Do Incentives Contracts Lead to Higher Risk-taking ? The Impact of Executives' Characteristics

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Abstract

Stock-option compensation is coherent with the principle of agency theory, by encouraging risk averse executives to take a more risk neutral stance. However, it is unclear whether the contract is actually more powerful than personal characteristics in shaping decision-making. We compare experimentally the risk aversion and prudence of 100 participants under a stock-option incentive contract and a classic equity granting one. We measure a number of personality variables, as well as cortisol and testosterone levels, which have been related to risk taking in previous studies. We first underline that stock-options contract indeed drives more risk neutral behaviour, both regarding variance and skewness. This effect is mainly driven by a shift in focus from losses to gains. Loss aversion and higher cortisol levels were linked to a preference for the safer equity contract. Second, we show that cortisol and testosterone levels are linked to preferences for variance and skewness, often in a quadratic fashion. Third, we show that this impact is actually stronger than the one of the contract, both in terms of predictive power and economic effect. Therefore, our study highlights the impact of personality and even biological variables on risk taking, and underline the need for a behavioural approach of contract setting.

Keywords Executive compensation – Risk Aversion – Prudence – Testosterone – Cortisol – Personality

EFM Classification Codes 110 - 120 - 720

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Introduction

" Often, those [compensation] systems encouraged the big bet—where the payoff on the upside could be huge and the downside limited. This was the case up and down the line—from the corporate boardroom to the mortgage broker on the street"
Conclusions of the Financial Crisis Inquiry Commission

What the financial crisis inquiry commission describes above is the impact of limited liability and contract on risk-taking. What is rarely mentioned in such reports and in the media is that these compensation systems incentivize managers to take risks on purpose, and in accordance with agency theory. The agent CEO fate is considered to be tied to the one of the firm. He is therefore considered more risk averse than the shareholders (principals), who can diversify away their risk. The remuneration is then simply a way to lead a risk averse CEO to a take a more risk neutral perspective (Wiseman and Gomez-Mejia 1998).

But are contracts the most important factor driving the risk taking of executives? In this paper, we underline that specifically designed incentives contracts indeed drive experimental CEOs to take more risks. However, personal characteristics, including both personality variables and hormonal level of testosterone and cortisol are the main drivers of risk taking, both in terms of economic significance and predictive power.

The compensation of CEOs has been under the spotlight in the previous two decades. The ratio of CEO wage of the top 350 US firms by sales to the one of production workers has indeed gone from 20 in 1965 to 303 in 2014 (Mischel and Davis 2015). In 2014, total compensation of the median CEOs in the Hay Group 300 was 13,5 million dollars[1]. Such numbers spark concern from the public. This level of remuneration is more and more described as excessive.

However, in most of the academic literature taking an agency perspective, this salary is not considered inherently problematic, provided it provides the right incentives for a skilled candidate to choose the right mix of wealth-maximizing projects. This is why the salary of nowadays CEOs are very different from the one of classic employees. Two-thirds of it is long term (more than a year) and is composed of equity and stock-options. The remaining third is composed of 12% fixed salary and 20% bonus (see for instance Equilar report, 2016). The variable part and the stock-options, linked to performance, are a means of aligning the interest of the risk averse CEO and the interests of the more risk neutral shareholders, according to agency theory. They are considered incentives based on performance.

[1]The 300 largest US companies.

Based on this intuitive line of reasoning, a large literature has emerged on the topic of the impact of incentivization on the risk aversion of executives. This literature underlines that variable incentivization, for instance through stock-options, indeed has an impact on the risk taking of CEOs (see for instance Hall and Murphy 2000, 2002 for mathematical models or Sawers et al. 2011, Lefebvre and Vieider 2014 for experimental evidence).

However, another intuitive line of reasoning has not yet been explored. While it is clear that the contract form has an impact on risk taking, personality (Becker et al. 2012, Desmoulins-Lebeault et al. 2018) and even biological variables, including hormones testosterone and cortisol (Desmoulins-Lebeault et al. Forthcoming) have also been shown to be linked to risk taking.

In this study, we investigate this question, both for classic risk aversion (u"<0) and prudence (u"'>0), respectively related to an aversion to variance and a liking for skewness. We underline that the contract indeed drives subjects toward more neutrality for both preferences. However, personal characteristics and in particular hormonal variables are the main driver of risk taking, both from an economic effect and predictive power perspective. To the best of our knowledge, this paper is the first to investigate a corporate finance question using hormonal testing. It is also the first to investigate the link between hormones and prudence.

1 Literature Review: CEO compensation

1.1 Risk Aversion and Prudence

Risk aversion is defined by economists as a negative second derivative of the utility function, $u'' < 0$ (Rothschild and Stiglitz 1970). It implies – but is not implied by – an aversion for variance. In a similar vein, prudence is defined as a positive third derivative of the utility function – and implies without being implied by – a preference for positive skewness (Kimball 1990). Generally speaking, people are risk averse and prudent when acting for self – i.e. dislike standard deviation and like positive skewness (Deck and Schlesinger 2010, 2014, Ebert and Wiesen 2011, 2014). As noted previously, CEOs are considered more risk averse than their shareholders, prompting the need for the contract to correct this difference.

In finance, models are generally moments based. The link between moments and utility is given by a Taylor expansion around the mean. For most of these models to be valid from an expected utility standpoint, one has to assume a particular form of distribution of return or a particular utility form[2].

[2]For instance, for a mean-variance analysis to hold, one either has to assume quadratic utility (i.e., derivatives of the utility function and therefore preference for moments higher

A given stock can be defined by all the moments of its distribution of returns. In itself, a given stock can be conceptualized as a portfolio of projects, each with their own given distribution and therefore moments. In this framework, the executives from a company have a mission to select the optimal portfolio of projects for their company. This is the theoretical framework we adopt in this study, with participants deciding about a project for their firm.

While the link between risk aversion and incentivization has been heavily researched, prudence is a rather new concept, dating back to Kimball (1990) and even more recently operationalized by Eeckhoudt and Schlesinger (2006). This seminal paper sparked a surge of research on the topic, both theoretical (Crainich et al. 2014, 2017) and experimental (Deck and Schlesinger 2010, 2014, Ebert and Wiesen 2011, 2014). However, our experiment is the first one on prudence and incentivization, even though some theoretical work had been performed (Chaigneau 2013).

