

French CEOs compensation: what is the cost of a mandatroy upper limit?

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Abstract

In the middle of the 90s, the sharp increase in globalization and the last privatization wave have promoted the shaping of a market for executives in France. Characteristics of this market are estimated for France and a competitive model is simulated in order to assess to what extent such a model can reproduce the observed chief executive officer (CEO) compensations. The size elasticity of CEOs' compensations in France is equal to 0.5 and justifies a large magnitude in compensations. To moderate these compensations, a wage cap is often called for not only by opinion and the European Left but also, more surprisingly, by representatives of shareholders. The cost of this policy is evaluated in this job assignment model and the lobbying of shareholders is investigated and explained above some thresholds.

Classification *JEL* : J31, J33, D33, D41.

Keywords: executives compensations, wage differentials, superstar theory

1 Introduction

The French public has recently focussed its interest on executive pay for two main reasons. The first is the disclosure of compensation for chief executive officers (CEOs) and other executives imposed on publicly-traded firms by the Law of 15 May 2001, known as "loi

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NRE".¹ The second is the double digit growth of CEOs' compensations compared to the 0.7% growth rate by year of the average revenue during the last decade. This rapid rise of French CEOs' compensations has been interpreted as a catching-up with Anglo-American CEO compensations. The catching-up explanation assumes an international market for the French CEOs but their real mobility is limited. Their compensations should be linked to the evolution of the French, or at best European, labor market for CEOs rather than to catching-up based on no economic ground once the fact that French CEOs are hired on the French market has been established.

The large privatisation waves, especially the last one (1993-1997) have increased the number of large firms which are publicly-traded and which fix freely the compensation of their CEO. At the same time, the mean CEO compensation for companies listed on the SBF120² index rised up to €3,000,000 in 2006. As descriptive statistics in Table 1 show for the 42 largest firms of the French Stock Exchange for 2003, 2004 and 2005, French CEOs earned significant payoffs. It raises the question of equity or ethics of such compensations. Indeed, the World Value Survey shows that France is one of the countries where on the question at income equality the answer "Incomes should be made more equal" is more common than the answer "We need larger income differences as incentives". So, the fact that French people frown upon very large compensations of CEOs was expected. But empirical studies and academic works are rare on this issue especially on French CEO compensations and more generally executive compensation has been examined to a much lesser extent than in the United States (US). This study, focussed on the magnitude of CEO compensations, is motivated by the gap between actual CEO compensations and what people regard as fair compensations. The main explanation put forward is the very tough competition between firms to obtain the most talented people at the head of large firms. Schleifer (2004) has begun to raise the question of whether competition can force unethical behavior and has numbered three ways to deal with this issue: long-market pressure, moral suasion and government regulation. He concludes that long-run market pressure and moral suasion do not work to curb unethical conduct because of short-term behavior of consumers and producers that overcome their desire for more ethical practices. Regulation of executive pay, as shown be the recent American experience in capping CEO compensations for firms which have been helped by the gouvernement during the 2008 financial crisis, is not going to work due to the limited state's enforcement powers. Nev-

1. NRE is the abbreviation for "Nouvelles regulations economiques", this law sets new rules on social reporting for listed companies, it demands to disclose all information (structure and amounts) about CEO's compensation in the company annual report.

2. SBF120 is the index of the 120 largest French companies listed on the French Stock Exchange.

Average CEO pay	2003	2004	2005
	42	42	42
Salary	18.3% 992 324 €	17.3% 929 210 €	21% 981 073 €
Bonus	13.6% 739 250€	19.7% 1 058 512€	22.3% 1 041 212€
Stock-options	66.7%	57.9%	55.9%
Black & Scholes	3 613 081 €	3 106 672 €	2 606 482 €
Total	5 417 226 €	5 367 490 €	4 662 803 €

Sources: Proxinvest. Data are deflated to 2005 constant prices.

Table 1: Descriptive statistics on the largest French publicly-traded firms

ertheless, Shleifer’s conclusion is optimistic enough as he forecasts that the willingness of societies to pay for ethical behavior will increase with the wealth of the country. Two main questions arise: is competition leading French CEO compensations, and what is the respective underlying French distribution of talent? What should be the willingness of the shareholders to pay for moderate and ethical pay for CEOs if a salary cap is introduced? This paper tries to bring some lights on those issues.

