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Experimental Evidence**

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Mars 2010

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Reining in Excessive Risk Taking by Executives: Experimental Evidence

Mathieu Lefebvre and Ferdinand M. Vieider#*

03 March 2010

Abstract

Compensation of executives by means of equity has long been seen as a means to tie executives' income to company performance, and thus as a solution to the principal-agent dilemma created by the separation of ownership and management in publicly owned companies. The overwhelming part of such equity compensation is currently provided in the form of stock-options. Recent events have however revived suspicions that the latter may induce excessive risk taking by executives. In an experiment, we find that subjects acting as executives do indeed take risks that are excessive from the perspective of shareholders if compensated through options. Comparing compensation mechanisms based on stock-options to long-term stock-ownership plans, we find that the latter significantly reduce the uptake of excessive risks by aligning the executives' interests with those of shareholders. Introducing an institutionalized accountability mechanism consisting in the requirement for executives to justify their choices in front of a shareholder reunion also reduces excessive risk taking, and appears to be even more effective than long-term stock-ownership plans. A combination of long-term stock-ownership plans and increased accountability thus seem a promising direction for reining in excessive risk taking by executives.

Keywords: executive compensation; stock-options; incentives; accountability; risk taking

JEL Classification: D03, G28, G32, J33, L22

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1. Introduction

Linking executives' wealth to company or stock-price performance has long been recognized as the solution to the agency conflict between the interests of owners and managers (Jensen & Meckling, 1976). The issue of how to best achieve such linkage has however resurfaced recently as the world debates how to improve the incentive mechanisms that have led to the recent crisis. Whilst there is clear agreement in the economic community that the debate is largely misdirected by focusing on the 'how much' rather than the 'how' of compensation (Jensen & Murphy, 1990), the mechanisms at the root of excessive risk taking as well as the best ways to obviate them appear more elusive.

The importance of stock-option payments has increased dramatically over the last two decades and holds a prominent place in the overall compensation of executives (Core *et al.* 2003; Hall & Liebman, 1998). Indeed, stock-option plans account for up to 40% of the median executive's compensation (Murphy, 1999). Our particular concern here is with the excessive risk taking that may be induced by distorted incentive mechanisms deriving from the overwhelming use of such stock-option plans (DeFusco *et al.*, 1991; Holden, 2005). Indeed, options seem to offer high rewards for increases in stock prices whilst sheltering their holders from downside risks, thus rewarding volatility over stable stock-price developments (DeFusco *et al.*, 1990).

We are particularly interested in the effectiveness of two measures that have been discussed both in the academic literature and in the recent policy debate as means to reduce excessive risk taking by executives—the compensation through company shares rather than stock-options, and increased accountability of executives towards their shareholders. Paying executives in restricted company stock increases the linearity of the incentive instrument, thus aligning executives' payoffs directly with the interests of shareholders (Holden, 2005; Jensen & Murphy, 1990). Another possible solution may be to increase the direct power of shareholders by creating institutional structures that increase the pressure on executives to account for their actions.

The availability of data on these issues is very limited, and often no clear-cut, causal conclusions cannot be drawn even where such data can be found. We thus investigate the effect of different compensation mechanisms experimentally. In a context where few clear data are available, experiments may provide evidence on the effects of different incentive regimes. Furthermore, experiments have the advantage of permitting controlled variations in one independent variable at the time, thus permitting the isolation of clear causal relationships. Even though such high internal validity comes at the cost of reduced generalizability of findings to real-world phenomena, experiments are common in finance for issues that are difficult to disentangle in the real world (e.g. Biais *et al.*, 2005; Haigh & List, 2005; Thaler *et al.*, 1997), and can significantly supplement results obtained from the analysis of real-world data.

Our results indicate that option-based compensation schemes can indeed induce risk taking

by executives that is excessive from shareholders' point of view. Comparing compensation mechanisms based on stock-options to long-term stock-ownership plans, we find that the latter significantly reduce the uptake of risks. Introducing an institutionalized accountability mechanism, consisting in the requirement for executives to justify their decisions in front of a shareholder reunion, also reduces excessive risk taking. Companies managed by executives rewarded through stock-ownership plans and held accountable are thus found to perform significantly better than companies managed by executives who are unaccountable and/or compensated through stock-options. A combination of long-term stock-ownership plans and increased accountability thus seems a promising direction for reining in excessive risk taking by executives.

The present paper proceeds as follows. Section 2.1 discusses the issue of incentive-distortions resulting from compensating executives through stock-options. Sections 2.2 and 2.3 discuss potential solutions under the form of long-term stock-ownership plans and accountability respectively. Section 3 introduces the experiment, with 3.1 presenting the experimental purpose and setup, 3.2 the experimental methodology, 3.3 showing the results of share ownership plans, and section 3.4 the effect of accountability; section 3.5 summarizes those effects statistically and introduces additional results, while section 3.6 presents results on selling behavior of stock options. Section 4 presents a discussion of our findings, and section 5 concludes the paper.

2. Stock-Option Plans: Distortion of Incentives and Potential Solutions

2.1 Stock option compensation: current practice and incentive effects

Stock-options play an important role in the compensation packages of executives, constituting up to 40% of the compensation of the median executive (Murphy, 1999). This is often justified by their incentive value, according to which options may be used to link the executives' income to company performance (Core *et al.* 2003). However, there are increasing doubts that options may indeed be the best way to provide such a linkage of pay to performance. On the one hand, stock options have been shown to be more expensive for shareholders to emit than for executives to receive, which casts doubt on their effectiveness as an incentive instrument (Hall & Murphy, 2003). Perhaps worse, serious doubts about the incentive value of options have been aired. One problem in the structure of incentives provided by stock options derives from the fact that while executives reap the benefits from increases in the stock value, they are at the same time sheltered from downside risks resulting from declines since they need not exercise their options. While traditionally this has been seen as potentially beneficial in aligning risk averse executives' interests with those of shareholders (Feltham & Wu, 2001; Guay, 1999; Hall & Liebman, 1998), it is increasingly recognized that this incentive structure may in some instances lead to risk taking that is excessive from the company's perspective.

One mechanism that may induce such excessive risk taking is the downward repricing of exercise prices following a decline in stock value. While such repricing has been justified with the need to maintain the incentive value of option plans intact, the anticipation of the possibility of option plans being repriced does *de facto* remove the downside risk for executives holding such options. The permissibility of hedging by the executive seems to be equally puzzling, given that it also allows the executive to profit from potential gains, while sheltering himself from potential risks (Bebchuk & Fried, 2003). Furthermore, executives have been found to be often compensated for “luck”, i.e. for general industry or market trends that are unrelated to the executive's performance (Bertrand & Mullainathan, 2001).

Even if none of the above were true, an executive holding large amounts of options on company stock could still benefit from large stock volatility (DeFusco *et al.*, 1990; Murphy, 1999). Indeed, it is common practice that stock options are emitted *at-the-money*, i.e. at an exercise price equal to the market price of the stock at the date of emission. Once such options get vested, any shares bought through them are immediately cashable. On the one hand, this creates an issue that, to maintain incentives, new options will need to be issued. More importantly, the executive will have an interest in spikes of share value more than in long-term company value. Indeed, while increased risk seeking deriving from option plans has traditionally been explained as a solution to the agency problem inasmuch as it counteracts natural risk aversion of executives (e.g. Agrawal & Mandelker, 1987), more recent accounts cast doubt on such beneficial effects and emphasize how stock options can encourage *excessive* risk taking (Bebchuk & Fried, 2003; DeFusco *et al.*, 1991; Hall & Murphy, 2003; Tufano, 1996).

Even if one were to accept the above hypothesis, the question remains why stock options are so widely diffused. One potential answer embedded in a traditional optimal contracting view is that executives have been seen as potentially shying away from risks that may be optimal from shareholders' perspective. Smith & Stulz (1985) discuss how the linear incentives provided by stock-ownership plans may induce risk aversion in executives. If the relative costs of caution on the executive's side are seen as high relative to the potential costs of an excess in risk taking, then such an approach could explain the large increases in proportions of stock-options in executives' compensation packages observed over the last two decades.

An alternative explanation can be derived from rent extraction models that have been recently formulated in opposition to the classical contracting view. The latter assume that high compensation derives from cosy relationships between managers and boards, where the latter's interests are aligned with the ones of the executives themselves rather than with those of shareholders (Bebchuk & Fried, 2003; Bebchuk *et al.*, 2002; Bertrand & Mullainathan, 2001). Indeed, there is mounting evidence on a correlation between weak governance structures and

excessive remuneration packages (Core *et al.*, 1999). While we are not so much concerned with the amount of compensation executives receive, rent extraction models also predict distortions in the provision of incentives. These distortions derive from the fact that compensation mechanisms need to be justifiable and their costs need to be played down in order to make them acceptable to shareholders. By apparently linking pay to company performance, option compensation may appear acceptable, especially since option payments seem to be commonly perceived as less costly to shareholders than they actually are (Murphy, 2002).

2.2 Aligning incentives of executives and shareholders: long-term stock ownership plans

One way to align executives' interests with the interests of shareholders may be to force them to hold actual company stock (Holden, 2005; Jensen & Murphy, 1990). Studying a sample of companies that adopted *target ownership plans*—requirements that managers hold a given target value of the company in common stock—Core & Larcker (2002) showed that increased stock-ownership by executives significantly increased operating performance in the adopting companies in the two years following the adoption of the target ownership plan. They do however not discuss *why* performance increases, since the causal direction cannot clearly be isolated in their study.