1.2 CEO compensation: taking stock of the situation

CEO compensation has received a lot of attention in the academic literature since the 90's. To paraphrase Murphy (1999), the only thing that grew faster than CEO pay in the 90's was the number of academic articles on the subject.

Agency theory states that the interests of the managers do not always coincide with the shareholders' ones. As shareholders claim the residual part of the results after all the other stakeholders, they want the managers to take higher risk in order to maximize the profits. On the opposite, the managers are more prone to invest in low-risk projects in order secure their jobs. Hence the need to tailor incentives contracts may align both interests by inciting the managers to take higher risk.

As underlined before, CEO compensation compared to unskilled and even skilled workers has increased since the 60's, and particularly since the 90's. If before, CEO's compensation was mainly composed of a salary and an annual bonus to mark a particularly successful year, efforts have been made to better align the remuneration of the CEO with the shareholder's interests. A larger portion of remuneration is now composed of Long-Term Incentives (LTI) such as stock options and performance awards (Murphy 1999, Frydman and Saks 2009).

A typical CEO employment contract generally lasts 5 years and specifies basic salaries, bonus payment upon meeting objectives, and severance agreement in the event of changes in corporate control or separation. In practitioners reports [3], executive compensation is generally split into Short term Incentives

than 2 is null) or a normal distribution of returns (moments higher than 2 being thus proportional to the mean and standard deviation).

[3]The main one being Hay Group, consultants formerly known as Tower Perrin.

(STI) and Long-Term Incentives (LTI)[4].

Long-term incentives now represent 64% in the Hay Group 300 (HayGroup 2015) of the CEO pay in 2014. The details of these LTIs in the Hay Group 300 is 50,8% Performance Award, 24% Restricted Stocks and 26% Stock Options. This last component is probably the one that received the most attention from the literature.

1.3 CEO compensation: stock options

Stock options remuneration indeed skyrocketed in the nineties (Murphy 1999), driving most of the increase in executive remuneration during this period (Murphy 1999). Stock options are particularly appropriate to drive an increase in risk taking for two main reasons. First, option price is driven up by a rise in stock price, encouraging the holder to increase the value of the underlying. Second, an increase in volatility of the underlying also increases the values of the option (Black and Scholes 1973), further encouraging the holder to take on risky projects to drive up the volatility of the stock. For these theoretical reasons, stock options are expected to drive risk-taking up more than equity remuneration.

A call European stock option gives the right but not the obligation to purchase a defined stock at a given date in the future, for a price fixed in advance. This price is called the strike price, and has a great importance in inciting managerial risk taking.

It appears from the theoretical literature that both studies assuming expected utility through a power utility function (Hall and Murphy 2000, 2002) or a prospect theoretic value function (Bahaji 2011) advise to set the strike price at the money. This is what is actually done in most corporation (Murphy 1999, Hall and Murphy 2000).

Concerning experiments, Sawers et al. (2011) studied a sample of MBA students and underlined that at the money options prompted more risk taking than in the money options for loss prospects. At the money options were also used in the experiment of Lefebvre and Vieider (2014) and were shown to prompt more excessive risk taking than compensation through stocks.

Hypothesis 1: At the money Stock Options contracts result in more risk-taking than the classic equity granting one.

Again, while there is a lot of literature on the impact of stock-options remuneration on risk taking, we do not know of a paper investigating the

[4]Murphy (1999) defines executive packages as made by four basic building components: basic salary, annual bonus, stock options and long term incentive plans.

relative importance of such a remuneration compared to personality, *a fortiori* to hormonal variables.

2 Personal characteristics

2.1 Personality, Risk preferences, and other control variables

Research has highlighted a number of links between personality and risk aversion in its various forms. The stronger one is probably the link between extraversion, for instance measured through the Big 5 and risk seeking (Becker et al. 2012, Desmoulins-Lebeault et al. 2018). One of the dimensions of extraversion is "sensation seeking", the tendency to seek novel and stimulating experiences, which probably explains why extroverts tend to be more risk seeking.

Similarly, financial literacy has been linked to a variety of protective behavior, including toward risk in investment for a firm (Desmoulins-Lebeault and Meunier 2018), which is why we include it as a control variable.

Gender (Charness and Gneezy 2012) and possibly age (Mather et al. 2012) have also been linked to risk taking, with women and older people[5] tending to be more risk averse. Research has not yet managed to clearly disentangle whether these effects were socially or biologically related.

Finally, risk preferences for self, for instance as captured by prospect theoretic parameters should theoretically have an impact on the decision under a given contract (see for instance Bahaji 2011).

2.2 Hormones and risk-taking

There is evidence that testosterone and cortisol impact behaviour through their action on the dopaminergic system. They affect the ventral striatum, and specifically the nucleus accumbens. These brain structures, part of the limbic system, are involved in decision-making and reward behavior (Coates et al. 2010). Recent evidence also underlines that Testosterone might also be positively linked to impulsive behaviour through an inhibition of the cognitive activity in the pre-frontal cortex (Nave et al. 2017), which could also explain an increase in risk taking. Cortisol might also have an impact on the amygdala, a brain structure involved in emotions, and in particular fear response (Coates et al. 2010).

[5]The effect size of this difference is lower and varies depending on the task at hand.

2.2.1 Testosterone

Testosterone is popularly viewed as a male hormone driving virile behaviours, including excessive risk-taking. Testosterone has indeed an important biological role. In particular, the male-female biological differentiation in vertebrate animals mainly stems from the impact of testosterone (Morris et al. 2004). Human males display on average thrice the testosterone levels of females. Given that men and women attitudes toward risk are different, with men tending to take on average more risk (Charness and Gneezy 2012), research has thus explored testosterone as a potential hormonal candidate explaining such a difference.

There is some evidence behind the popular link made between risk-taking and testosterone. A literature review by Apicella et al. (2015) underlines that circulating levels of testosterone are linked to risk-taking in numerous studies (Apicella et al. 2008, Sapienza et al. 2009, Stanton et al. 2011, Schipper 2012). The relation seems rather strong. Some studies have found it to only exist for men (Schipper 2012), only for women or for low concentration in both sex (Sapienza et al. 2009), or to be quadratic (Stanton et al. 2011).[6]

Interestingly, the literature review of Apicella et al. (2015) concludes on the need to explore further principal-agent contexts and their link to testosterone level.

