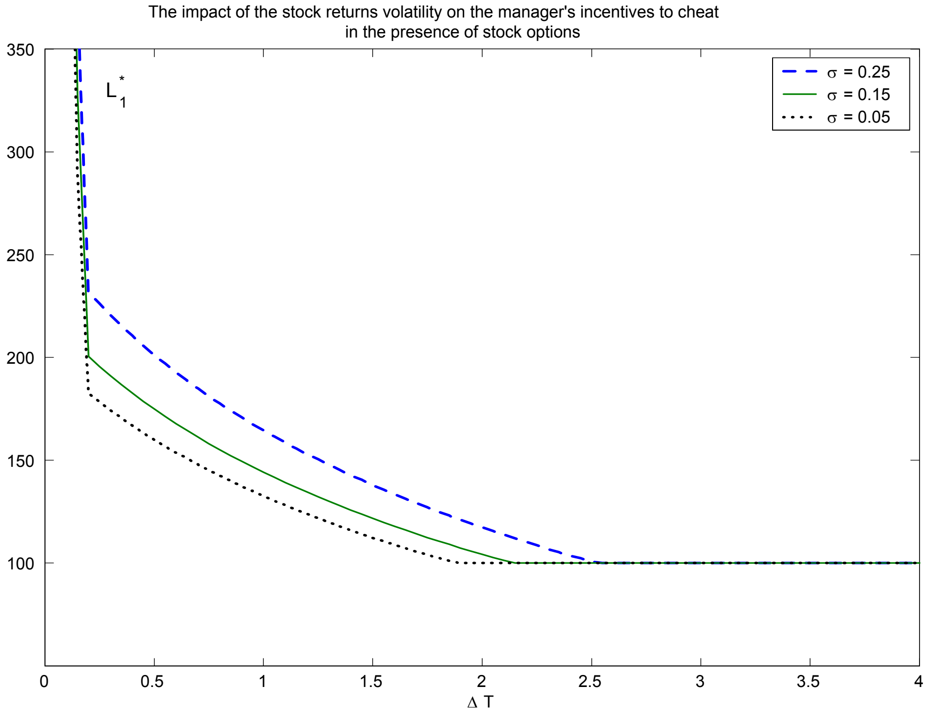

Figure 3a. The level of the stock price at which the manager will engage in illicit activities (L_1^*) as a function of ΔT for different values of the stock price volatility σ when the manager receives stock options and when the length of the legal procedure ΔT is deterministic. The other parameters are: $S_{t_0} = K = 60.65$, $S_{t_1} = 100$, $\rho = 0.15$, $\alpha = 0.5$, $r = 0.05$, $\mu_1 = 0.10$, $\mu_2 = 0.20$, $\mu_3 = 0.05$, $A = 500'000$, $C = 100'000$, $D = 5'000'000$, $\eta = 0.2$, $t_1 = 5$.

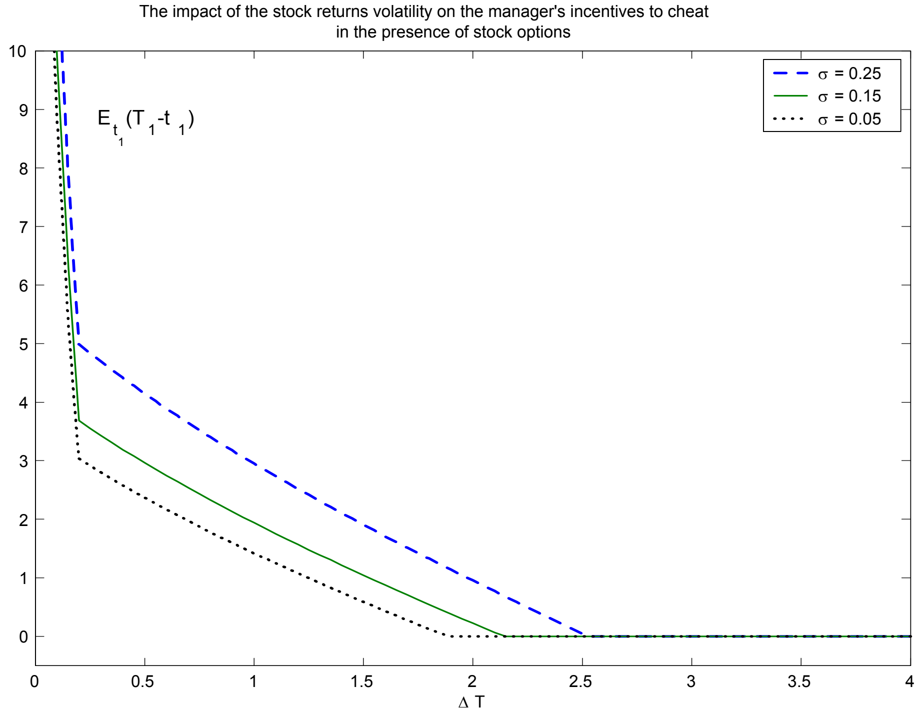

Figure 3b. The expected time at which the manager will engage in illicit activities, $E_{t_1}(T_1 - t_1)$, as a function of ΔT for different values of the stock price volatility σ when the manager receives stock options and when the length of the legal procedure ΔT is deterministic. The other parameters are: $S_{t_0} = K = 60.65$, $S_{t_1} = 100$, $\rho = 0.15$, $\alpha = 0.5$, $r = 0.05$, $\mu_1 = 0.10$, $\mu_2 = 0.20$, $\mu_3 = 0.05$, $A = 500'000$, $C = 100'000$, $D = 5'000'000$, $\eta = 0.2$, $t_1 = 5$.