In a first part, this article investigates the hypothesis of market-driven compensations for French CEOs, since the shaping of a competitive labor market for executives in the late nineties in France. A model in line with the job assignment and the superstars literatures is developed to assess how much French CEOs’ compensations magnitude can be explained in such competitive framework. The superstars theory analyses the rise in stars’ compensations in a competitive process (Rosen 1981). This rise is explained on the offer side by the imperfect substitution between stars’ talents (here CEOs) and on the demand side by the extension of the market for CEOs due to changes in technology, or others exogeneous factors like globalisation process and increased liquidity (low interest rates) which increase the size of the firms managed by CEOs. Although the talent is regarded as relevant to analyse very high earnings in some well known fields like sport and art, the question of characteristics and existence of CEO “talent” can be asked. The existence of talent for CEOs has been underlined by the presence of CEO fixed effects on the performance of large US firms (Schoar and Bertrand 2003), these fixed effects refer to different management styles linked to CEO characteristics (MBA degree, cohort). Nevertheless, the regression of compensations on observable CEO attributes, such as age, tenure or formal qualification, are non-significant, meaning that CEO compensations could not be estimated using a Mincer wage equation. As the observable characteristics are not

sufficient to specify talent heterogeneity, the CEOs' talents can be modeled by a general tail distribution based on the extreme values theory as introduced by Gabaix and Landier (2008). Job assignment theory helps to explain the compensations distribution by introducing job characteristics when compensations distribution differs from the distribution of expected talent (Sattinger 1993). By matching heterogeneous CEOs to heterogeneous firms, wages play an allocative role in assigning talent to resources, i.e. the firm size measured by the capitalization of the firm (market valuation of equity). The assumed complementarity between CEO's talent and the assets of the firm implies that output sensitivity to talent increases with firm size, leading to an allocation between the most talented CEO and the largest firm and so forth which is called a positive assortative matching³ (Becker 1973). In a competitive market, firm sizes and CEOs' talent distributions together with the shape of the matching function are key factors in wage determination as in Tervio (2008).

Whereas CEOs' compensations and firm sizes are observable by the economist, CEO talent is difficult to assess. The theoretical relationship between compensation and size built in this paper will allow us to estimate the underlying talent distribution needed to generate the magnitude of the observed French CEOs' compensations. Estimations are done in Section 3 which introduces data and parametrization. In this competitive framework, results suggest that to generate the French CEO compensations, the talent distribution has to be spread but concentrated in the highest talents, in other words the market-perception of differences between CEOs is less homogeneous than for the US (Gabaix and Landier 2008). It induces more differences between CEOs' talent and so a larger scale of talent. The French superstar effect for CEOs is lower than the one that benefits American CEOs, but very few differences between prospective executives still justify large magnitudes of compensation. The French superstar effect is lower because of the small size of the French market and of the small size of the French firms but also due to the distribution of talents. Talents are less homogeneous among CEOs but are less concentrated in the first quantiles and more concentrated in the latest ones. It means that there is a lower tension index on the French CEO market at the highest quantiles, and it implies lower differential rents at the highest quantiles of the distribution of compensations. The small size of the sample can be asked but it is relevant as the market for the CEOs of the largest French firms is segmented from the market of CEOs for small-cap. Himmelberg and Hubbard (2000) have shown that the elasticity of supply was lower for the largest firms, they conclude that CEOs able to manage the biggest firms of the economy are quite scarce. Those CEOs have not the same outside opportunities and do not belong to the same labor market.

3. called PAM in the following

Finally, in the last section, a cap is introduced and its cost is determined to appreciate to what extent shareholders can support such a regulation. Indeed, to cope with the rising public dissatisfaction due to the magnitude of CEO compensations of the largest firms, several European politicians, even conservatives like Angela Merkel, have expressed their disagreement and have mentioned the feasibility of a mandatory upper limit for the highest compensations in order to implement a "fair" ratio between the workers (blue and white collars) and the chief executive officer compensations. The main concern about the use of a limitation is to address the following question: how to attract the right CEO for the right job? Introducing such a cap policy in this sorting model allows us to assess the effect of a cap policy on shareholders' wealth, CEOs' earnings and production. A cap policy neutralizes the role of compensation and leads to a costly mismatch. The real cost of such a mandatory upper limit is simulated. This regulation leads to a new equilibrium where some firms offer the maximum allowed compensation in order to attract a better CEO on average than the one they can attract at the competitive equilibrium with PAM. According to the inequality of the resources (talents and assets) distribution, the model helps to explain why in several cases the call for a wage cap can come from shareholders themselves, as increasingly common (to compare to zero in early decades) proxy fights in general meetings could testify in France and in other countries. I also give an assessment of the kind of willingness needed to support such policy from the shareholders point of view and from the point of view of the society as a whole.

2 The job assignment model

In line with the recent literature on competitive market for CEOs, composed by Gabaix & Landier (2008) and Tervio (2008) papers, a reference framework is built to analyse CEO wages distribution on the French CEO labor market. The model takes-up the general distribution function of CEOs' talents highlighted by Gabaix and Landier, that allows me to have a closed form model. A differential rents model defined as a job assignment model is developed in order to express wages as a function of size and talent distribution parameters, and of the firm size itself.