2.2.2 Cortisol

Cortisol is a hormone secreted in response to physiological or psychological stress. In an experimental market, Cueva et al. (2015) underline that both endogenous and exogenously administered testosterone and cortisol lead to more risk taking. Kluen et al. (2017) underline that the exogenous administration of hydrocortisone significantly increased risk-taking in men in a modified version of the Balloon Analogue Risk Task (BART) compared to a placebo.

Hypothesis 2: Subjects having a higher level of testosterone and a higher level of cortisol will take more risks as CEOs.

From most of the empirical studies we reviewed, it would appear that higher level of both cortisol and testosterone have a positive effect on risk-taking. This effect is sometimes found to be *non-linear*, as underlined in Sapienza et al. (2009) and Stanton et al. (2011). Non-linearity makes sense, as a number of

[6]Some authors also use proxies for past testosterone exposition, as testosterone could have long lasting "brain masculinization effects". To be as comprehensive as possible, we did measure both hands 2D:4D and facial masculinity, following the best practice in the domain. Both were found to be non-significant and dropped from the analysis. This resonates with Desmoulins-Lebeault et al. (Forthcoming), who incites readers to be on the conservative side in their attitude toward such measures.

hormones and neurotransmitters have indeed been shown to have an n-shape relation with respect to favourable outcomes. For instance, cortisol and memory have been shown to have an inverted U-shape relation. High and low levels of cortisol have been found to negatively affect memories, with medium level leading to the best outcomes (see Lupien et al. 2007 for a review). Moffat and Hampson (1996), Kiura (1999) underline that testosterone has quadratic effects on spatial cognition when taking both genders together. Women with high testosterone and men with low testosterone perform better on spatial cognition tasks than individuals at the extremes of the distribution.

2.3 Relative Influence of Contract and Personal Characteristics

As underlined previously, there is currently no research on the relative influence of contract and personal characteristics on risk taking. Given the increasing amount of evidence regarding the impacts of behavioral factors on risk taking, we hypothesized that personal characteristics would have more influence than the contract in risk taking.

Hypothesis 3: Overall, personal characteristics will have more importance than the form of the contract.

3 Methodology

Our experiment is rather close to the one of Lefebvre and Vieider (2014). However, besides a different research question and our measure of hormones, it differs from theirs on three main points. First, we do not resolve the uncertainty of our lotteries before the end of the experience. While we can not explore the impact of previous decisions outcome as they did, it also prevents it from affecting decisions of participants in unpredictable ways. Second, we fully de-contextualize the experiment. De-contextualisation is an important point as it prevents preconceived idea about finance or CEO to affect the decision. Participants act more naturally. De-contextualisation also enables the experiment to be transposable to any situation with similar characteristics. The experiment was presented in the native language of the participants. Finally, we used a within-subjects design for the contract, increasing the power of our analysis.

3.1 Contracts

We considered 2 schematic types of contract, faced by all subjects in random order ("Within-subject design"): an equity granting contract and a stock-option one. We designed both contracts so that they are equivalent in terms of average Pay for Performance Sensitivity (PPS) in our experience. However, the stock option contract should promote risk-taking more. The average incentive received by participants whose incentivized decision was picked under the equity contract was 10.74EUR, against 9.92EUR in the stock option one (difference non-significant, $t - stat = 0.53$, $p = 0.59$)[7].

The classic equity granting one was giving 5% * (10 000 ECU + Gain or loss on their decision). One ECU was equivalent to 1 cent in the real world. The 10 000 ECU represented the initial value of the firm. In the stock options one, stock options were granted at the money, a common incentivization scheme advised theoretically. A small 1% equity was also granted, to avoid first order stochastic dominance of one option over another. Subjects thus got 1% of (10 000 ECU + Gain or loss on their decision) + 10% of their gains on the decision, if any.

We ask our subjects to write a short explanation of their choices at the end of each contract, to be able to understand the driving force behind their choices. It can be conceptualized as a CEO having to justify his choice in front of the board of director, even though to keep the experiment de-contextualized we did not present it this way to our participants. Finally, we also asked our subjects at the end of the experiment which contract they preferred.

3.2 Measure of Risk Aversion and Prudence

There are cases where a moment based view and a traditional economic approach based on derivatives of the utility function will perfectly match. One of them is the case of a Bernoulli distribution of returns. Bernoulli distributions have indeed been shown to be skewness comparable by Chiu (2010). Their higher moments are fixed once the first 3 moments are defined. Ebert (2015) further underlined that two-outcomes lotteries – binary lotteries – could be seen as resulting from a binomial distribution. In the case of binary lotteries, variance aversion is equivalent to risk aversion and skewness loving to prudence.[8]

These type of lotteries can be conceptualized as a firm project with two simplified potential outcomes – success or failure. They are therefore particu-

[7]Those whose decision was picked in the Tanaka et al. (2010) task for prospect theoretic parameters however received lower payoffs. The average payoff was 5.7EUR in that task. There was a possibility to earn 170EUR in that task, but no student earned that amount, reducing the average incentivization.

[8]One can also see the proof specific to binary lotteries given in Meunier (2018).

larly well suited for our case – choice on these lotteries have implication both in term of moments and derivatives of the utility function. Therefore, our results have implications both for finance and economic scholars.

We elicited a variance and a skewness premium through our method. For the variance premium, subjects were faced with several choices between two lotteries (projects), A and B. They had to choose the one they prefer, given their contract. The lotteries had the same skewness of zero, but differed in term of variance and mean. Lottery B displayed more standard deviation than A (9000 versus 5000). Lottery A was the same for each choice. For lottery B, we kept variance constant for each choice but increased mean returns. The point when participants switched from A to B determined their risk aversion level, equivalent to variance aversion in that setting (see Table 1 for a depiction of the choices).

We used a similar logic for skewness. Options A and B had the same variance, but different skewness (A displayed a positive skewness of 2.67, while B had a skewness of 0). We then increased the mean of B from choice to choice. The switching point from A to B determine a prudence level, equivalent to skewness loving in that case (see Table 1(b) for a depiction of the choices).