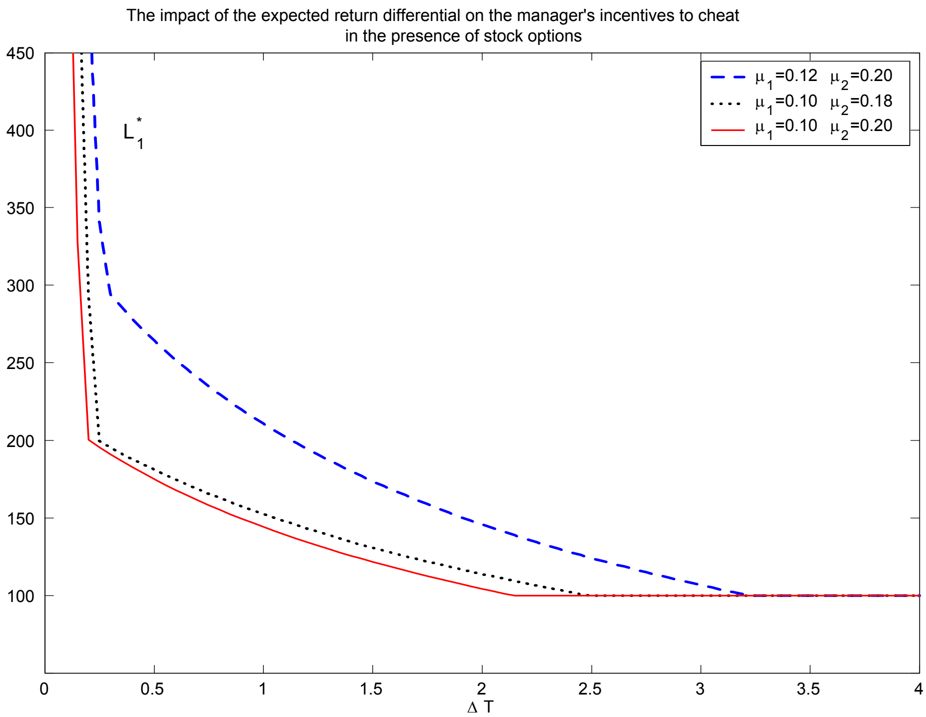

Figure 4. The level of the stock price at which the manager will engage in illicit activities (L_1^*) as a function of ΔT for different values of drifts of the stock price μ_1 and μ_2 when the manager receives stock options and when the length of the legal procedure ΔT is deterministic. The other parameters are: $S_{t_0} = K = 60.65$, $S_{t_1} = 100$, $\rho = 0.15$, $\alpha = 0.5$, $r = 0.05$, $\mu_3 = 0.05$, $\sigma = 0.15$, $A = 500'000$, $C = 100'000$, $D = 5'000'000$, $\eta = 0.2$, $t_1 = 5$.