On this market, there are two observable sources of heterogeneity: the ability of the CEO and the size of the firm. Shareholders choose the best CEO they can afford to manage their firm. Let $t \in [t_0, t_{\max}]$ denote the *ex ante* market-perception (Board of directors) of the CEO talent and let $s \in [s_0, s_{\max}]$ denote the firm size (market value of equity), both are unidimensional. Individuals and firms are a unit mass so that at the equilibrium there is full employment. The distributions of those inputs are continuous and

characterized by CDF denoted, $F(t)$ for talent distribution and $G(s)$ for size distribution with $j = F(t)$ the talent quantile of the CEO and $i = G(s)$ the quantile of the firm size. The production function $Y(\cdot)$ is twice continuously differentiable and is characterized by increasing differences:

$$\frac{\partial^2 Y(t, s)}{\partial t \partial s} > 0 \quad (1)$$

It means that the marginal impact of CEO's talent is assumed to increase with the value of the assets under his control, the factors of production are complements.⁴

Definition 1 *The competitive equilibrium consists in:*

(i) a matching function $M(\cdot)$ which allocates a firm from the i -quantile to a CEO from the j -quantile such that $j=M(i)$ for $i, j \in [0, 1]$ and

(ii) a wage function $w(\cdot)$, which verifies the two following conditions:

(b) a firm i selects a CEO j which maximizes the shareholder value $\pi(j, i)$ s.t:

$$\max_j \pi(j, i) = Y(t(j), s(i)) - w(j) \quad (2)$$

and (b) the participation constraints of both CEOs (w_0 the CEO's utility of reservation) and owners (π_0 the shareholders' utility of reservation) are fulfilled:

$$w(j) \geq w_0 \quad \forall j \in [0, 1] \quad (3)$$

$$\pi(j, i) = Y(t(j), s(i)) - w(j) \geq \pi_0 \quad \forall i, j \in [0, 1] \quad (4)$$

The wage function is derived from the maximization of profits equation (2) :

$$w'(j) = t'(j)Y_1(t(j), s(i)) \quad (5)$$

Moreover, according to the complementarity described by (1): $\frac{\partial Y_1(t(j), s(i))}{\partial s(i)} > 0$, the larger the firm, the higher is the return of the CEO's talent. Consequently, each CEO has preference for working in the largest firm and similarly the bigger the firm, the more sensitive to ability the firm is. A large firm wishes to hire the most able CEO, that it can afford. At equilibrium, the allocation is a positive assortative matching (denoted by PAM in the following). It implies that $M(\cdot)$ is the identity function, $i = j$. At equilibrium, the

4. For more details on scale of operation effect, see Sattinger (1979) and Dupuy (2008).

wage structure is the following:

$$w(i) = w_0 + \int_0^i t'(j)Y_1(t(j), s(j))dj \quad (6)$$

This equilibrium wage function is obtained by integrating (5) for a positive assortative matching and according to the fact that the output of the smallest firm is driven down by reservation prices of the inputs: $Y(t(0), s(0)) = \pi_0 + w_0$. The absolute wage levels are determined by the reservation price w_0 and the differential rents determined by the characteristics of the firm-CEO pair linked to the distribution of firms size and talents. The determination of wage through a differential rent mechanism implies that the production function can be a very simple multiplicatively separable function which exhibits the property described by (1). For the sake of simplicity, a very basic increasing positive-value function is chosen: $Y(t(i), s(i)) = (1 + t(i))s(i)$. Indeed, the share of the matching surplus does not depend on the exponents. Hence, the CEO impact exhibits constant return to scale with respect to firm size in the following, without loss of generality. Gabaix and Landier (2008) have estimated the return to scale in firm size for American firms through two different ways. First, through the evaluation of their dual scaling wage equation (result for France: -1.070) which is a linear function of the own-firm size and of the reference firm size. Such a panel evidence for France 2003-2005 is given by pooled OLS estimator from the following regression (the more relevant according to the Hausman test):

$$\begin{array}{l} \ln(w_{n,t+1}) = 27.8 - 1.070 \ln(s_{n,t}^{MedianSize}) + 0.51 \ln(s_{n,t}) + \epsilon_{n,t} \\ s.e \qquad \qquad (8.067) \qquad (0.353) \qquad \qquad (0.056) \end{array}$$