The mean B-A displayed in these tables can be conceptualized as a Variance and a Skewness premium. It is the minimum premium needed to switch from a more desirable option (less variance or more skewness) to a less desirable one.

Table 1: Variance Tasks

Option A		**Option B**		Mean B-A
Boules 1-5	Boules 6-10	Boules 1-5	Boules 6-10	
8 000	-2 000	10 250	-7 750	-1750
8 000	-2 000	11 000	-7 000	-1000
8 000	-2 000	11 500	-6 500	-500
8 000	-2 000	12 000	-6 000	0
8 000	-2 000	12 500	-5 500	500
8 000	-2 000	13 000	-5 000	1000
8 000	-2 000	13 500	-4 500	1500
8 000	-2 000	14 000	-4 000	2000
8 000	-2 000	14 500	-3 500	2500
8 000	-2 000	15 250	-2 750	3250
8 000	-2 000	16 000	-2 000	4000

Table 2: Skewness Tasks

Option A		**Option B**		Mean B-A
Boule 1	Boules 2-10	Boules 1-5	Boules 6-10	
31 500	-1 800	10 000	-10 000	-1530
31 500	-1 800	10 500	-9 500	-1030
31 500	-1 800	11 000	-9 000	-530
31 500	-1 800	11 500	-8 500	-30
31 500	-1 800	12 000	-8 000	470
31 500	-1 800	12 500	-7 500	970
31 500	-1 800	13 500	-6 500	1970
31 500	-1 800	14 500	-5 500	2970
31 500	-1 800	15 500	-4 500	3970
31 500	-1 800	17 000	-3 000	5470
31 500	-1 800	18 500	-1 500	6970

3.3 Measure of Personality, Risk preferences, and control variables

There is a massive literature on the topics of personality and risk preferences. We used the French version of the Big 5 scale, validated by Plaisant et al. (2010). We measured financial literacy through the classic financial literacy scale of Lusardi and Mitchell (2008).

Concerning risk preferences for self, we took a prospect theoretic approach. We measured risk aversion, probability weighing and loss aversion through the method of Tanaka et al. (2010).

3.4 Measuring Hormonal Levels

Hormonal sampling took place just before the experiment, in a separate room, where the participants also completed the legal documentation to participate in the study. We followed standard procedures concerning the sampling of cortisol and testosterone (see for instance Salimetrics documentation on the topic). We used non-invasive unstimulated passive drooling, which is considered to be the golden standard in the field. Alcohol or sweet food consumption can affect the pH of the sample and thus bacterial growth. We asked our participants to refrain from consuming alcohol 12 hours before the experiment and to refrain from eating 60 minutes before the experiment. To further minimize these factors, we made participants rinse their mouth thoroughly 10 minutes before beginning to drool.

Cortisol and Testosterone follow a circadian cycle, and should thus be sampled at roughly the same time of the day for a given sample (Diver et al. 2003).

Cortisol and Testosterone levels are more stable during the afternoon. We performed the sampling between 1:30 PM and 3:30 PM for all our participants. There was no effect of time of the day on the concentration of both hormones in our sample.

Finally, it is imperative to refrigerate sample within 30 minutes after collection and to freeze them at -20°C within 4 hours (Samples may be stored at -20°C for up to 6 months). In our case, after collection, the samples were immediately placed in ice. A research assistant came every 45 minutes to collect the samples and put them in a freezer at -20°C.

The collection period lasted for 2 weeks. After all samples were collected, they were sent through a medical transporter to a Salimetric lab in the UK, where the assays were performed. The temperature during transport was between -20°C and -60°C. The temperature of the Salimetric lab freezer was -80°C. Sample and standard reactions were run in duplicate. We used in the analysis the averages concentration of the duplicates. The intrassay coefficient of variation, representing precision, was a reassuring 3.36% for testosterone and 3.59% for cortisol. The guideline is that such coefficients should not be above 10%. In a study on the quality of various labs, Calvi et al. (2017) find for instance an average intra-assay coefficient of variation of 6.4%, much higher than ours.

3.5 Sample

Our sample was composed of 53 women and 47 men in their first year of Master, in a French Business School. Average age was 21.6, with a standard deviation of 1.2 and 27% of the sample indicated their major to be finance. Therefore, our sample appears to be rather representative of the population of the business school, who has 51% of female students and on average 25% of students finding their first job in finance.

The fact that we used students as a proxy for executive making decision for a firm might raise the question of the external validity of the study. This question has been discussed in numerous papers, reaching the conclusion that students were, in general, a reasonable proxy for various financial-related questions (see for instance Elliott et al. 2007, Krause et al. 2014). In particular, students have been used as a proxy for CEOs by Devers et al. (2007) and Lefebvre and Vieider (2014).

We display in Table 3 Mean, Standard Deviation (SD) and Coefficient of Variation (CV) for Testosterone and Cortisol. Interestingly, the coefficient of variation for women testosterone was higher than the one of Men, while the opposite holds true for Cortisol.

The experiment took roughly 45 minutes to complete. Monetary decision-dependant incentivization has historically been considered the golden way to

Table 3: Mean, Standard Deviation (SD) and Coefficient of Variation (CV) for Testosterone and Cortisol