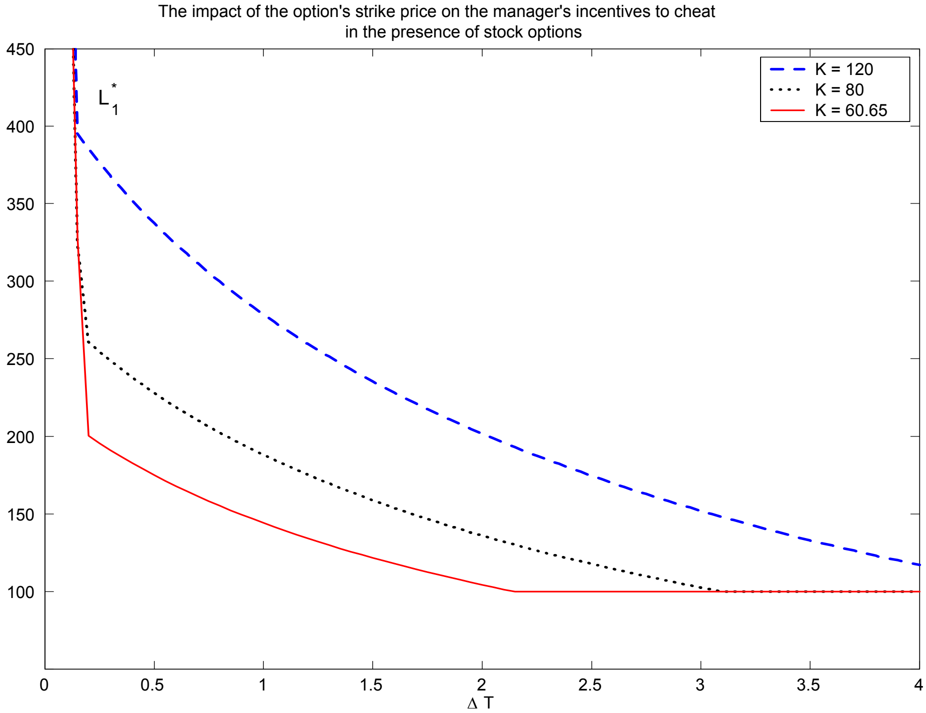

Figure 5. The level of the stock price at which the manager will engage in illicit activities (L_1^*) as a function of ΔT for different values of the options's strike price K when the manager receives stock options and when the length of the legal procedure ΔT is deterministic. The other parameters are: $S_{t_0} = 60.65$, $S_{t_1} = 100$, $\mu_1 = 0.10$, $\mu_2 = 0.20$, $\mu_3 = 0.05$, $\rho = 0.15$, $\alpha = 0.5$, $r = 0.05$, $\sigma = 0.15$, $A = 500'000$, $C = 100'000$, $D = 5'000'000$, $\eta = 0.2$, $t_1 = 5$.

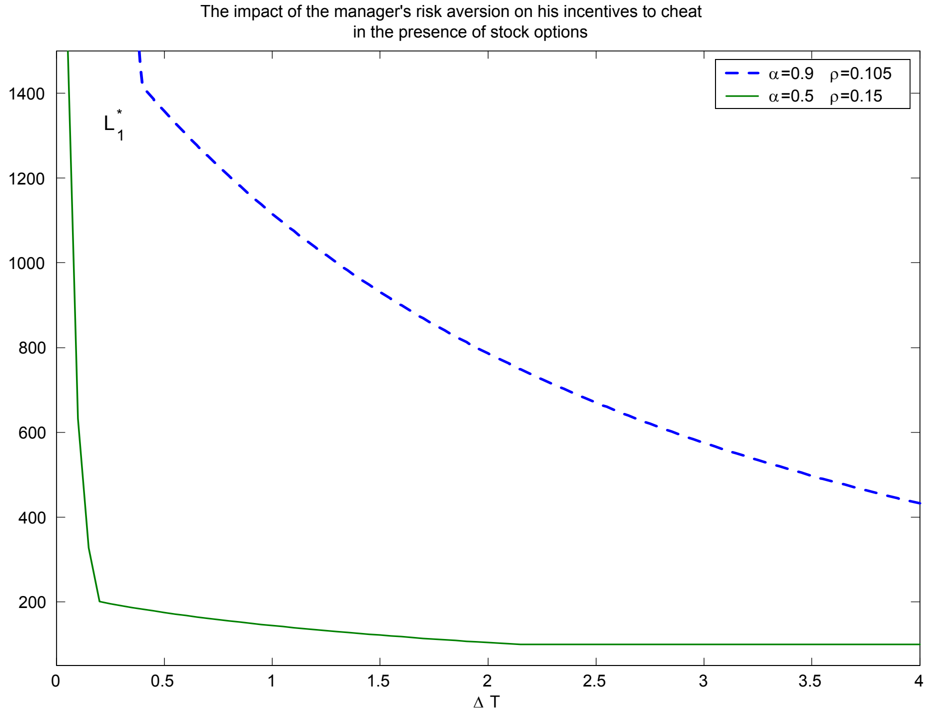

Figure 6. The level of the stock price at which the manager will engage in illicit activities (L_1^*) as a function of ΔT for different values of the risk aversion parameter α and the manager's discount factor ρ when the manager receives stock options and when the length of the legal procedure ΔT is deterministic. The other parameters are: $S_{t_0} = K = 60.65$, $S_{t_1} = 100$, $r = 0.05$, $\mu_1 = 0.10$, $\mu_2 = 0.20$, $\mu_3 = 0.05$, $\sigma = 0.15$, $A = 500'000$, $C = 100'000$, $D = 5'000'000$, $\eta = 0.2$, $t_1 = 5$.