We have already mentioned potential criticisms against the linear incentive structure provided by stock-based compensation, inasmuch as the latter may make executives too risk averse. Such a structure does however also provide numerous advantages. Stock options provide an incentive only as long as they are *at-the-money* or *in-the-money* (exercise price below current market price of shares). Indeed, *out-of-the-money* (exercise price above current market price) stock options may lose any kind of incentive value if the expectation of raising stock prices above their exercise price is low. Stocks owned on the other hand do always have incentive value, no matter what their current price may be. This also means that stocks do not need to be emitted as frequently as stock options, which tend to lose their incentive value much more quickly. Also, while executives are always sheltered against a stock depreciation when paid in options since the latter need not be exercised, stock that is actually owned by executives will move with company value, so that losses of stock value will also be felt.

Arguably, a dimension that maybe just as important as the fact whether executives are compensated through stock options or actual company stock is the time-horizon of the compensation scheme. Indeed, it has been argued that option schemes may provide incentives that are better aligned with the interests of shareholders if the vesting period of options is postponed, without any need for radical change of the compensation structure. On the opposite side of the spectrum, permitting executives to sell stock at any time may trigger excessive risk taking, inasmuch as they may benefit again from short-term stock-price fluctuations more than from the

creation of long-term value. Bebchuk *et al.* (2009) discuss this issue at some length. Given however that stock options lose their incentive value if the stock-price declines while actual company stock does not, longer-term incentive structures would appear to be more effective when compensation takes the form of company stock rather than stock-options. In the present experiment, we thus compare stock-options with short vesting periods to long-term stock-ownership plans.

2.3 Increasing Accountability of Executives Towards Shareholders

Although the legal situation is quite heterogeneous across countries, shareholders do not generally have a direct influence on executive compensation. While in the USA shareholders can vote down complete budgets set aside for compensation, they cannot specifically act on the compensation package of the chief executive officer alone. In general, the managerial power approach shows how there may be an issue in the fundamental structure of the principal-agent relationship postulated by traditional agency theory (Jensen & Meckling, 1976). Indeed, the board seems to hold most of the powers theoretically attributed to the principal, while in practice its interests may often be closer to those of the agent (Bebchuk & Fried, 2003; Bebchuk *et al.*, 2002). This suggests that increasing the institutional power of the original principal in the principal-agent relationship—the shareholder reunion—*vis-à-vis* the executive and at the expense of the board may improve the relationship itself.

Obviously, this brings us back to the origins of the principal-agent problem itself—the hidden information or limited time problem that has made delegation of power necessary in the first place. Clearly, day to day monitoring of the CEOs actions by a dispersed ownership structure is neither necessary nor advisable. Indeed, it may suffice for shareholders to have the power of requesting the CEO to justify and explain her decisions, and to vote about the approval or disapproval of such decisions, to change the CEOs course of action.

Indeed, some evidence on the effectiveness of accountability requirements on the behavior of executives surfaces here and there in the finance literature. Johnson *et al.* (1997) find that negative press coverage of executive pay packages leads to lower subsequent compensation increases. Furthermore, it has been suggested that large shareholders will monitor the executive's actions more closely since they have a greater interest in the company (Shleifer & Vishny, 1986). Empirically, the presence of large shareholders has been found to be associated with lower executive pay and better performance (Benz *et al.*, 2001; Cyert *et al.*, 2002). And the influence of such large shareholders seems to be particularly strong when they are present on the board, which increases their institutional standing (Bertrand & Mullainathan, 2001).

We argue that an institutionalized requirement for the executive to justify her actions in front of shareholders directly could restore at least in part the original principal-agent relationship.

Regardless of whether monitoring is close enough to really establish control, the mere threat of a shareholder resolution on the executive's performance (possibly with tangible consequences connected to it) may be enough to remind the executive of shareholders' interests. Indeed, in the present context the interests of the shareholders must appear to be rather clear—although they may well be in contrast with the private preferences of the executive. Taking actions that are clearly more conducive to the achievement of her own objectives than the fulfillment of shareholders' interests may become a lot more costly for an executive if her reputation or even job may thus be threatened.

3. The Experiment

3.1 Purpose and setup

We propose to study experimentally whether compensating executives through stock-options may induce risk taking behavior that is excessive from the point of view of shareholders. We further want to test how such excessive risk taking can be reined in—and especially the effectiveness of long-term stock-ownership plans at achieving that aim. We thus contrast a compensation mechanisms based purely on stock-options to one based purely on stock-ownership compensation. The issue whether at least some stock-options should be included in an executive's compensation package to induce desirable convexities in the compensation structure is not under investigation here. Indeed, by showing that options can induce *excessive* risk taking, we implicitly acknowledge the argument that they may be used to induce more risk taking by risk averse executives if that should seem desirable.

We also introduce an explicit requirement for the executive to justify her actions in front of a shareholder reunion to test for potential effects of increased accountability. This is implemented through a mechanism giving a certain probability for a shareholder reunion to be called. Shareholders can then question the manager's choices, and are asked to hold a final vote of approval/disapproval of the executive's actions. That vote does not carry any practical consequences for the executive in our design. It seems important to underline at this point that the shareholders are called to ask the executives about the reasons behind her decisions, so that no observation of the *ex ante* information at the disposal of the executive is required, limited knowledge about which is often invoked as one potential reason for the principal-agent relationship.

3.2 Experimental Design

Subjects. 156 subjects were recruited from a list of experimental subjects maintained at GATE, University of Lyon, France, using the ORSEE software (Greiner, 2004). Groups of six subjects needed to be formed, so that all sessions were run with either 12 or 18 subjects each. Subjects had

an average age of 22 years, and 52% of subjects were female. 71% were studying economics or business management, 22% mathematics or engineering and the rest is not specified.

Risk attitude. The experiment was divided into two parts. In part one of the experiment, risk attitudes were elicited following the method of Abdellaoui *et al.* (2008). While one choice was selected for real pay in each domain (gains, losses, and mixed gambles), no information on payoffs was given until the very end of the experiment to avoid income effects. This part of the experiment lasted approximately 20 minutes.

Task. In the main part of the experiment, groups of six subjects are formed. The composition of the groups is kept fixed for the 15 periods, and subjects do not know whom they are matched with. At the outset of the experiment, each group member is assigned the role of CEO of one company. In their function of CEO of a company, subjects are confronted with a sequence of investment decisions over 15 periods. In each period, the CEO decides between two investment opportunities into which to invest the total stock of company assets (screenshots in appendix A). The initial stock value of the company is €100 (\$150) for everyone. The final value of the company will be determined by the outcome of the 15 investment decisions¹. At the same time, each group member also acts as shareholder in the five other companies managed by the five other subjects in her group. The shareholder role is a passive role, in the sense that it does not require any action on the part for the subject (except at the very end in the accountability treatments, see below). However, it contributes towards final payoffs in the following way. Each subject is given one share with the initial value of €1 (\$1.50) in each of the other five companies in her group. She is then paid the final value of that share (total company value divided by 100) at the end of the 15 periods. The experiment was conducted using the REGATE software (Zeiliger, 2000).

Investment Decisions. In each period, the CEO has to choose between two investment opportunities in which to invest total company assets. The investment opportunities (*prospects*) are described in terms of percentage increases or decreases of the company's value. Investments are displayed graphically by means of pie-charts representing the probabilities of winning and losing in addition to a verbal description. The choice is always between a high volatility (*HV*) and a low volatility (*LV*) prospect. The LV prospect always offers a higher expected value than the HV prospect, so that any risk taking observed is excessive from the point of view of the company or the shareholders by

¹Please note that any change in share prices in our experimental model are generated purely by changes in the underlying value of the company assets as determined by investment outcomes—potential reactions by shareholders to option plans or to differences in risk taking by the CEO are not captured inasmuch as there is no market for shares.

definition, inasmuch as it delivers a lower expected value. Indeed, differences in expected value were such that consistently investing in the LV option would yield an expected final company value that was almost 30 percentage points higher than the one obtainable by consistently investing into the HV option. In the initial instructions, subjects were given a graphical overview of the general characteristics of the two investments as well as an example representing a choice between two 'typical investments'. This graphical display, as well as the complete instructions and a table showing the parameters of all prospect pairs can be found in the appendix.

Stock-Option Compensation. The stock-option treatment is our baseline treatment. Each CEO obtains five stock-options in each period, which are emitted at-the-money, i.e. giving the right to buy company stock at the current stock value. For example, the five options granted before period one investment decisions are made give each the right to buy a share of the company at €1 (\$1.50). The options get vested in the subsequent period and remain exercisable until the end of the game, so that they can be 'cashed' at any time. While in reality the options give right to buy company stock which can then be either sold or kept, this decision was unified in order to simplify the game. That is, exercising options in the experiment means buying stock and reselling it immediately, thus realizing the difference between current stock value and the exercise price of the option. This process seems to closely mimic real-world practices of "cashless exercise" (Heath *et al.*, 1999). Thus in every period after the first, the CEO is called upon to decide whether to cash her options after the results of the investment have become known (separately for options emitted in different periods). She will then obtain the new options and decide what kind of investment to take for the subsequent period.