	Testosterone			Cortisol		
	Mean (pg/ml)	SD	CV	Mean (μg/dL)	SD	CV
Women	53.29	21.91	0.41	0.15	0.07	0.48
Men	164.18	53.29	0.32	0.22	0.14	0.63

ensure participants take the questions seriously and answer regarding one own's preference since Holt and Laury (2002). In line with best practice, one of the decisions taken during the experiment was randomly selected to be paid to participants. Average pay-offs were 9EUR. Recently, evidence has underlined that non-monetary incentives are important too for participants. For instance, the simple use of encouraging instruction can have the same impact as monetary incentives (Herranz-Zarzoso and Starmer 2018). In our experiment, participants who wanted it were able to obtain their testosterone and cortisol levels, in addition to a report regarding the personality and risk preference "for self" measures we used. We thus asked a few questions to check if this incentivization was successful. We asked questions on a likert scale from 1 to 5 ("completely disagree", 1 to "completely agree", 5, with 3 being "Do not agree nor disagree"). We display the results of these questions in Table 4, alongside a test of whether these numbers are equal to 3. It appears that having access to personality test (4.12/5) and hormonal level (4.09/5 for men, 3.55/5 for women, $p = 0.02$) was a strong motivation for our participants. Both scores were not significantly different from the monetary incentives (4.16/5) for men. Given the cost of such salivary hormonal sampling (around 40EUR), it is not particularly surprising that participants were highly motivated to have access to it. While having access to personality tests was not rated different from the monetary incentives for women, hormonal sampling was rated lower in terms of motivation ($p < 0.01$). Overall, participants considered the monetary and non monetary reward to be high compared to other experiments (4.14/5). They also found the experiments interesting (4.30/5). It appears that our participants were adequately motivated to participate in this experiment, both by the fixed non-monetary incentives we offered and by the variable monetary ones.

4 Results

4.1 Contracts

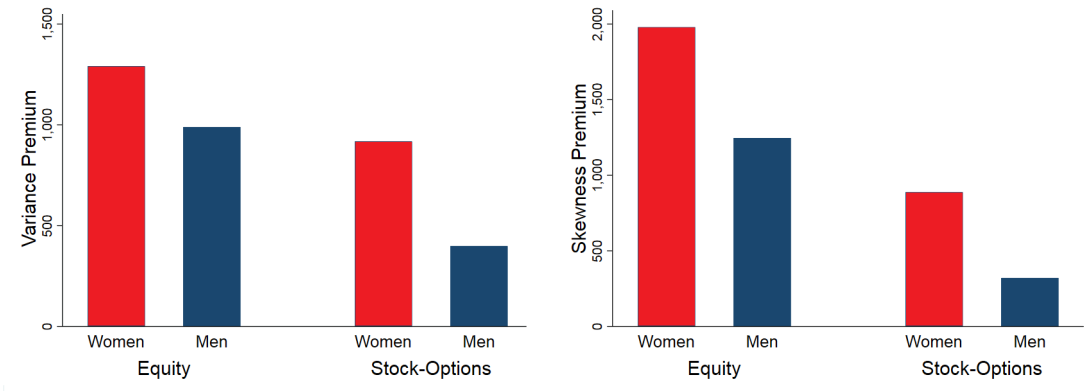
A first result clearly appearing was the effect of the contract in neutralizing risk preferences. Participants required lower variance premium when subjected to the stock-options contract compared to the equity one (paired $t - test = 3.83$,

Table 4: Participants Perception of the Experiment and Motivations

Items	Likert score /5	$p \neq 3$
The experiment was Interesting	4.3	$p < 0.01\%$
Financial incentives were a strong motivation	4.16	$p < 0.01\%$
Access to personality test results was a strong motivation	4.12	$p < 0.01\%$
Access to hormonal results was a strong motivation	3.76	$p < 0.01\%$
Compared to other experiments, monetary and non-monetary rewards were high	**4.14**	**p<0.01%**

$p < 0.01$). They also required lower premiums to switch to the lower skewness prospect when subjected to the stock-options contract (paired $t - test = 5.08$, $p < 0.01$). The result is displayed in Figure 1 and hold true in regressions, in the presence of covariates.

Men requires marginally less variance premium ($t = 1.74$, $p = 8.5\%$), and less skewness premium ($t = 1.83$, $p = 6.87\%$), in accordance with previous studies (Charness and Gneezy 2012).



(A) Standard Deviation (B) Skewness

Figure 1: Risk Taking by Contract and Gender

Result 1: Stock option contracts result in more risk-taking than the classic equity granting one, both for Variance ($p < 0.01$) and Skewness ($p < 0.01$) in line with our hypothesis.

We run a textual analysis on the explanation provided by the participants,

concerning their decisions under each contract. The words pertaining to the register of "gain", "loss" and "risk" were the most important in term of frequency. We display their occurrence and frequency under the two contracts in Table 5.

We subtracted the number of occurrence of the word associated with loss to the one associated with gain and compared the scores under the two contracts. It appears that the words associated with gains compared to losses were appearing more often under the stock-options contract compared to the equity one (paired $t - test = 3.89$, $p < 0.01$). A similar result is obtained by using proportion tests, as in the table below. The increased risk-taking under the stock-option contracts seems to be explained by shifting the focus from losses in the case of the equity contract to gains in the case of the stock-option one. This result is perfectly coherent with the inherent difference between these two products, and their purpose in the case of executive remuneration.

Table 5: Textual Analysis of Participants Explanations

	Equity contract		**Stock options contract**		Proportion
	Occurrence	Frequency	Occurrence	Frequency	$p - value$
Win, gain...	264	7.7%	346	9.9%	0.001
Loss, losing...	274	7.4%	182	5.2%	0.001
Risk	76	2.2%	72	2.0%	0.550

Participants did not have a significant preference for one contract over another overall: 49 preferred the stock-options one, 37 the equity one, and 14 declared to equally like both. We run an ordinal probit regression (see Table 6) to pinpoint the determinants of this preference (with 1 being a preference for the stock-option contract, 2 being neutral and 3 being a preference for the equity one).

This regression underlines that both cortisol and loss aversion are related to a preference for the equity contract. Participants who were more loss averse tended to prefer the equity contract. Similarly, participants having higher levels of cortisol, which denotes higher levels of psychological or physiological stress preferred the equity contract. These results are robust to various specifications (using a logit instead of a probit model, or using a logistic regression coding 1 participants who preferred the stock option contract and 0 the others).

4.2 Hormonal Variables and Risk-Taking

4.2.1 Variance Premium

Table 7 underlines again the impact of the contract on variance premium, with the stock option contracts leading participants to require a lower variance pre-

Table 6: Ordinal Regression: Determinants of the Preference for the Equity Contract

	Coef.	P>|z|
Man	0.27	0.563
Testosterone	0.00	0.673
Cortisol	2.47**	0.047
Age	0.04	0.732
FinLit	0.21	0.329
LossAv	0.11*	0.082
Curvature	-0.13	0.766
ProbWeigh	0.59	0.266
Extraversion	0.00	0.864
Openness	0.03	0.287
Agreableness	-0.01	0.652
Neuroticism	0.00	0.862
Conscientsciousness	0.01	0.596
Treatment	-0.20	0.441
Cut-off 1	3.21***	
Cut-off 2	3.59***	
Pseudo R^2	0.048	

Stars besides the cut-off values are indicative that the cut-off values are significantly different from one another. The parallel line assumption appears not violated.

mium. This effect of the contract was independent of hormonal or personality variables. Men also required lower variance premium, even when accounting for hormonal levels as in the regression.