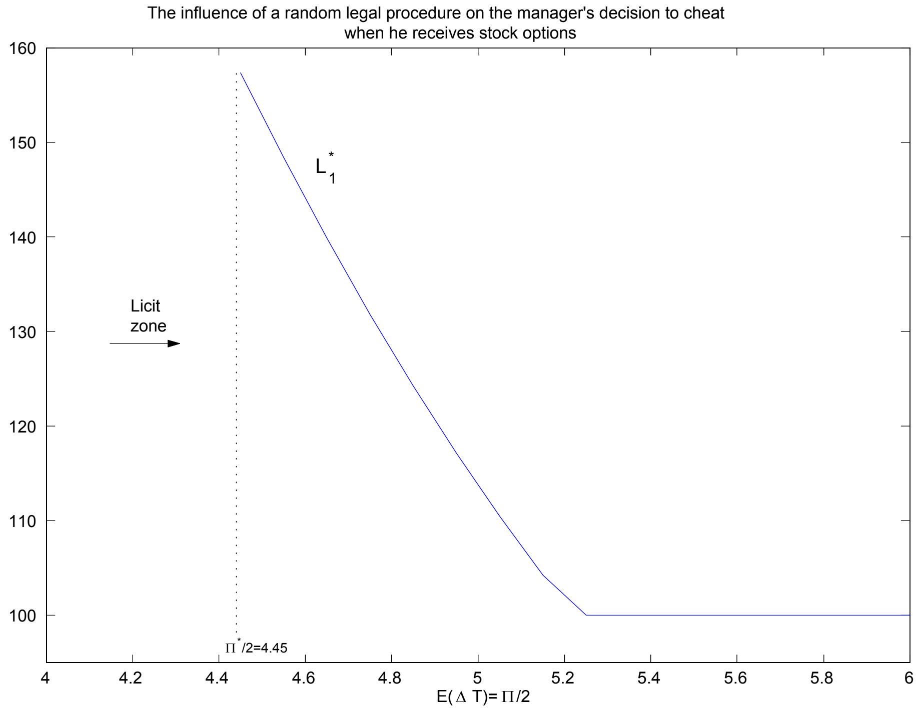

Figure 7. The level of the stock price at which the manager will engage in illicit activities (L_1^*) as a function of the mean value of the length of the legal procedure ΔT, i.e. $E(\Delta T)$, when the manager receives stock options and when the legal procedure is random (with a uniform distribution over $[0, \Pi]$). The other parameters are: $S_{t_0} = K = 60.65$, $S_{t_1} = 100$, $\rho = 0.15$, $\alpha = 0.5$, $r = 0.05$, $\mu_1 = 0.10$, $\mu_2 = 0.20$, $\mu_3 = 0.05$, $\sigma = 0.15$, $A = 500'000$, $C = 100'000$, $D = 5'000'000$, $\eta = 0.2$, $t_1 = 5$.

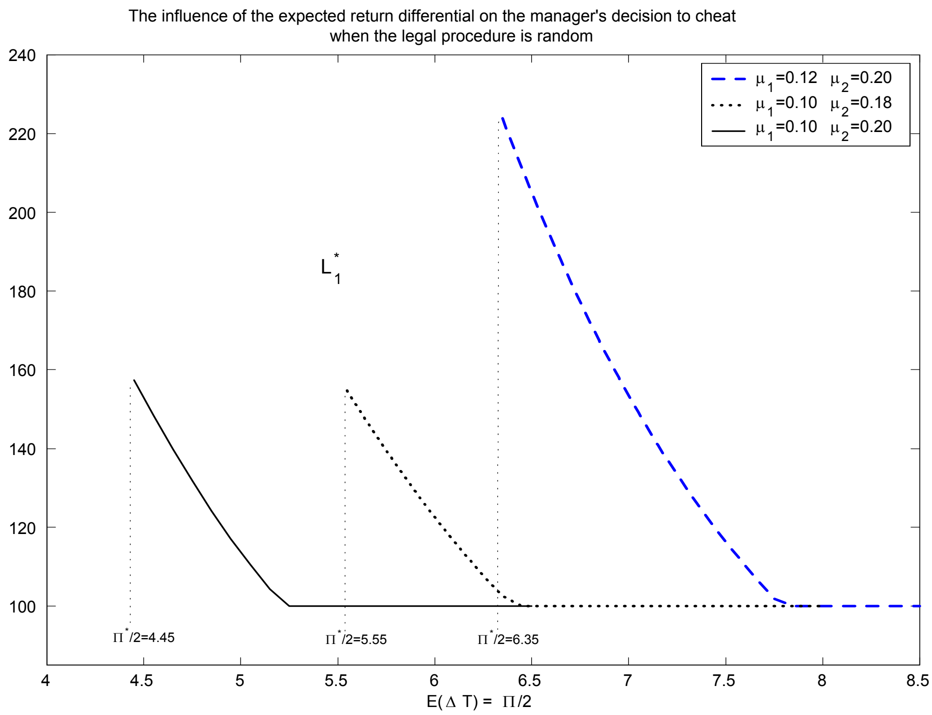

Figure 8. The level of the stock price at which the manager will engage in illicit activities (L_1^*) as a function of the mean value of the length of the legal procedure ΔT, i.e. $E(\Delta T)$, for different values of drifts of the stock price μ_1 and μ_2 when the manager receives stock options and when the legal procedure is random (with a uniform distribution over $[0, \Pi]$). The other parameters are: $S_{t_0} = K = 60.65$, $S_{t_1} = 100$, $\rho = 0.15$, $\alpha = 0.5$, $r = 0.05$, $\mu_3 = 0.05$, $\sigma = 0.15$, $A = 500'000$, $C = 100'000$, $D = 5'000'000$, $\eta = 0.2$, $t_1 = 5$.