Stock-Ownership Plan. In the stock-ownership condition subjects obtain an initial endowment of 10% of the company stock, corresponding to an initial value of €10 (\$15). At the end of the 15 periods, they are paid the final value of their stocks. They cannot sell their stock before the end of the 15 periods. Their payment structure thus coincides with the one of shareholders, who also obtain the value of their shares at the end of the 15 periods. The compensation parameters were designed in such a way that the total amount to be earned on average should be roughly equal to the compensation in the stock-option condition (see results sections for a discussion).

Accountability manipulation. In the baseline treatment subjects are *unaccountable*. While their actions will determine the final payoff of their shareholders, they cannot be traced back to them personally. In the *accountable* treatment on the other hand, subjects acting as CEOs may be called upon to justify their decisions in front of their shareholders. At the beginning of the experiment

subjects were asked to indicate their name so that they could be identified in case they would be extracted to justify their choices. They were assured that their names would not be kept together with their data and that this information would be destroyed after the experiment. Subjects are informed at the outset that in each group of six, one subject will be randomly extracted at the end of the game to justify her choices in front of the other five subjects in her group, who will act as shareholders. The randomized extraction was implemented inasmuch as it simulates a probability with which the executive's actions become known, and hence mimics the hidden action problem at the base of the principal-agent relationship. During the shareholder reunion, the shareholders were given a summary sheet displaying the decisions of the CEO and the evolution of the stock-value, and were allowed to interrogate the CEO about the reasons behind the decision making process. At the end of that questioning phase, they were required to hold a vote approving or disapproving the management of the company. This vote held no monetary or other practical consequences, and subjects were dismissed as soon as this procedure was over.

Treatments. The overall experimental setup has thus the following structure:

Table 1: Experimental Design (number of subjects in parentheses)

	Stock Ownership	Options
Unaccountable	USO (48)	UOP (48)
Accountable	ASO (30)	AOP (30)

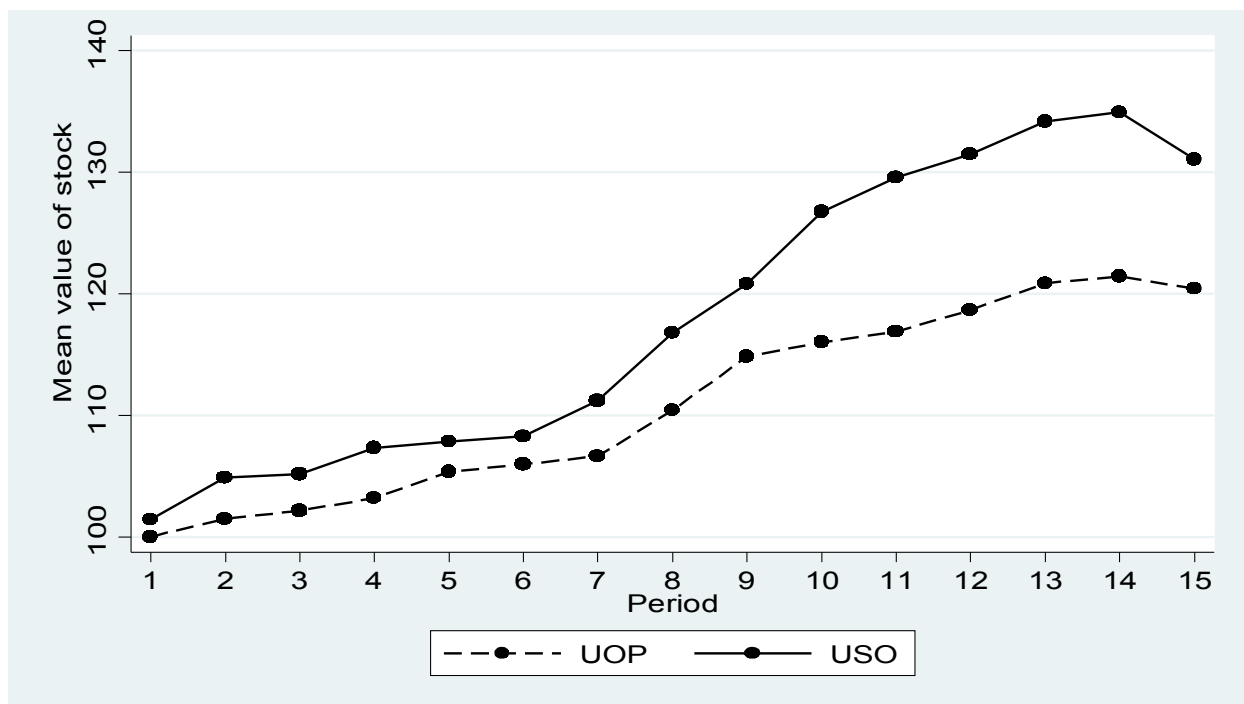
Hypotheses. We hypothesize that stock-option incentives lead to suboptimal behavior, in the sense that they induce risk seeking that is excessive from the shareholders' perspective. We also hypothesize that such excessive risk taking is reduced when the incentives of executives are aligned with those of shareholders through a long-term stock-ownership plan. Finally, we hypothesize that accountability also improves decision making by aligning it with the interest of shareholders. We thus expect the best performance in the stock-ownership/accountability (ASO) treatment.

3.3 Results: reducing risk taking through long-term stock-ownership plans

As hypothesized, executives take risks that are excessive from the point of view of shareholders when compensated through stock-options. Figure 1 shows the development of mean stock values by compensation type. It can clearly be seen that the mean stock value of companies managed by CEOs compensated through stock outperforms companies managed by CEOs compensated through stock-options. Indeed, the mean final value of companies managed by CEOs compensated by means

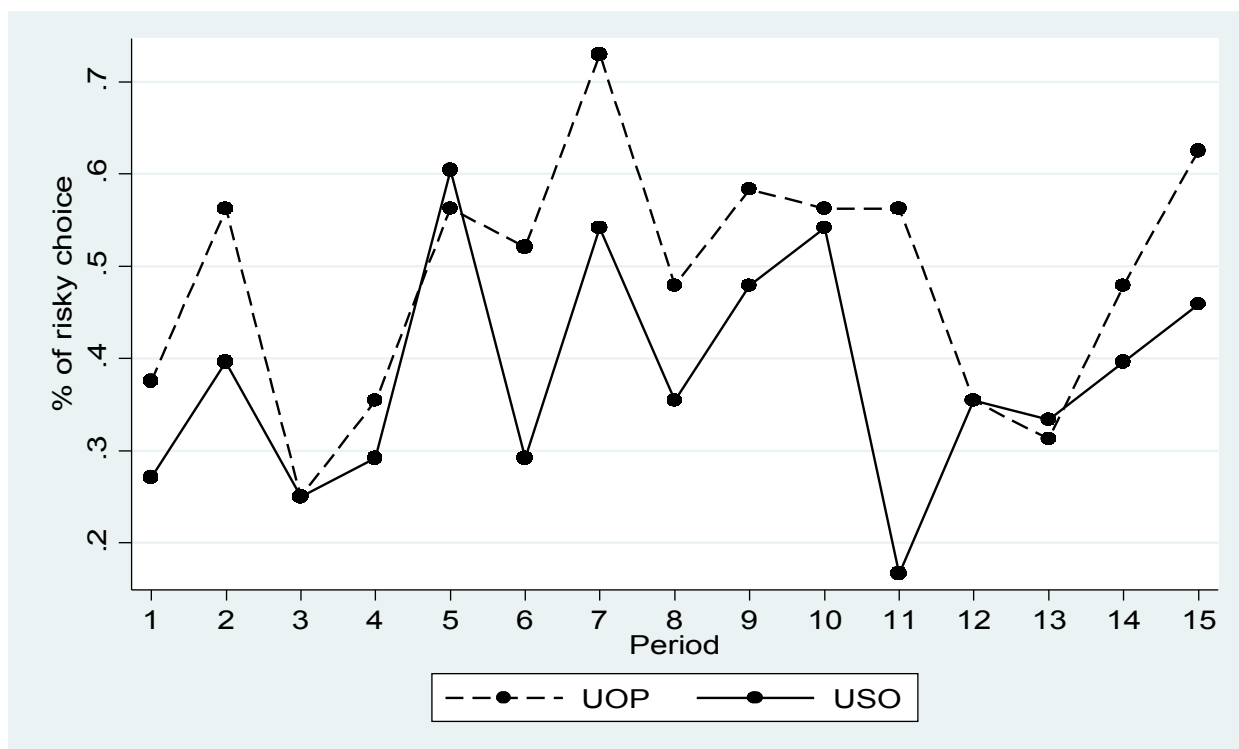
of stock-ownership plans is over 10 percentage points higher than the mean final value of companies managed by CEOs compensated with stock-options. On average, subjects earn a payoff of €19 in the option condition and €17 in the stock ownership condition. This difference is not significant ($Z = -0.557$, $p=0.578$; Mann-Whitney test), although the payoff in the stock option treatment has significantly more variance than in the stock ownership condition ($p<0.001$, variance ratio test).

Figure 1: Average stock evolution in option treatment (UOP) versus stock ownership (AOP) treatment over the 15 periods.