Regarding testosterone, we observe a significant quadratic relation with the variance premium required under the two contracts, displayed in Figure 2. We display both the impact of testosterone ($p < 0.01$), testosterone squared ($p < 0.01$) and gender ($p < 0.01$), over the range of value observed for testosterone in our sample. Even though there is a slight overlap between the testosterone level of male and female, the two range are quite distinct. The relation is positive and linear for females. Low testosterone females are closer to neutrality, while higher testosterone ones are more risk averse (robust to a regression using the female only sample). This first effect is rather surprising in light of the existing literature. The quadratic term starts to play a role for the male part of the sample (robust to a regression using only males). Low and medium testosterone men are close to neutrality, while high testosterone ones tend to be risk loving, in line with theoretical explanation and literature on the subject. Other dependent variables have been shown to have quadratic

Table 7: Regression: Determinants of Variance Premium Under the Two Contracts

	Coef.	$P > \|t\|$
Stock-Options	-455.00**	0.030
Man	-2710.05***	0.001
Testo	38.79***	0.001
Testo^2	-0.11***	0.001
Corti	-5360.35**	0.020
Man*Corti	5783.47**	0.024
Age	71.98	0.479
FinLit	348.83*	0.074
LossAv	174.71***	0.002
Curvature	-425.65	0.263
ProbWeigh	488.84	0.278
Extraversion	-16.99	0.260
Opennes	-5.88	0.764
Agreableness	3.92	0.843
Neuroticism	-7.11	0.719
Conscienscious ness	-2.14	0.910
Treatment	11.60	0.958
Constant	-1665.75	0.532
R^2/ Adj. R^2	0.189 / 0.113	

n-shape relation with testosterone. In particular, the shape of our relation (women with high testosterone and men with low testosterone having high risk aversion) looks very much like the relation found for spatial ability Moffat and Hampson (1996), Kiura (1999). More related to our study, Sapienza et al. (2009) and Stanton et al. (2011) also find a quadratic n-shape relation between testosterone and risk taking.

Cortisol is linked to less variance aversion in women, but not in men ($p < 0.05$ robust to gender separated regressions). The interaction term we inserted for men counteract the effect existing for women. In our sample, men levels of Cortisol are slightly higher. This interaction could therefore also be represented through a quadratic term (marginally significant). Cortisol is linked to psychological and physiological stress, and is sometimes referred to as a "fight or flight" hormone. Therefore, high level of cortisol could lead to risk taking "fight" behavior.

Concerning covariates, it appears that participant being more loss averse required higher variance premium ($p < 0.01$). In accordance with previous studies associating financial literacy with protective behaviors, higher scores in financial literacy were associated with higher required variance premium

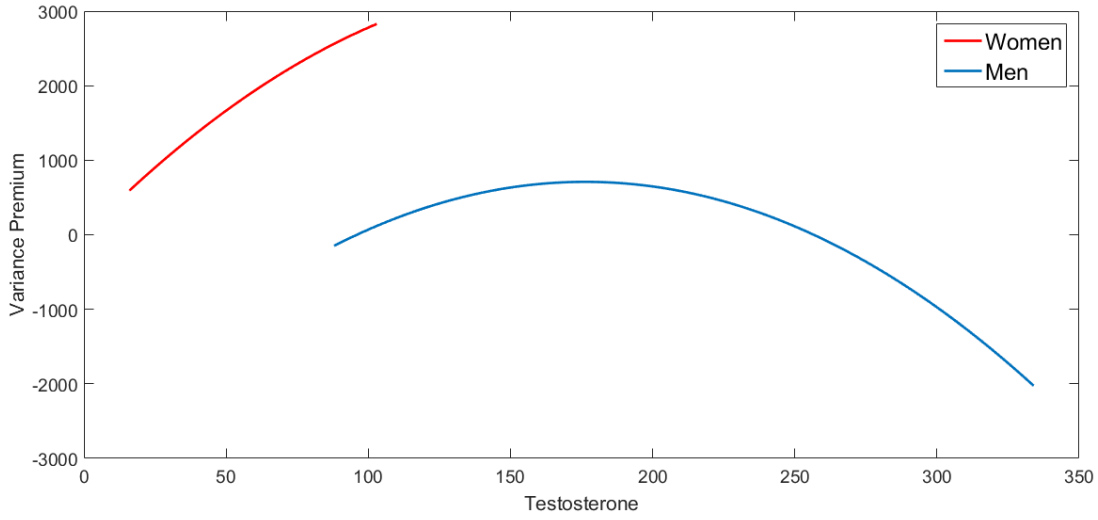


Figure 2: Variance Premium as a function of Testosterone

under both contracts ($p = 0.074$, marginally significant). The treatment order (being confronted first to the stock-option contracts or the equity one) had no effect on the decisions.

Result 2a: A n-shape quadratic relation exists between testosterone and variance premium, with high levels of testosterone linked to lower variance premium.

Result 2b: Women presenting higher levels of cortisol have lower variance premiums.

4.2.2 Skewness Premium

Table 8 display the results of three regressions regarding the skewness premium. As the endocrine response of men and women was very different regarding the skewness premium, we preferred to display a male only and a female only regression. While it is possible to display this in a single regression by using complex interaction patterns, it is more readable to separate the regressions in this case.

We performed a first regression[9] on the complete sample, without the hormonal variable. This first regression underlines that the stock-option contract results in a lower required skewness premium. This effect of the contract was independent of hormonal or personality variables. Men also require a lower

[9]We used robust standard error in this regression, as the errors displayed heteroscedasticity.

skewness premium, in both contracts. These effects were already observed in Figure 1). We also observe marginally significant effects of age and neuroticism. Older participants require higher skewness premium, while more neurotic participants require lower ones.