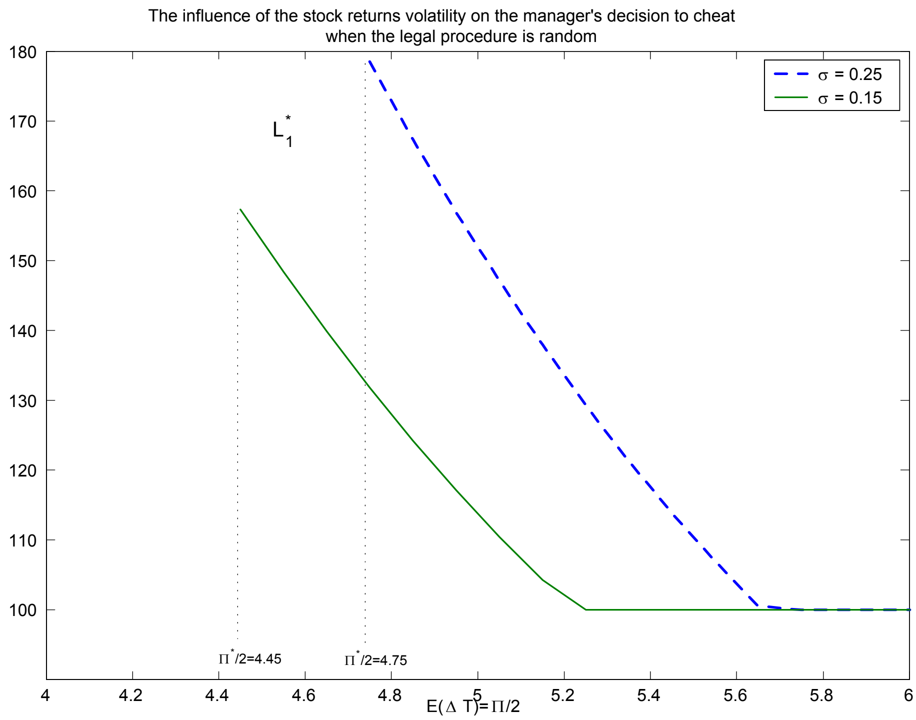

Figure 9a. The level of the stock price at which the manager will engage in illicit activities (L_1^*) as a function of the mean value of the length of the legal procedure ΔT, i.e. $E(\Delta T)$, for different values of the stock price volatility σ when the manager receives stock options and when the legal procedure is random (with a uniform distribution over $[0, \Pi]$). The other parameters are: $S_{t_0} = K = 60.65$, $S_{t_1} = 100$, $\rho = 0.15$, $\alpha = 0.5$, $r = 0.05$, $\mu_1 = 0.10$, $\mu_2 = 0.20$, $\mu_3 = 0.05$, $A = 500'000$, $C = 100'000$, $D = 5'000'000$, $\eta = 0.2$, $t_1 = 5$.

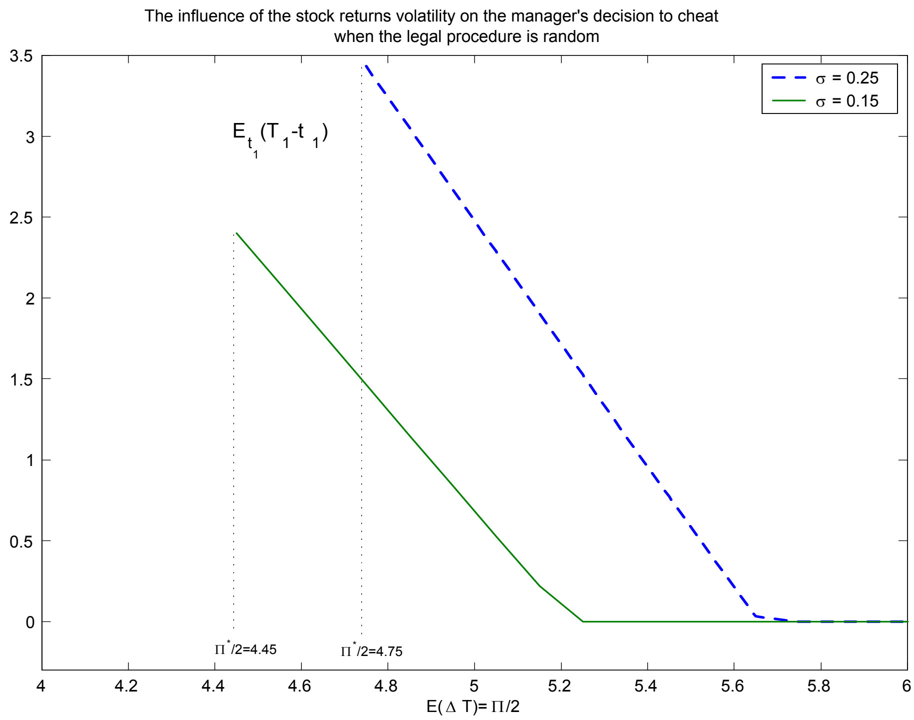

Figure 9b. The expected time at which the manager will engage in illicit activities, $E_{t_1}(T_1 - t_1)$, as a function of the mean value of the length of the legal procedure ΔT, i.e. $E(\Delta T)$, for different values of the stock price volatility σ when the manager receives stock options and when the legal procedure is random (with a uniform distribution over $[0, \Pi]$). The other parameters are: $S_{t_0} = K = 60.65$, $S_{t_1} = 100$, $\rho = 0.15$, $\alpha = 0.5$, $r = 0.05$, $\mu_1 = 0.10$, $\mu_2 = 0.20$, $\mu_3 = 0.05$, $A = 500'000$, $C = 100'000$, $D = 5'000'000$, $\eta = 0.2$, $t_1 = 5$.