For this regression the number of observation is 126 and the adjusted R^2 is equal to 0.41. Second, the return to scale is estimated through time-series estimate (result for France: -0.2032) and by looking at the respective increase in compensation levels and firm size from 2003 to 2005 (result for France: -0.549). As the results provided in brackets hereinbefore show, the return to scale for France is difficult estimate with a so short panel (2003-2005). I take the Gabaix and Landier baseline with their gamma equal to 1. The panel estimation does not allow me to infer the talent distribution that's why I have expressed the function of CEO compensations in a different way, in order to estimate the underlying parameters of the distribution of talents. So, I have followed Tervio's way to modelize the matching function $\varphi(\cdot)$ in order to express wages as a function of the size of the firm

directly. According to the positive assortative matching result:

$$F(t) = G(s) \quad \Rightarrow \quad t = \varphi(s) \quad (7)$$

The wage function is now written:

$$w(s) = w_0 + \int_{s_0}^s \varphi'(x) Y_1(\varphi(x), x) dx \quad (8)$$

with $\varphi'(s)$ the matching function slope: $\varphi'(s) = \frac{G'(s)}{F'(\varphi(s))} > 0$. This latter equation is the ratio of the potential demand for talent on the potential offer which is made up of substitute talents. The matching slope is a kind of tension index on the CEO labor market for each firm size (which determines the firm position into the distribution). The wage function increases with the size of the firm and is concave.⁵ The wage function of a CEO in particular is the sum of the CEO's reservation wage and of the accumulation of rents over this outside opportunity for each CEO whose talent is besides the talent of the this specific CEO. The rents depend both on the tension index and on the marginal product of the CEO.

To go further into the specification we need to select distribution to represent the resources: talent and firm assets. The distribution of firms selected is a Pareto distribution. This distribution is defined by a tail index α (shape parameter) and a scale parameter s_0 , which is the size of the smallest firm of the tail distribution of firm size, the CDF is written: $G(s) = 1 - \left(\frac{s}{s_0}\right)^{-\alpha}$. More details will be provided in the section dedicated to the parametrization of this model (Section 3) to justify this choice. To benefit from a closed form solution, in spite of the unobservability of the talent distribution, I take up the general form of talent distribution introduced by Gabaix and Landier (2007) for tail of distribution:

$$F(t) = 1 - C (t_{max} - t)^{\frac{1}{\beta}}, \quad t < t_{max} < +\infty \quad (9)$$

with $C = \frac{1}{K} \left(\frac{\beta}{B}\right)^{\frac{1}{\beta}}$, K is the number of firm (sample size), t_{max} is the maximum talent available on the CEO labor market studied, β is the tail index and B is the scale parameter of the talent distribution. This distribution is expected to be a power law distribution

5.

$$w'(s) = \varphi'(s) Y_1(\varphi(s), s) > 0$$

$$w''(s) = \varphi''(s) Y_1(\varphi(s), s) + \varphi'(s) [Y_{1,1}(\varphi(s), s) + \varphi'(s) Y_{2,0}(\varphi(s), s)] \leq 0$$

With $Y_{2,0}(\varphi(s), s) \leq 0$ and $Y_{1,1}(\varphi(s), s) > 0$ due to the complementarity. The wage equation is concave when $\varphi(\cdot)$ is sufficiently concave function: $\varphi''(s) < 0$, i.e when the cumulative distribution function of the talent is enough convex.

with finite support (no genius among the CEOs, $t_{max} < \infty$), i.e $\beta > 0$.⁶ Nevertheless, in the parametrization section (Section 3), the estimated parameters of this underlying distribution of talent are found without restrictions on the span of values they can take. The CEO's compensation function (6) can be rewritten as an explicit function of all these parameters and a non-linear function of the firm size:

$$w(s) = w_0 + \frac{\alpha s_0^{\alpha\beta} K^\beta B}{(1 - \alpha\beta)} \left(s^{1-\alpha\beta} - s_0^{1-\alpha\beta} \right) \quad (10)$$

The wage of the CEO is always increasing and concave in its own-firm size. The wage is increasing in: K the number of firm, s_o the minimum firm size, B the talent scale parameter and with the shape parameters α (if $s < s_o \exp(\frac{1}{\alpha\beta})$) and β (if $s < s_o K^{\frac{1}{\alpha}}$), i.e according to the localisation of the firm into the distribution. Such a modelization leads to a non-linear relationship between CEO compensations and firm sizes. A simple Ordinary Least Square regression of CEO compensations on the sizes of firms and on the square of those sizes corroborates this theoretical result.

To test the explanatory power of this model, I have estimated the parameters for France in order to carry out some estimates of the underlying French CEOs' talents distribution and so some simulations of CEO compensations predicted by this modelization.