Looking directly at investment decisions, subjects can be seen to take significantly less risk on average when they are forced to hold stock in the company they manage compared to when they are compensated through options. As can be seen in figure 2, subjects holding stock in the company they manage take less risk than subjects compensated through options for almost all choices.

Figure 2. Average choice of HV investment in the option treatment (UOP) and the stock ownership treatment (USO)



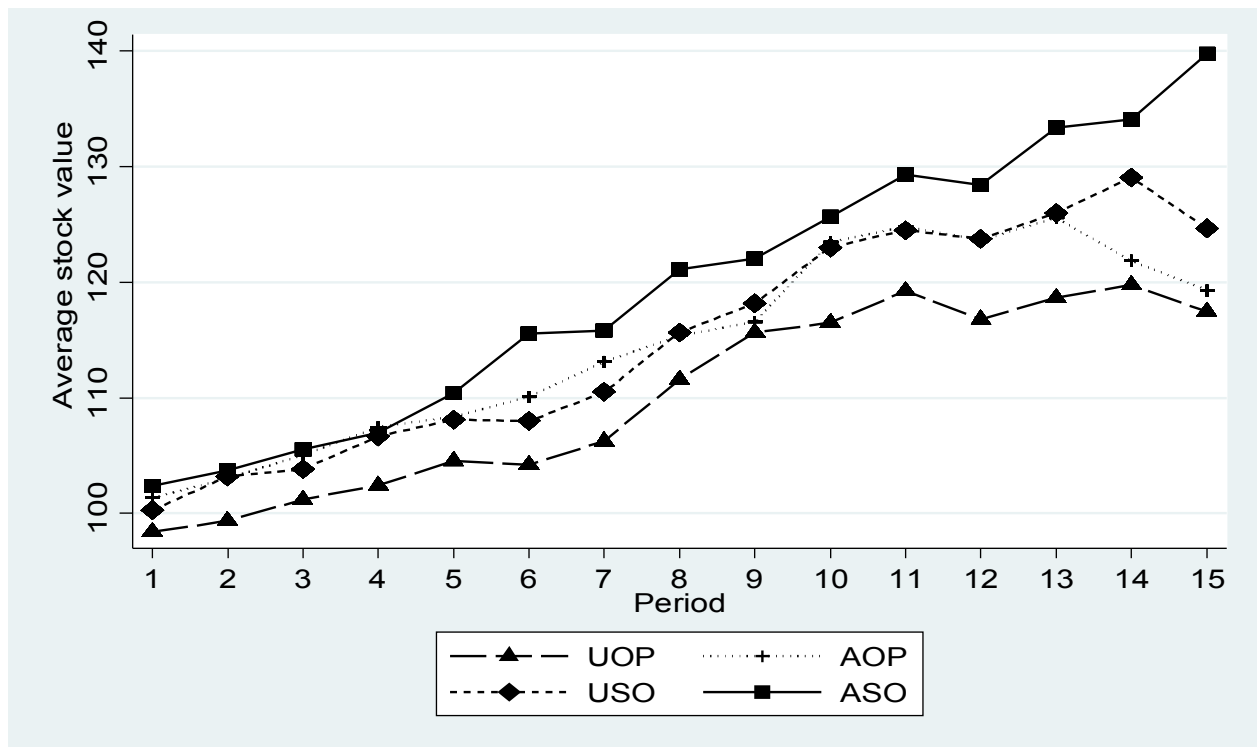
3.4 Results: reducing risk taking through increased accountability

We now proceed to looking at the accountability manipulation. As can be seen from figure 3, accountability improves company performance under both the option compensation and the stock-ownership compensation mechanism. The best performing companies are those managed by CEOs who are held accountable and incentivized through stock-ownership plans. The worst performing companies are the ones managed by unaccountable CEOs incentivized through stock-options. Average payoffs for unaccountable subjects are now €18 (\$27), which compare to average payoffs of €16 (\$24) for accountable subjects. Such a general comparison is however misleading, since it aggregates across incentive conditions. Indeed, when looking at the stock ownership condition alone, we find that unaccountable subjects earn an average of €17 (\$25) as compared to an average of €22 (\$33) earned by accountable subjects. This goes to show that executives take risks that are excessive not only from the perspective of their shareholders, but that the level of risk is suboptimal even for themselves.

This beneficial effect of accountability on earnings of executives in the stock ownership condition is however reversed in the stock option condition, in which accountable subjects earn only €11 (\$26) on average, which compare to an average of €19 (\$28) earned by unaccountable subjects in the same payment condition (significantly different at $p < 0.05$). As will be further shown below in the section on option selling behavior, this difference is indeed caused by differences in

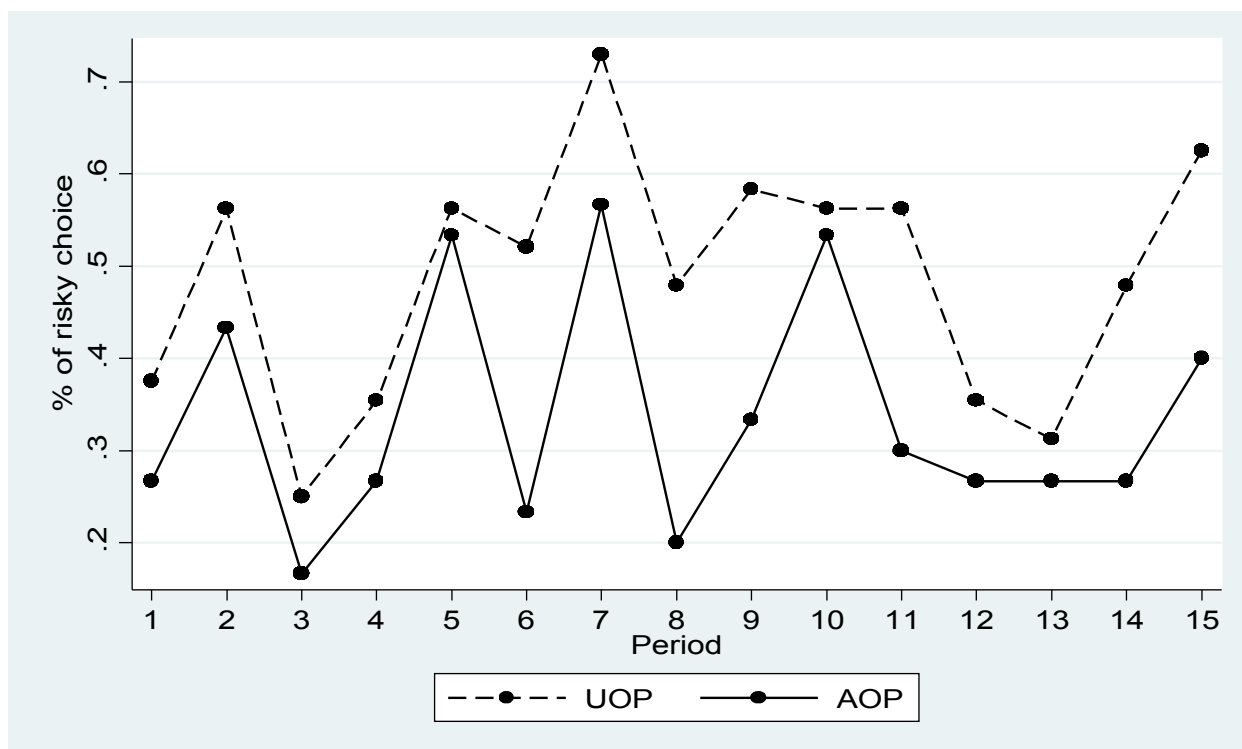
risk taking and not so much in the selling behavior of options. This finding thus indicates a conflict between the maximization of own profits and maximization of shareholder value in the option condition. Making executives accountable in the option compensation condition pushes them towards acting more in the interest of shareholders by taking fewer risks, even if they thus have to sacrifice some of their own profits.

Figure 3: Comparison of mean company performance across the four treatments



This intuition is confirmed when looking at the choice data. Figure 4 shows average choices for the risky investment under the option condition when subjects are unaccountable and when they are accountable. It shows clearly how on average accountable subjects choose less risk throughout. While the same general pattern of reduced risk taking by accountable subjects is also observed for subjects who are compensated through stock-ownership plans, the difference is less pronounced. This is not surprising, given that original risk taking is already much lower in the stock ownership treatment. While the effect is much less clear than for option compensation, accountability still reduces risk taking in the stock ownership condition. This will become more apparent from the statistical results presented in the next section, where additional elements of the decision making process such as differences in expected value of the two investment prospects can be controlled for.

Figure 4: Average choices of risky investment in the option condition by accountable (AOP) and unaccountable (UOP) subjects



3.5 Regression analysis of overall results: drivers of choice

The last two sections have descriptively shown the effectiveness of stock-ownership plans and of accountability in reducing sub-optimal risk taking behavior by executives. We now take a closer look at what is driving choice behavior in general, across all treatments. Table 2 shows the results from a random effects Probit model regressing the choice of the riskier investment on dummy variables indicating the treatments and a number of other variables. All specifications include period dummies as well as demographic variables such as age, gender and whether the participant is studying economics or business administration.