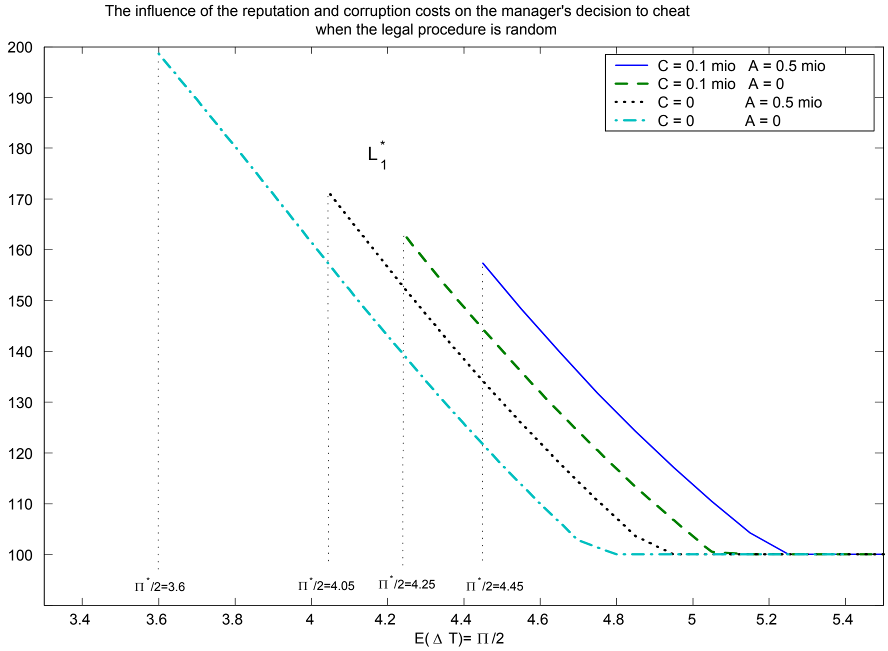

Figure 10. The level of the stock price at which the manager will engage in illicit activities (L_1^*) as a function of the mean value of the length of the legal procedure ΔT, i.e. $E(\Delta T)$, for different values of the initial reputational capital A and corruption cost C when the manager receives stock options and when the legal procedure is random (with a uniform distribution over $[0, \Pi]$). The other parameters are: $S_{t_0} = K = 60.65$, $S_{t_1} = 100$, $\rho = 0.15$, $\alpha = 0.5$, $r = 0.05$, $\mu_1 = 0.10$, $\mu_2 = 0.20$, $\mu_3 = 0.05$, $\sigma = 0.15$, $D = 5'000'000$, $\eta = 0.2$, $t_1 = 5$.