3 The French superstar effect: data and parametrization

3.1 Data

The data come from Proxinvest, a French independant consulting firm and have been collected from corporate reports. For the purpose of this study, the sample includes the 42 largest French listed companies, i.e the large and mid-cap which represent about 60% of the total French market capitalization. This study exploits the 2002-2005 data. Two series of data are used: CEO compensations and firm sizes. Data are in real terms, using the current compensations and the firm sizes deflated by the 2005 retail price index.⁷

The compensations are compiled with non-monetary perks, salary, bonus and the option values but ignoring deferred compensations. According to the belief that deferred compensation fulfilled other roles than the allocation of talent there is no loss of information

6. See Gabaix and Landier (2007) for more details

7. Source: INSEE, the National Institute for Statistics and Economic Studies.

in not using them in this model. The compensation of the year is reconstructed by using salary, bonus, options (using the Black and Scholes formula⁸) and others compensations awarded for a specific year after their publication in the next year corporation report. These compensations are calculated for the number one, i.e the best paid. The title of the person which represents the firm can be in French: “Président directeur général” (Chief Executive Officer), “Directeur général” (Executive Officer), “Président du directoire”(Chairman), “Directeur général” or “Gérant”.⁹

The size of firm is measured in many different ways in the literature either by the number of employees, the turnover, the sales, or by market capitalization. The choice of the measure depends on the way a CEO interacts with firm assets. The CEO is assumed to have a permanent effect on the firm value. Indeed, according to the findings of Bertrand and Schoar (2003), although the CEO has a very general range of actions, the CEOs’ fixed effects are significant mostly for financial and strategic decisions. The marginal product of CEO’s talent is relative to the real role played by the manager. Consequently, the number of employees is not regarded as an appropriate measure even if it is the INSEE criterion to define firm size, the CEO’s impact does not depend on the capital intensity of the firm all the more that outsourcing is increasingly common. The CEO links the firm to their shareholders and creditors through the implementation of strategic decisions (acquisition, dividend policy...). Thus, using the turnover does not take into account the firms’ potential and the long term effect of the CEO actions on shareholders’ wealth. According to those argues, the most relevant measure of the size in this modelization seems to be the valuation of firm equities at the beginning of the year, which is also the variable that offers the strongest correlation with CEO compensations in the data, about 0.4. The value of equities at the beginning of the year is given by the number of shares outstanding multiplied by the share price on 31 december of the first year of the CEO contract with the firm. Indeed, the two distributions of size and talent, are not independent. This issue is mentioned by Rosen (1990) who highlights the difficulties to separate the size effect from the performance one through the joint output. As performance itself does not play any role in this model, there is no effort cost and so no incentives. The CEO is paid for his *ex ante* talent relative to his competitors. For this purpose, in the estimation, the size at the previous year is used. As analysed by Mullainathan and Bertrand (2001), the CEO

8. This work has been done by Proxinvest, in addition they have taken into account that options are restricted and have applied a fix discount rate of one third by restricted year to the maturity of the option.

9. One CEO is clearly above the others in term of total compensation: Lindsay Owen Jones, for this reason he is dropped from the studied French sample. The explanation of this difference can lie in the outside opportunities of this CEO, which are international.

could be rewarded for luck. In this model, luck is immediately included into firm size through the increasing amount of assets the CEO has the opportunity to manage. The PAM assumption is tested through the computation of the Spearman coefficient which indicates the correlation between the rank of the compensation and the rank of the size of the corresponding firm. This coefficient is around 0.62 for 2004, it is different from one, which indicates that there are maybe frictions on this market but that the assortative matching is nevertheless a good assumption.

3.2 Parametrization

The previous model has allowed us to understand how market forces, through distribution of complement heterogeneous inputs, drive the wage structure. Most components of the theoretical wage could be observed or calculated: the sizes of firms, the Pareto parameters, the CEOs' compensations and the number of firms.

3.2.1 The size distribution

The size distribution kernel density is similar to a Pareto distribution. The Pareto index is estimated on the data by maximum likelihood estimator and by the OLS estimator. For both, the chosen scale parameter of the Pareto distribution is the minimum size of the firm on the market. The estimation with maximum likelihood does not allow us to give confidence interval given that $\alpha < 2$ implies that the variance cannot be calculated. Furthermore, as recommended by Hossain and Zimmer (2000) in the book of Kleiber et al.(2003) at page 79: "a least-squares estimator be generally preferred (or equivalent) over the maximum likelihood for estimating α for small value of the parameter ($\alpha < 4$)". The process described by Gabaix and Ibragimov (2009) is used to obtain the ordinary least square estimates. The following regression is done for each year, here the result for 2004 with $R^2 = 0.80$:

$$\begin{array}{l} \ln(Rank_n - 1/2) = 18.81 - 0.706 \ln(s_n) \\ \textit{std error corrected} \quad (1.23) \quad (0.152) \end{array}$$

Estimates are reported in Table 2. The estimates of Pareto tail index are lower than the ones found in the literature on size of firms distribution. The French firm size distribution is extremely heavy-tailed as $\alpha < 1$. For the adequation of Pareto distribution for size of firm distribution see Axtell (2001, 2006), Buldyrev et al. (1995).