Table 8: Regression: Determinants of Skewness Premium Under the Two Contracts

	All		Women		Men	
	Coef.	$P > \|t\|$	Coef.	$P > \|t\|$	Coef.	$P > \|t\|$
Stock-Opt.	-1014.71***	0.010	-1094.34**	0.043	-925.53*	0.098
Man	-1528.78***	0.005				
Testo			200.41***	0.007	-5.30	0.412
Testo^2			-1.39**	0.017		
Corti			-831.42	0.865	16331.94**	0.040
Corti^2					-20007.83*	0.068
Age	373.88*	0.064	107.07	0.735	347.87	0.205
FinLit	132.24	0.703	-93.36	0.851	414.16	0.503
LossAv	-97.73	0.378	-262.78*	0.070	423.17**	0.026
Curvature	729.28	0.304	1928.77*	0.086	279.11	0.791
ProbWeigh	-1012.67	0.229	-1821.87	0.175	-309.10	0.833
Extraversion	-26.43	0.340	-35.88	0.422	-10.64	0.801
Opennes	5.96	0.865	34.90	0.497	2.99	0.959
Agreableness	-35.93	0.293	-31.55	0.621	5.82	0.916
Neuroticism	-57.09*	0.064	14.92	0.818	-94.78	0.106
Consciens.	-43.10	0.248	-16.42	0.780	-102.98	0.045
Treatment	307.48	0.441	618.64	0.308	-750.22	0.258
Constant	-387.21	0.941	-3377.75	0.653	-3216.07	0.664
R^2/ Adj. R^2	0.121 / 0.061		0.252 / 0.127		0.232 / 0.084	

The effect of the contract is also observed in the separate regressions for women and men. These regressions also display the hormonal effects we observed. For women, we again observe a n-shape quadratic link between testosterone and the skewness premium. This relation is displayed in Figure 3, over the range observed for women testosterone. Such a quadratic relation is close to the one observed in Stanton et al. (2011).

For men, we observed a quadratic n-shape relation between cortisol and the skewness premium. Men with low and high cortisol level required lower compensation to switch to a contract with less skewness. The shape of this relation is for instance closely similar to the one established between cortisol and memory (Lupien et al. 2007). Cortisol being a hormone related to stress, lower level of cortisol would be related to lower stress. In a low stress situation, participants might be more likely to take risks. As noted previously, cortisol is sometimes referred to as a "fight or flight" hormone. Therefore, high levels of cortisol could also be related to risk taking behavior. This quadratic relation is displayed in Figure 4, over the range observed for men cortisol.

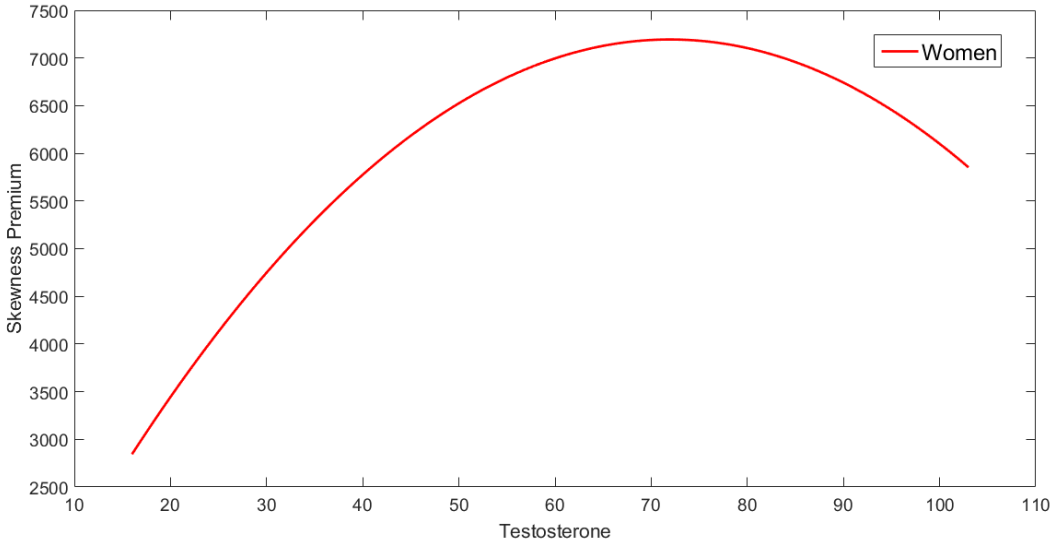


Figure 3: Skewness Premium as a function of Testosterone - Women

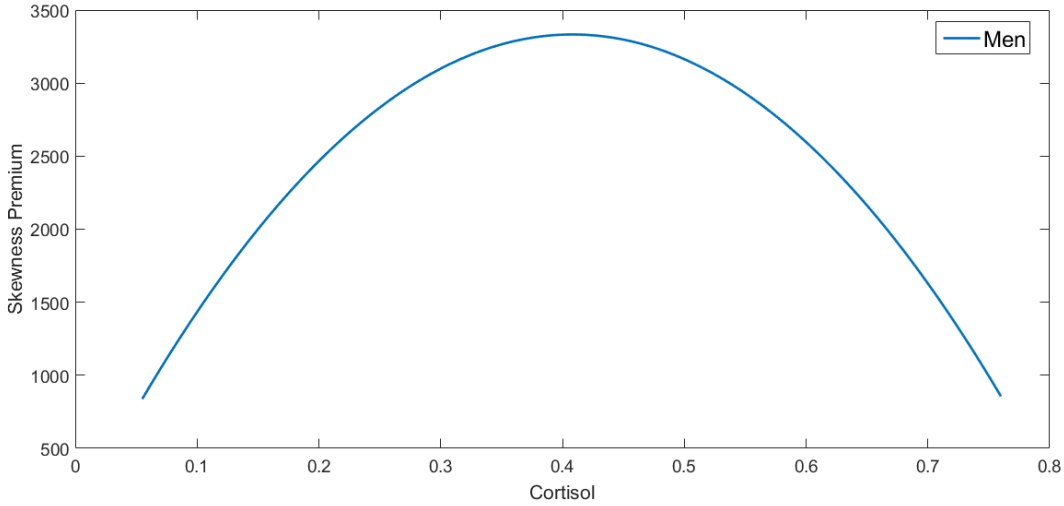


Figure 4: Skewness Premium as a function of Cortisol - Men

Result 2c: A n-shape quadratic relation exists between cortisol and skewness premium for men, with high and low levels of cortisol linked to lower skewness premiums.