In specification (1), we simply look at the effect of our main treatment variables—whether executives are compensated through options or stock, and whether they are held accountable or not. In addition, we include the difference in expected value between the two proposed investments. This variable allows us to check if subjects take expected payoffs into account when making their decision. In specification (2), we add several measures of two other potentially important drivers of choice—past choices and the general company performance. In order to investigate the possibility of path dependency or simply the effect of past events, we add the stock-value in the previous period as well as the growth rate of the stock value resulting from the last investment. We also add information on whether the participant chose a risky investment in the preceding period, if the investment in the previous period was successful, and a crossed variable indicating success of a risky investment. Specification (3) adds the cumulative income from selling the options in the

stock-options treatment and the current value of the owned shares by the participant in the stock-ownership treatment to control for potential income effects. Finally, in the last specification (4), we introduce a measure of risk aversion, calculated as the difference between the expected value of a pure gain prospect and the certainty equivalent elicited for that same prospect.

Table 2: Drivers of choice (Random-effects Probit model)

Dep. Variable: choice of the risky investment	(1)	(2)	(3)	(4)
Stock-ownership	-0.243** (0.116)	-0.255** (0.131)	-0.438*** (0.157)	-0.417*** (0.153)
Accountability	-0.301** (0.121)	-0.335** (0.136)	-0.329** (0.135)	-0.375*** (0.131)
Difference in expected value	-0.351*** (0.106)	-0.343*** (0.108)	-0.342*** (0.108)	-0.354*** (0.108)
Previous period stock value		-0.049 (0.146)		
Growth rate		-0.011*** (0.003)	-0.013*** (0.003)	-0.013*** (0.003)
Choice of risky in previous period		-0.194** (0.093)	-0.187** (0.093)	-0.188** (0.093)
Success in the previous period		0.078 (0.083)	0.065 (0.083)	0.063 (0.083)
Success in the previous period if choice of risky		-0.390*** (0.135)	-0.417*** (0.134)	-0.418*** (0.134)
Accumulated Income			0.020** (0.010)	0.021** (0.010)
Gender (male=1)	0.024 (0.116)	0.010 (0.130)	0.016 (0.129)	0.004 (0.124)
Econ/business studies	-0.271** (0.134)	-0.312** (0.150)	-0.312** (0.150)	-0.296** (0.144)
Age	-0.013 (0.013)	-0.014 (0.015)	-0.014 (0.015)	-0.010 (0.015)
Risk aversion (EV-CE)				-0.029*** (0.008)
Constant	0.183 (0.381)	0.767* (0.438)	0.516 (0.421)	0.457 (0.406)
Period effects	YES	YES	YES	YES
Nb observations	2340 (156 subjects)	2184 (156 subjects)	2184 (156 subjects)	2184 (156 subjects)
LL	-1375	-1278	-1276	-1270

Note: *** significant at the 1% level; ** at the 5% level and * at the 10% level. Standard errors in parentheses.

The compensation through stock instead of options significantly reduces risk taking by executives—an effect that is very stable across all specifications. This confirms our conjecture that the use of stock-option plans encourages excessive risk taking. Accountability is also effective at reducing the uptake of excessive risks, and stays significant throughout. The fact that differences in expected value (actually: expected stock-value changes) are highly significant throughout goes to show that subjects carefully examine the parameters of the investment options when making a decision. It also seems worth mentioning that the effect of the difference in expected value appears much more important in the stock-ownership condition than in the option condition. Indeed, it is highly significant in the former ($p < 0.01$), while only marginally so in the latter ($p < 0.1$), and the coefficient is almost twice as large for stock-owners. This makes indeed sense if one considers that the aim of maximizing own revenue is best achieved through expected value maximization if one is compensated through actual stock, while income in the option condition may depend more on stock-value change than expected value. It also provides an additional indication that when risk taking occurs in the stock-ownership condition it does so mostly for prospect pairs that are close in terms of expected value, and that it is thus relatively more beneficial (or less harmful) to shareholders than the more erratic risk-seeking embarked upon by executives compensated through options.

As to the general population variables, there is no main effect of gender or age. Interestingly however, field of study has a significant effect. Indeed, economics or business management students take less risk than the other subjects. In order to understand this finding better, we need to look at the effect for different compensation schemes in isolation. Indeed, if we regress the choices of the riskier investment on the same variables separately for the stock-ownership and option conditions, we find that economics and business students take significantly less risks than other subjects in the stock-ownership conditions ($p < 0.01$). When compensated through stock options on the other hand, they take slightly more risks than other subjects (ns). This means that in a way they are better at maximizing their own payoff, which is linked to stock value in the stock-ownership conditions, but not necessarily in the stock-option conditions.

Apart from the main effects just discussed, several interesting insights can be gained from the data. Indeed, in a dynamic setting carrying over the effects from past events, investment choices are likely to be dependent on the path taken by the stock-value of the company managed. This shows in the data in several ways. First of all, subjects are much less likely to make a risky investment if they have invested into the risky asset in the previous period, and the investment has been successful. This goes to show how they try to capitalize upon a gain that has been obtained, and to gradually increase it with less risky investments. As shown by the slight negative effect on

risk taking of the growth rate in company stock, especially a large increase in company value makes it less likely that the risky investment will be chosen again, while a large decrease will make risk taking more likely. Interestingly, the interaction effect between risky choice and success in the last period is completely driven by the stock-option condition—once a large gain has been realized there, subjects try to further increase their return on options held by investing in the low volatility prospect ($p < 0.01$; see below for selling behavior of options). In the stock-ownership condition on the other hand what is significant is the simple choice of a risky investment in the previous period ($p < 0.01$)—once the riskier prospect has been chosen, subjects generally revert to the low volatility investment regardless of whether the risky investment chosen in the last period has been successful or not.

In order to control for accumulated income, we use the cumulative gains from selling the options in the stock-option incentive treatment. We also use the current value of the owned shares by the participant in the stock ownership treatment. Please note that the latter variable represents an approximate measure of the subject's income, since current stock value may still be lost due to future stock-price declines. Using this measure, we do indeed find evidence of an income effect. We find a positive effect of income, such that a higher accumulated or expected income leads to more risk taking. This finding is consistent with previous findings in the literature on income effects and risk taking (Barberis *et al.*, 2001; Thaler & Johnson, 1990). Looking separately at the two incentive conditions, we can see that this finding is completely driven by the option condition, in which our adopted measure indeed indicates accumulated income that cannot be lost ($p < 0.05$). The effect is not significant in the stock-ownership condition, where the measure does not really represent accumulated income, but only an indication of expected income.

Looking at the graphs of choice patterns in the preceding sections, one could see that the proportion of risky choices increases in the last period of the game. Though we have chosen not to report coefficients of period dummies in detail, it is interesting that the coefficient for the last period is positive and significant and amongst the highest period effects. This means that subjects take a last period long shot that goes beyond what may be expected from the fundamentals of the investment prospects available in that period. Interestingly, looking at the interaction between the last period dummy and the accumulated income index, a negative and significant effect is found ($p < 0.10$). This means that the high peak of risky choices in the last period is driven by those who *did not* accumulate enough gains previously. Notice how this effect actually runs counter to the general income effect described above, since it is now subjects with low accumulated income that take more risk. There thus seems to be a sort of aspiration level effect that drives last-period risk-taking behavior.

Risk aversion is thought to play an important role in the decision making of CEOs. Indeed,

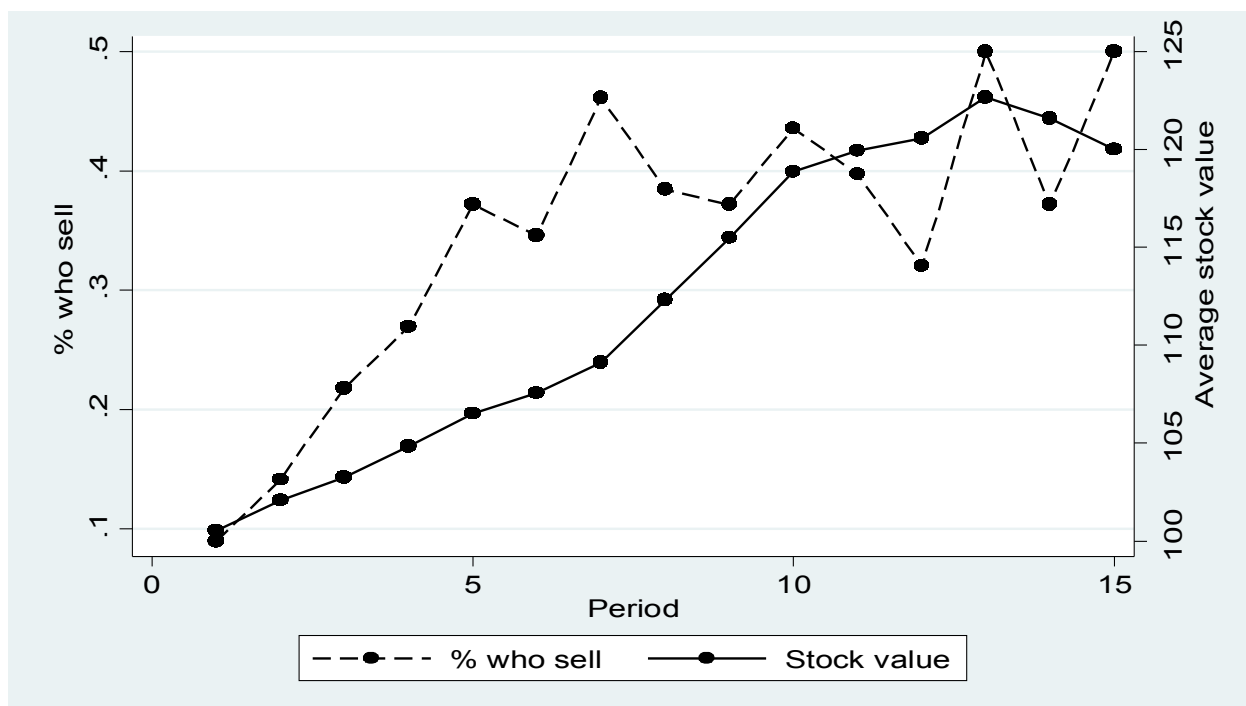
risk aversion by CEOs has been used as an argument for using stock-option compensation over stock-ownership plans to link CEO pay to company performance. Adding a general index of risk aversion in specification 4, we find a negative and strongly significant effect as we would expect. Notice however that all other effects—and especially the ones of the main treatment variables stock-ownership and accountability—remain highly significant after controlling for risk attitude. Looking at the effect of risk aversion separately for the option and stock-ownership conditions, it emerges that the effect is driven mainly by decision makers compensated through stock ($p < 0.01$), while it is only marginally significant in the option condition. This makes sense inasmuch as stock-price is not the main determinant of the CEO's payoffs in the option condition. Indeed, we will see below that risk aversion will play a role for selling decisions of options.