3.2.2 The underlying French talent distribution

The talent distribution parameters β and B are unknown. An estimation of the French underlying talent distribution characterised by these parameters is carried out. These estimates are obtained through Generalised Method of Moments (GMM) estimation of the equation (10) which is non-linear in firm size, and is written:

$$w_{t+1,n} = w(s_{t,n}, \beta, B) + \epsilon_n$$

GMM has been preferred to maximum likelihood because this latter requires to specify the form of the likelihood function and because residuals present heteroscedasticity of unknown form. The shape and space parameters, the talent distribution parameters β and $B * 10^{-6}$, are estimated on French data for the years 2003 to 2005. There is no problem of overidentification as there are two orthogonality conditions and two parameters to estimate, such that:

$$E \left[\frac{1}{K} \sum_{n=1}^K z_n (w_{t+1,n} - w(s_{t,n}, \beta, B)) \right] = 0, \quad E(\epsilon_n | z_n) = 0 \quad \forall n$$

With $Z = \begin{pmatrix} 1 \\ r_{t,n} \end{pmatrix}$ the vector of the two instruments, the constant and $r_{t,n}$ the operating result. We observed a vector of operating results uncorrelated with the CEO compensations and which are explanatory variable when the dependent variable is the market capitalization of the firm. The GMM estimators are asymptotically Gaussian so we can compute their asymptotic variance-covariance matrix.¹⁰ But as it is an exactly identified case I cannot do inference about the specification of the model. As the wage function is non-linear in the firm size and depends on the sample size I cannot obtain standard errors and confidence intervals through the usual delta method which provides asymptotic estimates for the non-linear function variance. I used Monte Carlo simulations to approximate the asymptotic confidence intervals of the simulated wage function as a replacement for asymptotic variance estimation by delta method. For Monte Carlo simulations I have chosen a population distribution for the sizes which depends on the parameters of the Pareto ditribution estimated for France in the subsection 3.2.1. The sample size is $K=42$. I have drawn a random sample of size K from the distribution and I have utilized the sample to obtain an estimate of the parameters of the talent distribution. I repeat the process for several iterations $M = 2500$. I have reported asymptotic confidence intervals

10. I make GMM estimations following the process summarized in J.D Hamilton pp-416-421 in his book on Time Series Analysis.

Parameters	2003	2004	2005
κ	42	42	42
β	2.51*** <i>0.65</i>	2.11*** <i>0.64</i>	2.31*** <i>0.34</i>
B	3.41 <i>4.32</i>	4.01* <i>3.6</i>	4.31* <i>2.24</i>
α_{OLS}	0.609*** <i>0.13</i>	0.706*** <i>0.15</i>	0.758*** <i>0.16</i>

*Note: std err; *** significant at 1% ** 5% *10% to 30%*

Table 2: Estimates of the distribution parameters

on Figure 1 to see how well they cover the empirical data relative to a 95% confidence level (See Wooldridge 2001). The GMM estimation is performed and the results for years 2003, 2004 and 2005 are summarized in Table 2.

The spacing between talents for very highly educated individuals which are on CEOs' labor market were expected to be small according to the findings of Gabaix and Landier on the American CEO labor market and according to the fact that French CEOs of the largest French publicly-traded firms have for most of them the same background (former civil servants and graduates from "Grandes Ecoles" like Polytechnique). The shape parameter should be conditional on the screening process which leads to a very uniform background for the CEOs of Large and Mid-cap French firms. As the distribution of talent represents a subjective assessment (board of administrator) of the differences between the French CEO talents, these parameters were expected to induce a concentrated distribution.

The estimates obtained for the three years are quite close and predict a power law distribution for French CEO talents with finite support as expected. The French underlying talent distribution seems more unequal and more spread than the US one, estimated by Gabaix and Landier (2008). Either such differences in French talents can be justified or understood, or the same exercise needs to be done for the US data to understand to what extent estimations overestimate or underestimate the talent distribution according to the methodology. The reasons behind and the consequences of this underlying French talent distribution will be described and discussed in the following subsection.

3.2.3 The French superstar effect

To generate the observed French CEO compensations, the underlying talent distribution needs to be very concentrated in the highest talents and is composed by CEOs which are considered as less similar from each other in terms of talent than on the US market. The

model is simulated in order to illustrate the way this modelization helps to reproduce the data thanks to the parametrization performed in this Section. The model is simulated for the 2004 data, a sample containing 42 of the largest publicly-traded firms which distribution of sizes is characterized by a scale parameter equal to the smaller firm size of the sample $s_0 = 0.6$ billion euro. The minimal compensation corresponds to the common outside opportunity of the CEOs who belong to this labor market €386,940. The simulated compensations are presented in Figure 1 with confidence intervals at 95%. The very highest compensations are not covered by the interval so are unexplainable in this competitive framework, whereas the main CEO compensations are in the confidence intervals at 95%.