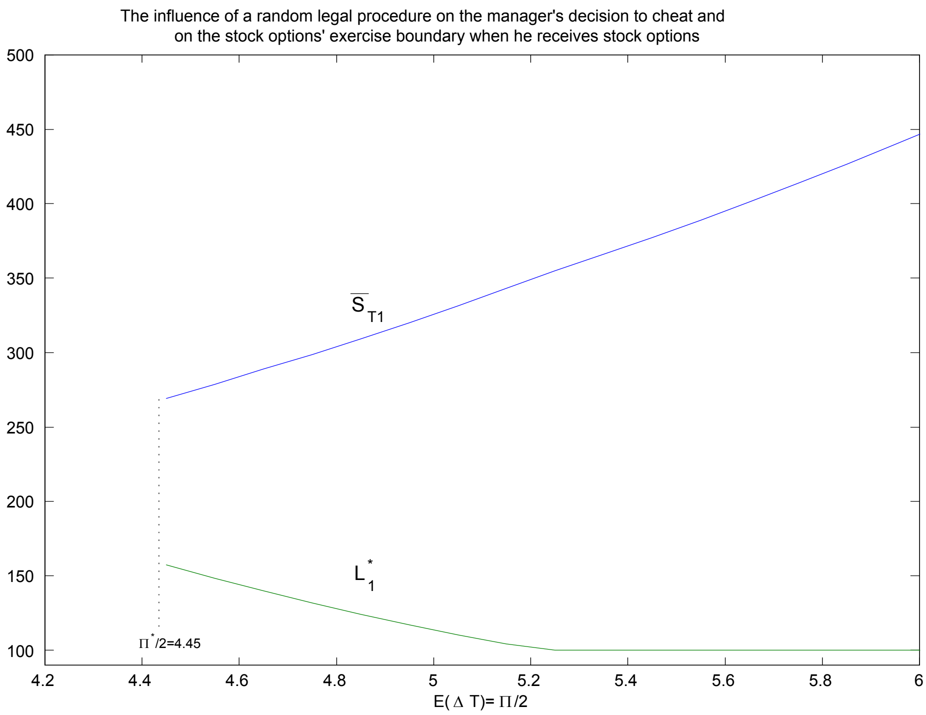

Figure 11. The level of the stock price at which the manager will engage in illicit activities (L_1^*) and the level which defines the boundary at which the stock options are exercised $(\bar{S}_{T1})$ as a function of the mean value of the length of the legal procedure ΔT, i.e. $E(\Delta T)$, .when the manager receives stock options and when the legal procedure is random (with a uniform distribution over $[0, \Pi]$). The other parameters are: $S_{t_0} = K = 60.65$, $S_{t_1} = 100$, $\rho = 0.15$, $\alpha = 0.5$, $r = 0.05$, $\mu_1 = 0.10$, $\mu_2 = 0.20$, $\mu_3 = 0.05$, $\sigma = 0.15$, $A = 500'000$, $C = 100'000$, $D = 5'000'000$, $\eta = 0.2$, $t_1 = 5$.

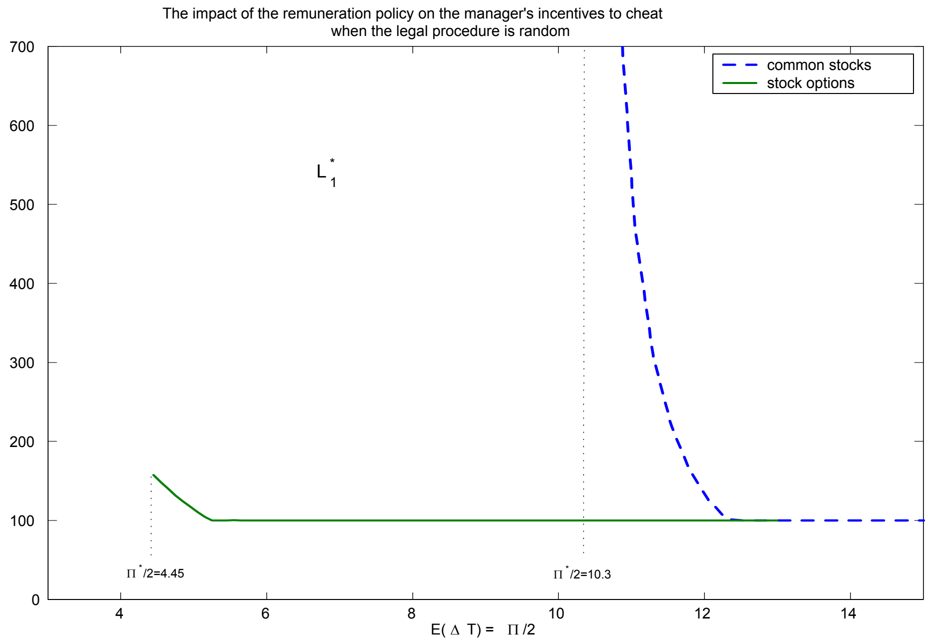

Figure 12. The level of the stock price at which the manager will engage in illicit activities (L_1^*) as a function of the mean value of the length of the legal procedure ΔT, i.e. $E(\Delta T)$, under different remuneration policies: (i) when the manager receives stock options, and (ii) when the manager receives common stocks, and when the legal procedure is random (with a uniform distribution over $[0, \Pi]$). Capitalizations of stock options and common stocks are both equal to 5 millions. The other parameters are: $S_{t_0} = K = 60.65$, $S_{t_1} = 100$, $\rho = 0.15$, $\alpha = 0.5$, $r = 0.05$, $\mu_1 = 0.10$, $\mu_2 = 0.20$, $\mu_3 = 0.05$, $\sigma = 0.15$, $A = 500'000$, $C = 100'000$, $D = 5'000'000$, $\eta = 0.2$, $t_1 = 5$.