3.6 Selling decisions for Stock Options

We next take a look at executives' option selling behavior. While some studies on behavioral patterns in option selling behavior do exist (Core & Guay, 2001; Heath *et al.*, 1999; Huddard & Lang, 1996), no experimental studies on the issue have been conducted to the best of our knowledge. Retracing previously found patterns in our data may thus serve the double purpose of confirming the generality of behavioral patterns found, and of validating the behavior of our subjects if such patterns are indeed reproduced.

On average, subjects wait three periods before exercising their options and the average number of options sold at once is 15.3. Out of the 1170 option bundles emitted, 305 are never exercised. The average gain on the sale of a group of 5 options is 0.57 cents (0.90¢) which correspond to a gain of 11.4 cents (16¢) per option. However the standard deviation is 0.88 which shows that some of the subjects make mistakes and sell their options with a loss. If we look at treatment differences, accountability does not affect the waiting time for selling the options nor the number of options sold. The average gain is however 0.69 cents (11¢) for unaccountable subjects, and only 0.36 cents (5.5¢) for accountable subjects. This is explained by the lower levels of risk taking under accountability discussed above. Figure 5 plots selling decisions of at least some stock-options against the average stock value.

Figure 5. Option selling decisions and stock-price evolution



From the descriptive analysis presented so far it appears clear that options are often exercised long before their termination date. From a normative point of view, people should not exercise options before they expire because the market value of a “live” option exceeds the proceeds from exercise (Heath *et al.*, 1999). However, studies have shown that this premature exercise may be rational. The main reason for selling stock option is cash money (liquidity considerations) which do obviously not apply in our experimental setting. In addition however, stock-options do also provide subjects with a sure amount of cash in the current period and an uncertain amount of cash in the future. In this sense, subjects may sell their options too early if they are loss averse, thus exhibiting a sort of myopic loss aversion (Benartzi & Thaler, 1995; Fellner & Sutter, 2009; Thaler *et al.*, 1997).

Huddart & Lang (1996) show that recent movements in the stock value are also important in explaining exercising decisions. This provides an indication that exercise decisions are sensitive to risk aversion. Heath *et al.* (1999) examine whether psychological factors influence exercise decision. They show that exercise decisions depend on whether the current price is above or below a psychological reference point. Individuals are found to be more likely to exercise their options when the stock value exceeds a reference point fixed at the maximum value of the stock-price over the last year. They also present evidence that decisions to exercise options depend on recent stock-price movements. In particular, they are found to depend positively on past short-term returns, while longer term returns seem to play no significant role. Core & Guay (2001) confirm the psychological findings documented by Heath *et al.* (1999) in a broad sample.

Table 3 presents a Probit regression analysis of option selling decisions on a number of potential explanatory variables. We take as dependent variable the selling decision (1 if sold, 0 if kept) for each bundle of five options. Option bundles are thus followed from their emission period through the selling period, and may thus be included in the regression between one and 15 times, depending on when they are emitted and when they are sold. This results in a total of 5159 observations.

Accountability produces a marginally significant negative effect, indicating that accountable subjects are less likely to sell their options in any given period compared to unaccountable subjects. However, a closer look suggests that the effect captured by accountability may be due to different selling strategies pursued by accountable subjects relative to unaccountable subjects. Indeed, if one includes an additional variable measuring total risk-taking throughout the 15 investment periods, accountability is no longer significant (although the risk-taking measure is not significant either). This indicates a different investment strategy pursued by accountable subjects relative to unaccountable subjects, which in turn changes selling behavior, rather than a direct effect of accountability.

Reassuringly, the potential gain that can be realized by selling a package of options influences decision. This goes to show that the overall majority of subjects understood the payoff mechanism quite well. In order to test for economic rationality in the decision to exercise, we also include the expected value of any option packages held. This variable is calculated by taking future choices of subjects for given, and taking the expected value of the stock-price evolution conditional on those choices. We find a significant negative effect of this measure of potential future gains on selling decisions. This indicates that the higher the value of any options held is likely to get in the future, the more likely subjects are to hold on to them instead of selling them immediately. This fact is again conducive to the conclusion that subjects clearly understood the remuneration mechanism. Quite naturally, holding a larger amount of options makes selling them more likely. Furthermore, the number of options already sold also makes it more likely that options will be sold in any given period. The latter finding could be due to several factors, including a general positive trend in stock-price, a different investment strategy, or the perpetuation of an initial selling strategy (e.g. 'sell as soon as a positive gain can be realized').

As already for investment choices, we find an income effect also for selling (exercising) decisions. Indeed, a higher accumulated income makes it less likely that options are sold in any given period, indicating a higher acceptance of the risk deriving from keeping the options longer-term. We also find a highly significant effect of a reference point as suggested by previous studies. Representing such a reference point by a dummy variable indicating whether the current stock-price is higher or lower than in any preceding period, we find that a stock-price above the reference point

makes an exercising decision much more likely. We also find a very strong effect of loss aversion. Indeed, loss averse individuals are much more likely to sell their stock in any given period, thus foregoing potential future gains due to their fear of losing already available gains.

Table 3: Decisions to exercise options

Dep. Var: exercising option	(1)	(2)	(3)
Accountability			-0.108* (0.059)
Potential gain	0.170*** (0.033)	0.148*** (0.034)	0.147*** (0.034)
Expected value	-0.223*** (0.034)	-0.156*** (0.034)	-0.156*** (0.034)
Nb options available	0.062*** (0.004)	0.062*** (0.004)	0.062*** (0.004)
Nb options sold	0.113*** (0.005)	0.114*** (0.005)	0.116*** (0.005)
Cumulated gains	-0.034*** (0.011)	-0.044*** (0.011)	-0.048*** (0.011)
Reference point	0.346*** (0.069)	0.368*** (0.069)	0.368*** (0.070)
Stock value (t-1)	-0.671*** (0.220)	-0.442* (0.232)	-0.389* (0.233)
Loss aversion		0.055*** (0.018)	0.051*** (0.018)
Nb observations	5159	5159	5159
LL	-1409	-1404	-1403

Note: The dependent variable is the decision to exercise options or not. *** significant at the 1% level; ** at the 5% level and * at the 10% level. Standard errors in parentheses. All specifications include period effects and control for gender, age and field of study.

5. Discussion

We hypothesized that compensating executives through stock-options may induce risk taking that is excessive from shareholders' point of view. Investigating the issue experimentally, we do indeed

find excessive risk taking by executives compensated through stock-options. This results in companies managed by executives compensated through stock-options faring significantly worse than companies managed by executives who are compensated with actual company stock and forced to hold such stock long-term. A further way to reduce risk taking is making executives more accountable in front of their shareholders, by introducing the possibility for shareholders to ask executives to justify their decisions. Such an accountability requirement is indeed effective for both types of incentive mechanisms, such that the best performance is obtained by companies managed by executives who are compensated through stock and held accountable. The worst performance on the other hand obtains when executives are unaccountable and compensated through stock-options.

What is more is that the different incentive structure under stock-ownership plans does not only reduce excessive risk seeking per se. As indicated by the increased effect of the expected value difference between the two investment options under stock-ownership, stock-ownership also canalizes what risk seeking remains to high volatility investments that are relatively closer to the low volatility prospect in terms of expected value. This indeed explains why company performance is improved so clearly under stock-ownership incentives, even though a certain amount of risk taking survives in the stock-ownership condition.

It is interesting to see how an underlying factor of the differences in risk taking found in the experiment is the tension between own interest and the interests of shareholders. Indeed, in the accountability stock-option treatment, CEOs can be seen to reduce their own payoff in order to act in the interest of shareholders fearing that they may have to justify their choices in front of the latter. Also, while risk averse CEOs do indeed take less risks in the stock-ownership condition than risk neutral CEOs, risk aversion has a much smaller effect on investment decisions in the stock-option condition. On the other hand, risk aversion—and particularly loss aversion—does affect executives' option exercise strategies. This gives an indication that incentives may indeed be misaligned when executives are compensated mainly through stock-options. Indeed, risk aversion seems to play into the decisions only as long as one's own payoffs are concerned, while only marginally affecting decisions when these are taken on others' behalf.