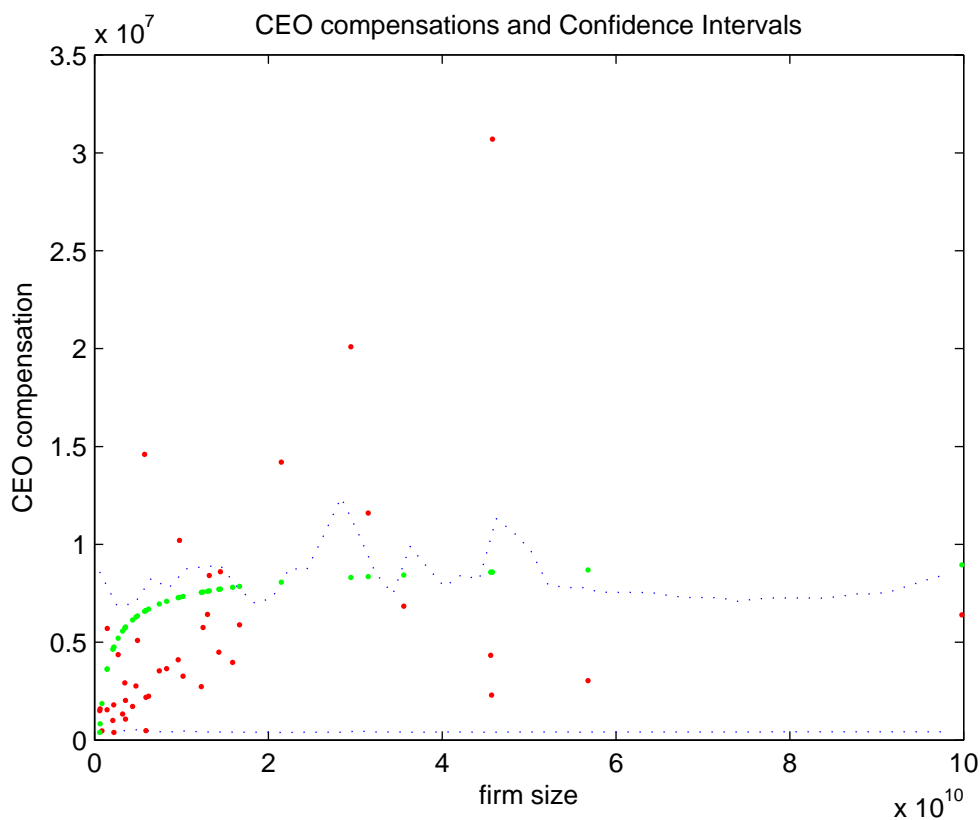


Figure 1: Empirical (dark), simulated CEOs' compensations (grey) and confidence intervals (dotted lines)

The degree of inequality of the assets distribution, given by the shape parameter of the distribution of size, the scale of the distribution, s_0 , and the size of the market, K , are not enough to generate differential rents for CEOs equivalent to the one observed in France. It explains why the offer side effect needs to be reinforced to generate the observed differential rents. It means that we need larger differences between CEO talents to generate

compensations close to the real ones, such that the market perception of differences and distribution of CEO talents will be larger than for the US. The offer side is essential to understand French CEO compensations.

How can such differences in talents be justified in France? Before the large waves of privatizations, most of the CEOs of the French largest firms were nominated according to the will of the State. This situation was like a monopsony rather than a competitive market on which employers compete to attract the best CEO at the head of their firm. The State fixed most of the CEO compensations, the prestige of the status was the only rent the CEOs can have (for firms owned by the State or the one implying political choices). As it is well-known, in the case of monopsony, wages are lower than under a competitive situation. The recent shaping of a labor market for executives in France, due to privatization waves, has increased the competition between CEOs. But how much difference lie between CEOs on this "new" labor market? In France, CEOs of large and mid-cap firms (the ones we are looking at in this paper) have very homogeneous background. They are former civil servants or have some Grandes Ecoles diploma, see Kramartz and Thesmar (2007). As a consequence, they have very similar outside opportunities in high-responsability jobs (public service). The CEOs of the largest firms are completely different from the CEOs of non publicly-traded firms or CEOs of the smallest firms on the French Stock Exchange. In France, there was no private training specific to managers which could compete with the most prestigious training provided by the State (Polytechnique, etc)¹¹. The training of those CEOs has been very generalist for a long time and the screening was (and is still) done at the early stages of the training rather than by a ranking by results obtained internally as executive at a lower level in the firms' hierarchy. It may explain why perception of CEO talents are so heterogeneous. French CEOs do not evolve according to very homogenous process of tournaments into the firms but through tournaments in the public sphere with more complicated and less competitive rules. This French screening process seems very different from the American one. The US screening is maybe more competitive given that executives' promotion were due to tournaments which take place in the private sector. American executives who work their way up through a hierarchy that is very demanding are more numerous than among French executives. This Darwinian process might result in a more homogenous pool of top executives in the US. The dispersion of the French CEO talents can also be interpreted as the reflection of better information on the talent of the managers due to the strong networks at stake on the French market which is smaller than the US one. It can also be some misperception or overestimation of