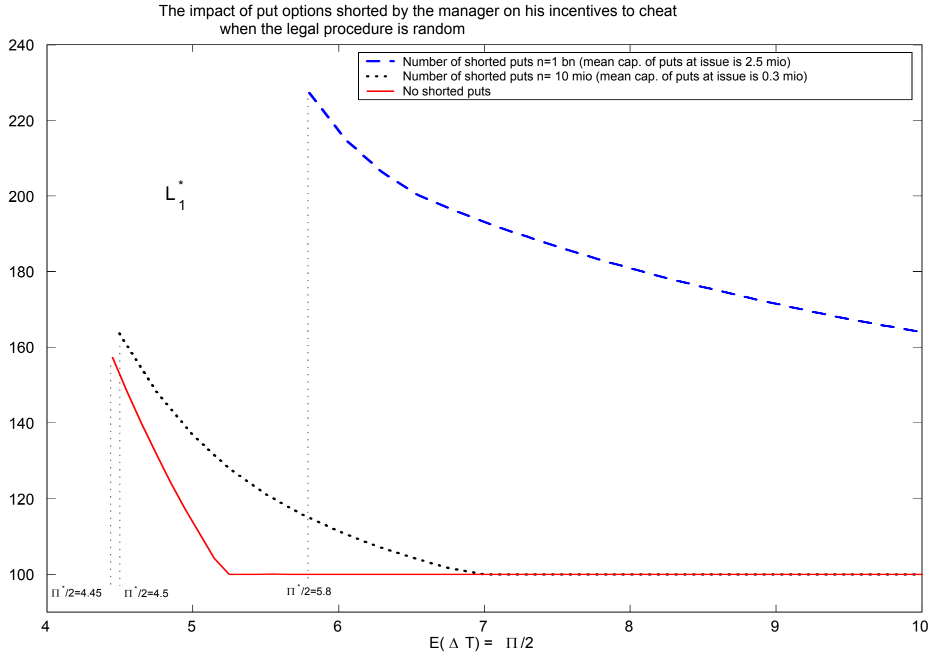

Figure 13. The level of the stock price at which the manager will engage in illicit activities (L_1^*) as a function of the mean value of the length of the legal procedure ΔT, i.e. $E(\Delta T)$, for different numbers of the put options when the manager receives stock options, shorts put options and when the legal procedure is random (with a uniform distribution over $[0, \Pi]$). The other parameters are: $S_{t_0} = K = 60.65$, $S_{t_1} = 100$, $\rho = 0.15$, $\alpha = 0.5$, $r = 0.05$, $\mu_1 = 0.10$, $\mu_2 = 0.20$, $\mu_3 = 0.05$, $\sigma = 0.15$, $A = 500'000$, $C = 100'000$, $D = 5'000'000$, $\eta = 0.2$, $t_1 = 5$.

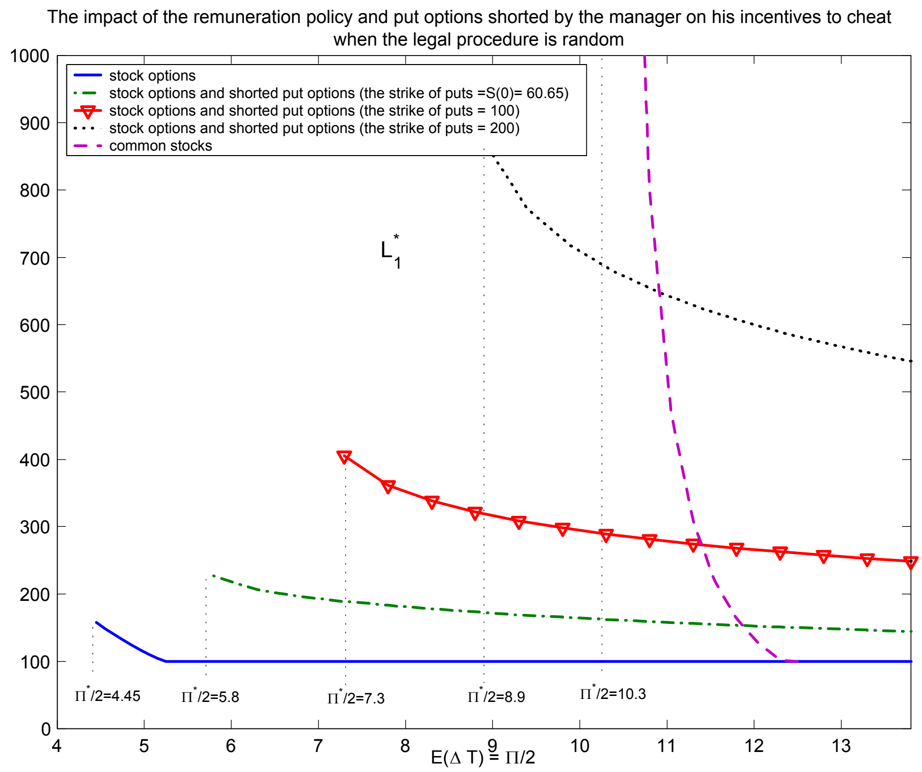

Figure 14. The level of the stock price at which the manager will engage in illicit activities (L_1^*) as a function of the mean value of the length of the legal procedure ΔT, i.e. $E(\Delta T)$, under different remuneration policies: (i) when the manager receives stock options, (ii) when the manager receives stock options and shorts one billion units of put options, and (iii) when the manager receives common stocks. The legal procedure is random (with a uniform distribution over $[0, \Pi]$). Capitalizations of stock options and common stocks are both equal to 5 millions. The other parameters are: $S_{t_0} = K = 60.65$, $S_{t_1} = 100$, $\rho = 0.15$, $\alpha = 0.5$, $r = 0.05$, $\mu_1 = 0.10$, $\mu_2 = 0.20$, $\mu_3 = 0.05$, $\sigma = 0.15$, $A = 500'000$, $C = 100'000$, $D = 5'000'000$, $\eta = 0.2$, $t_1 = 5$.