The last point deserves some further attention. Indeed, it echos classical arguments in favor of stock-options that represent them as a remedy to potentially excessive risk aversion on the side of CEOs. We however clearly show that the option incentives can induce risk-seeking that is *excessive* from the point of view of shareholders. Also, even risk averse CEOs do still take some risks in the stock-ownership condition, indicating that risk aversion per se may not be a good argument against stock-ownership plans. Ultimately however, the most important element in the choice of compensation scheme seems to lie in the assessment of the relative costs deriving from risk-seeking and risk-averse behavior. While the traditional literature has focused primarily on the foregone

gains from risk-averse behavior, the recent financial crisis points in the direction that excessive risk-seeking behavior may have much larger costs. In this sense, we believe that accepting some risk aversion may be preferable over inducing strong—and potentially excessive—risk-seeking.

The nature of the compensation scheme is not the only difference between our option and stock-ownership treatments. Indeed, one characteristic of the stock-ownership plan that seems rather fundamental is the long-term nature of the stock compensation, which is contrasted to a short-term structure of option compensation. In reality, stock-ownership often provides short-term incentives as well, and may in such a case reinforce the perverse effects of stock-options already held by executives (Bebchuk *et al.*, 2009). It is thus conceivable that increasing vesting periods of options may be effective at reducing risk taking as well. Indeed, there is some evidence in our data that by decreasing risk seeking, accountability also changes option selling strategies by making executives hold them longer-term—an indication that the inverse relationship of lower risk taking when options have to be held longer-term may also hold. Notwithstanding this evidence, long-term stock ownership plans seem the best way to encourage lower risk taking. Indeed, while options lose their incentive value after significant declines in stock prices because they are too far out-of-the-money, stocks preserve their full incentive value at any stock price. Executives also bear actual losses, especially if some of the regular compensation is provided through stock as seems to be the case in the US because of tax issues.

There remains however the question of the best temporal structure of incentives and selling restrictions on stocks. Bebchuk *et al.* (2009) show that the fact that stock could only be sold after five years at Lehman Brothers did not obviate the advantage of short-time stock-price fluctuations over long-term value creation after the first five years in office, since in every year thereafter new stocks become sellable and are indeed offloaded by executives. One potential solution may be to force executives to hold their stock until they retire from the company as in our experiment. This solution has however been criticized for creating potential incentives for early retirement—a fact that was not an issue in the experiment, since the duration of the game was fixed at 15 periods. An alternative may be to permit the sale of only a small fraction of stock every year. Obviously, differences in the exact implementation may all have specific advantages and disadvantages. An investigation of this issue is certainly important, but lies beyond the scope of the present paper.

There are several smaller findings in the data that warrant a discussion. Consistent with many previous findings in the literature, we find an income effect on risk taking. The higher the accumulated earnings of subjects, the more willing they become to take risks. Since there can only really be accumulated income in the stock-option condition, the effect is particularly strong there. Given that income effects have been found also to hold for large-stake decisions (Gertner, 1993), this in turn may indicate that highly compensated CEOs who can realize their gains at any time may

also become more risk seeking, even when such risk seeking should be deemed excessive from the point of view of shareholders. We also find that especially subjects with a low accumulated income or low stock value tend to choose the riskier prospect in the last period. This type of last period betting on long shots is consistent with previous findings in the literature and may indicate some type of mental accounting or aspiration level effect (Camerer, 2000).

We also need to address potential subject pool effects. We have already seen in the results section how economic and business students seem to take more rational decisions than others. This may well derive from their better understanding of the issues at hand. It is however often alleged that using students as experimental subjects may reduce the external validity of any results obtained. The fact that the overwhelming proportion of our subjects are economic and business students—and that future CEOs can be expected to be drawn from that pool to a large extent—seems to reduce such concerns. Furthermore, alleged subject pool effects need not always go in the expected direction. For instance, Haigh & List (2005) find that myopic loss aversion is actually *accentuated* by using professional traders instead of students in an experiment—the opposite of what one may have expected. One could thus argue that having more experience with the kind of decisions subjects are called upon to take in our experiment may if anything increase their tendency to increase own profits.

6. Conclusion

The recent crisis has drawn attention to the incentive effects of current equity compensation practices. To test for such effects, we conducted a laboratory experiment to clearly identify causal relationships. We found that executives do indeed take risks that are excessive from shareholders' point of view when compensated through stock-options with short vesting periods. Compensating executives through long-term stock-ownership plans instead of stock-options is shown to reduce such excessive risk taking. Furthermore, making executives accountable for their actions in front of their shareholders is also effective at reducing excessive risk taking. This leads to the conclusion that the most effective instrument for reducing risk appetite in executives may be a combination of long-term stock-ownership compensation and an institutional or regulatory framework increasing the accountability requirements on the side of executives. Reducing risk appetite at the potential cost of suboptimal caution under a linear stock-ownership compensation scheme does indeed appear to be less costly than the potentially devastating consequences of excessive risk taking.

Appendix A: Decision Screens, Main Experiment

i) Investment screen

regate-client

Period: 1/15

Please make a choice between the two investments below:

Investment A
A prospect giving you a 0.5 probability of a **8% increase** and a 0.5 probability of **4% decrease** in company value.

Outcome	Probability
8% increase	0.5
4% decrease	0.5

investment A

Investment B
A prospect giving you a 0.2 probability of a **40% increase** and a 0.8 probability of **8% decrease** in company value.

Outcome	Probability
40% increase	0.2
8% decrease	0.8

investment B

Validar

ii) feedback screen

regate-client

Period: 1/15

Summary of investment outcome

In this period you chose investment A

Your investment was unsuccessful

Your company stock has thus **decreased by 4%**

Your company stock is currently worth EUR96.0, EUR0.96 per share

Company stock evolution over the last 1 periods. The investment is indicated for each period.

Period	Stock Value
0	100
1	96

Validar

iii) option selling decision (option compensation only)

regate-client

Period: 1/15

The current stock price is EUR0.96 per share. Please take a decision
You hold the following vested options:

5 Period 1 options, exercise price: EUR1.0 each sell keep

 Valider

Appendix B: Instructions main experiment (option payment, unaccountable)

In this part of the experiment you will be asked to take repeated decisions over 15 rounds. You have **two roles** in this part, one as CEO of a company, and one as stockholder in 5 other companies managed by five other people in your group. Groups are randomly formed at the beginning of part 2 and stay the same for all 15 rounds. Just as you are a shareholder in the 5 companies managed by the other 5 people in your group, the other 5 people in your group are shareholders in your company and part of their payoff thus depends on your company's performance.

Please notice that your decisions are **completely anonymous**, and that neither the experimenter nor any of the shareholders in your company (the other 5 people in your group) can trace any decisions or outcomes back to you. As a matter of fact, neither you nor the other people taking part in the experiment will know who of the others in the experiment was in their group of 6.

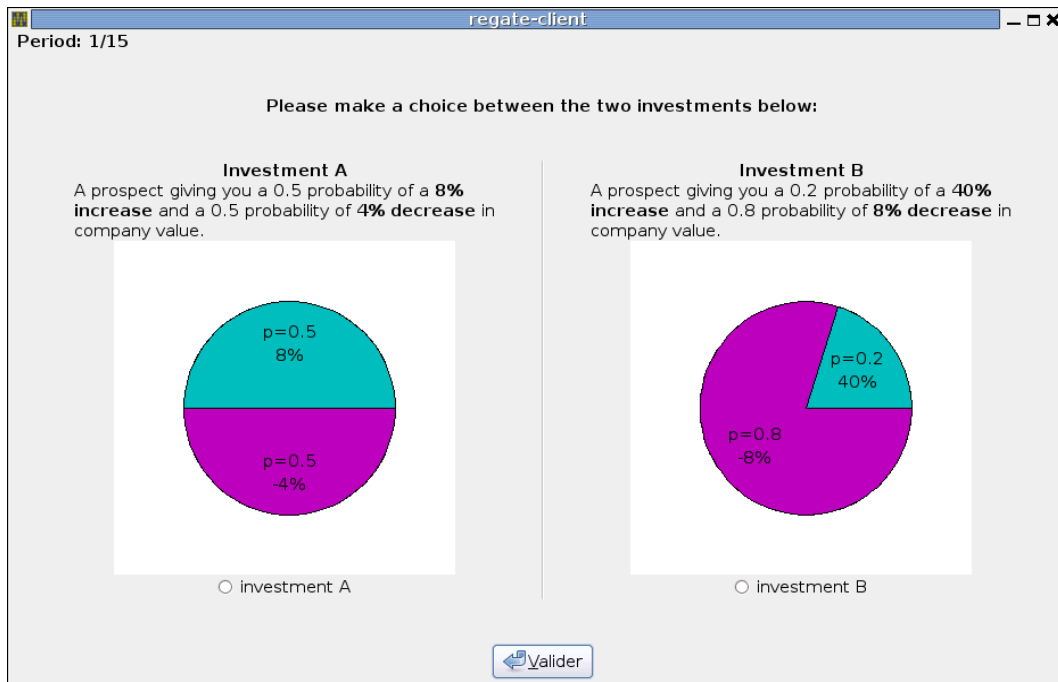
In your function as CEO, you are managing a company. Your company has an initial value of 100 euros, corresponding to 100 shares of the value of 1 euro each. Your main decision will be to choose in each period **which of two investment projects you want to invest the assets of your company in**: investment A or investment B. You will have to make a choice between these two options, and you have to invest the total value of your company in every period. Each investment will be described for each period, and is characterized by its outcomes and its probabilities. Outcomes are given in percentage changes of company value, which can be either positive, negative or zero.