Result 2d: A n-shape quadratic relation exists between testosterone and skewness premium for women.

4.3 Relative Importance of Individual Characteristics and Contract

We now investigate the relative importance of the contract and the personal characteristics, both in terms of predictive power and economic effect.

Concerning predictive power, we display the modelled variance attributable to these variables in Table 9. In all cases, the contract is indeed an important variable, accounting for 2.2% to 3.5% of the R^2. While the R^2 attributable to individuals characteristics is much higher, it is somewhat misleading, as there were many more personal characteristic variables than contract ones in this study.

This is why we also display the R^2 attributable only to testosterone and cortisol, the hormonal variables. In the case of the variance premium, they account for respectively 7.2% and 2.6% of the R^2. Testosterone accounts for 7.0% of the R^2 in the case of the skewness premium for women. Cortisol accounts for 4.5% of the R^2 in the case of the skewness premium for men.

Therefore, while the form of the contract is indeed a very important variable, individual characteristics appear to be at least as important, if not more.

Table 9: Predictive power: modelled variance (R^2)

	Variance All	**Skew All**	**Skew Women**	**Skew Men**
R^2 Total	18.9%	12.1%	25.2%	23.2%
R^2 attrib. to contract	2.2%	3.1%	3.5%	2.8%
R^2 attrib. to indiv. charact.	16.7%	9.0%	21.7%	20.4%
R^2 attrib. to Testosterone alone	7.2%	N/A	7.0%	N/A
R^2 attrib. to Cortisol alone	2.6%	N/A	N/A	4.5%

This is confirmed if we take a look at the economic effect of these variables. The graphical representation in Figure 1 is already quite representing, showing that the economic effect of being a man versus woman has roughly the same effect as switching from the equity to the stock option contract. Our model in Table 7 predicts that an increase of 0.085μg/dL of Cortisol level for a woman

(roughly 1.15 standard deviation) has the same effect as switching from the equity to the stock-option contract regarding variance premium required. Similarly, for a man, our model predicts that an increase in testosterone of +1.5 standard deviation from the mean has the same effect as switching from the equity to the stock-option contract regarding the variance premium required. For the skewness premium, being one standard deviation below the mean regarding cortisol level or near the maximum observed in our sample compared to being at the mean had the same effect as switching from the equity to the stock option contracts.

Overall, it would clearly appear that personal characteristics and in particular hormonal levels have more importance than the form of the contract.

Result 3: Overall, personal characteristics have more importance than the form of the contract.

4.4 Robustness Checks

We performed a number of checks, to ensure our results were robust to different specifications. As previously underlined, running separate regressions for men and women in the case of the variance premium or on the contrary performing a single regression with interaction term in the case of skewness does not change the results regarding hormones.[10] We then used a more sophisticated random effect panel, using the decisions under both contracts as the "time" variable. We obtain the same pattern of significance regarding the effect of contracts and hormones. Instead of using the actual premium as the dependent variable, we also try using the switching line (see table 1 and 1(b)). Even though this measure is much cruder, we obtained again the same results regarding the effect of contracts and hormones. Overall, it appears our model is robust to different specifications.

A last issue might be raised. We might indeed have over-fitted the data by adding a quadratic term. We thus performed a Leave One Out Cross validation. The idea is to estimate the model on $n-1$ observations, and assess how well it performs in predicting the observation left out. The process is repeated until all observations have been left out once. This cross-validation technique underlines that models with interactions and/or quadratic terms outperform the ones without, in term of RMSE, MAE and pseudo-R^2.

[10] While the assumptions supporting classic OLS regressions were respected, a high VIF was observed for regressions with quadratic terms. Such a VIF is not a problem. A simple way to show it is to centralize both variables and to rerun the regressions. The same results are obtained, without any VIF problem. We chose to display non-centralized regressions, to have results easier to read. There was no other point of concern regarding multicollinearity.

Conclusion

"I would like to see more behavioral finance research in the field of corporate finance."
Thaler, 1999 in a paper titled "The End of Behavioral Finance", Financial Analyst Journal.

We investigate in this paper the relative importance of the form of the contract (stock-option versus equity granting) and personal characteristics on risk-taking.

First, it appears that stock-options contracts are indeed effective in prompting more risk neutral behaviour, both regarding variance and skewness. The stock option contract induces participants to focus more on the gains than the losses compared to the equity one, as revealed by a text analysis of participant's explanations of their decisions. While participants overall did not have a statistically significant preference for one form of contract over the other, cortisol salivary level and loss aversion were positively related to a preference for the safer equity granting contract.

Second, we found a number of statistical association between testosterone, cortisol and risk taking. A quadratic relation exists for our sample between testosterone and risk seeking (variance seeking). High levels of testosterone in men were associated with more risk seeking. Women with higher levels of cortisol were also more risk seeking, in line with a fight or flight reaction. Concerning skewness seeking (prudence) we found again a quadratic relation between testosterone and prudence for women. For men, we found a quadratic relation between cortisol and prudence, with low and very high levels of cortisol associated with lower skewness premium (more imprudent behavior).

Third, our results underline that while the form of the contract is an important factor of risk taking, personal characteristics remain the main driver of choice, both in terms of statistical explanatory power and economic effects. For instance, our model predicts that for men, an increase in testosterone of 1.5 standard deviation above the mean has the same effect as switching from the equity to the stock option contract regarding risk aversion.

Behavioural finance research and even more so neurofinance research in the realm of corporate finance remain scarce, even 20 years after R. Thaler exhortation. Our results underline that behavioural and even biological factors play a role in the decision making of individuals, even more so than the form of the contract. Therefore, the call for paper of R. Thaler appears more relevant than ever. Given the advance in neuroscientific methods in the past 20 years, the use of neurofinancial methods to further explore behavioural factors in corporate finance seems a particularly fruitful avenue of research.

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