Example:

A typical choice is shown in the screen below. In the example shown, you are called upon to decide between two investments for your company assets:

- *investment A*, which gives you a 50% chance that the company assets will *increase* by 8% and a 50% chance that they will *decrease* by 4%
- *investment B*, which gives you a 20% chance that the company assets will *increase* by 40%, and an 80% chance that the value of your company assets will *decrease* by 8%

Imagine that you are facing the first investment decision (period 1), and that the company you manage is thus worth 100 euros. Imagine now you choose investment A and your investment is successful. Your company is now worth 108 euros, which corresponds to a value of 1.08 euros per share. This will be your starting value for period 2. There are 15 periods of investment in total.



Payoffs:

Contrary to part 1, **all your decisions will now count** towards your final payoff. Your payoffs are determined as follows. Before each investment period, you will obtain **5 stock options** that give you the right to buy company stock in any future period for the exercise price indicated on the option. Options will be emitted at company value and will become vested (that is, cashable) in the subsequent period. You can then decide separately for options obtained in different periods whether you want to: 1) cash the options, thus obtaining the difference between the current stock price and the emission value of the option (times 5 since you have five options); or 2) keep the options and preserve the right to exercise them in a later period.

Example (continued):

Following the example given above, this means that before your first investment decision you have obtained 5 stock options with an exercise price of 1 euro each (the company value divided by 100). Imagine again that you chose option A and that your investment was successful, so that your share value increased to 1.08 euros per share. You will now be asked whether you want to sell your options (*actually*: buy company stock and resell the stock, but the decision is only one and incorporates the two steps) or whether you want to keep the options.

If you decide to sell your options, in the example above you now gain 0.08 euros (8cents) on each

of them for a total of 40 cents (the current stock value minus the exercise price for the five shares you can buy). If you decide to keep them, you obtain no money but preserve the right to sell them at a later point. Whatever your decision, at this point 5 new options will be emitted at an emission value of 1.08 euros each and you will start round 2. Once again, you will choose an investment, become feedback on whether the investment was successful or not, and you will again be asked whether you want to exercise your stock options. In case you have not yet sold your period 1 options, you will now be asked separately whether you want to sell your period 1 options and whether you want to sell your period 2 options.

Your Role as Shareholder:

In addition to your role as CEO, you are also a **shareholder in the 5 companies** managed by the other 5 people in your group (just as those other 5 people are shareholders in your company). This is a passive role, inasmuch as it does not require you to take any decisions. However, the shares you hold in the other companies will contribute towards your final payoffs as follows. In each of the 5 companies, you initially hold one share worth 1 euro. At the end of the 15 rounds, you will be paid out the total value of the shares you own in the different companies. For instance, if the final value of company 4 is 103 euros and the final value of company 6 is 187 euros, you will obtain 1.03 euros from your share in company 4, and 1.87 euros from the share you own in company 6 (plus whatever your shares in the other 3 companies are worth).

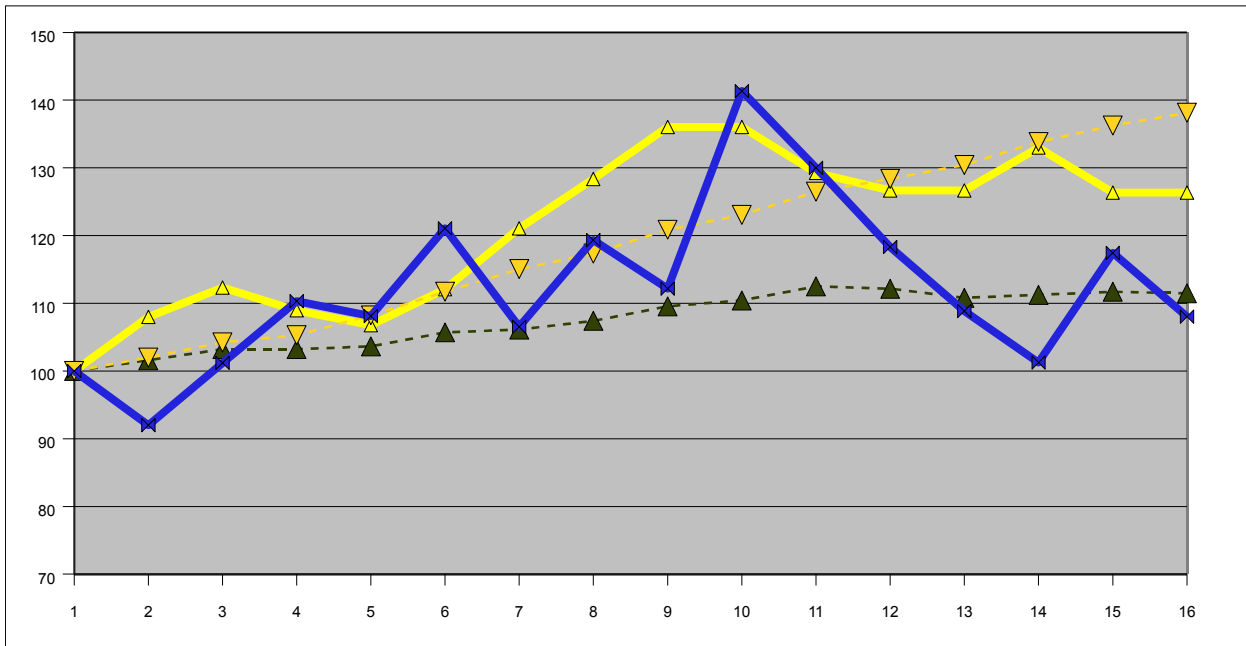
Typical Properties of Investments:

Finally we include a graphical display of the **typical properties of investments A and B**, derived from a simulation of investments with very similar characteristics. Please notice that the changes displayed in the graphs below are not the ones that will obtain in the experiment, but that they represent only random realizations from the same type of investment that have obtained in the past. However, the general trends that are indicated reflect the two types of investment that you will face. This means that the graphical display should not be seen as a substitute for careful considerations of probabilities and outcomes, but only as **an indication of the general average characteristics of the different investment types**.

Graph 1 below displays the evolution of typical investments A and B in 15 periods in the past (thick solid lines, with the light line representing investment A and the dark line representing investment B). Graph 1 also shows the long-term average returns of the two investment types (thin dashed lines, with the light line representing investment A and the dark line representing investment B). Those average returns are what results from observing investment types A and B over thousands of

trials and averaging the outcomes.

Graph 2 shows the same data in a different way. While graph 1 shows the evolution of company stock as you will also see it during the experiment, graph 2 shows absolute percentage changes on the previous period (not taking base values into account). The data are the same as in graph 1, but they are displayed in a different way to show changes period per period.



Graph 1: Solid lines indicate the evolution of investments A and B over 15 periods in the past; the dashed lines indicate long-time trends of the two investment types; light grey lines indicate investment type A, dark grey lines investment type B.

Appendix C: Investment Pairs

	HV prospect		LV prospect	
	Prob. (loss, gain)	% change	Prob.(loss, gain)	% change
Pair 1	(0.8, 0.2)	(-8, 40)	(0.5, 0.5)	(-4, 8)
Pair 2	(0.6, 0.4)	(-4, 10)	(0.3, 0.7)	(-2, 4)
Pair 3	(0.6, 0.4)	(-6 ,9)	(0.6, 0.4)	(-1, 7)
Pair 4	(0.9, 0.1)	(-2, 22)	(0.2, 0.8)	(-2, 4)
Pair 5	(0.5, 0.5)	(-8, 12)	(0.3, 0.7)	(-4, 5)
Pair 6	(0.6, 0.4)	(-12 ,19)	(0.5, 0.5)	(-2, 8)
Pair 7	(0.4, 0.6)	(-15 ,12)	(0.5, 0.5)	(-2, 6)
Pair 8	(0.8, 0.2)	(-6, 34)	(0.2, 0.8)	(-6, 6)
Pair 9	(0.7, 0.3)	(-10 ,26)	(0.7, 0.3)	(-0, 6)
Pair 10	(0.5, 0.5)	(-8, 13)	(0.4, 0.6)	(-5, 8)
Pair 11	(0.7, 0.3)	(-9, 20)	(0.5, 0.5)	(-2, 5)
Pair 12	(0.9, 0.1)	(-8, 60)	(0.6, 0.4)	(-0, 4)
Pair 13	(0.8, 0.2)	(-7, 30)	(0.3, 0.7)	(-3, 5)
Pair 14	(0.6, 0.4)	(-10, 16)	(0.6, 0.4)	(-5, 12)
Pair 15	(0.9, 0.1)	(-8, 70)	(0.8, 0.2)	(0, 7)

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