11. Maybe partly due to the central role played by the State in France in the economy in general which necessitates to have businessmen connected to political circles of power.

those differences due to the methodology. But, this dispersion of French talent explains the large effect of the own-firm size on the CEO's compensation in the dual scale equation introduced in Section 2, equal to 0.5 when it is closer to 0.3 in other countries (Murphy 1999).¹²

As a result, the gain due to the substitution¹³ of the median CEO by the best CEO of the sample in the median firm is around 0.11% to compare to the 0.016% of Gabaix and Landier for the United-States. The corresponding differential compensation for CEOs is equal to 128.4%, in this competitive framework. It illustrates the French actual superstar effect which is one fourth of the US superstar effect. Even if the superstar effects can not be compared so roughly. The difference in CEO compensations in the real sample is: 133%, when CEO compensations unexplained by this model (uncover by confidence intervals at 95%) are dropped.

In spite of what the market-driven explanation suggests, the question of the regulation of CEO compensations is raised due to the public interest for the question, the numerous European (Netherlands, Switzerland, Germany and France) policymakers who call for CEO compensation temperance. Indeed, the Codes of Best Practice, made public in France (95 and 99 Viénot reports, 2002 Bouton report) to moderate those compensations and the laws which force disclosure of CEO compensations have reinforced the comparison between CEO compensations and helped the shaping of a "competitive" labor market for CEOs rather than put pressure on those compensations. In most of the countries, the Board of Administration alone fixes and is responsible for the CEO compensation. Nevertheless, some representatives of shareholders call for a mandatory upper limit. How shareholders can rationally sustain a mandatory upper limit? How much does it cost? What should be the shareholders' willingness to pay for ethical behaviors in terms of CEOs' compensations?

4 The effects of a mandatory upper limit

This section investigates the effects of a policy which implements a maximum compensation for CEOs. This study helps to understand the emergence of protest from shareholders themselves without any equity considerations or changes in the objective function (maximization of stakeholder value rather than shareholder value).

12. The elasticity of CEOs' compensation with firm size estimation have most of the time been done in earlier decade and according to different proxy for firm sizes.

13. at no extra salary cost

4.1 A salary cap for CEOs

Doing the assesment of the effect of a cap policy in this sorting framework makes sense as the main economic issue is how to attract the best manager for the firm. Most of the time, incentives (the need to motivate the CEO to do the maximum effort) are not mentioned to justify the magnitudes of the CEO compensations. I introduce a mandatory upper limit, some cap¹⁴ on CEO compensation \bar{w} which affects executives whose firm size is above a threshold \bar{s} such that:

$$\forall s \geq \bar{s} \quad w(s) = \bar{w}$$

Until now, only limits on the deductibility of executive pay, like the Omnibus Budget Reconciliation Act in the United-States, have been implemented. This policy has been assessed by Rose and Wolfram (2000). Their results suggest that the growth of total pay, for limited firms, decreases slightly and that the structure of compensation changes in favor of non salary pay.

When a cap on CEO compensations is introduced, compensations can no longer play their allocative role for firms affected by the mandatory upper limit. The positive allocation becomes a random matching for all the firms above the upper limit. The random matching assumption is done to avoid other ranking properties linked to additional underlying CEOs' preferences that could enhance or decrease the effect of the mismatch. The main concern is about the incentive that the introduction of a mandatory upper limit creates for some firms to offer the maximum wage to attract a better CEO than the CEO they are matched with in case of PAM. Each firm who fixes freely its CEO compensation must do a trade-off between hiring his "positive assortative matching" CEO at the previous PAM equilibrium price, $\Pi_{PAM}(s) = Y(\varphi(s), s) - w(s)$, or trying to attract a more talented CEO on average by offering exactly the compensation cap to have the following profit $\Pi_{NE}(s) = Y(t_{random}, s) - \bar{w}$. The last firm for which it is interesting to offer voluntarily the wage cap in order to attract a better manager is called sc , and the following equality must hold: $\Pi_{PAM}(sc) = \Pi_{NE}(sc)$ with $\Pi_{NE}(s)$ the profit of a firm of size s when its CEO compensation is set equal to the maximum amount authorized by the law and when the talent is randomized t_{random} . This randomized talent is the expected talent for all the firms affected, voluntarily or not, by the upper limit. It is the average talent between $\varphi(sc)$,

14. The salary cap terminology derives from the professional sports vocabulary. More precisely, from team sports like Basketball or Baseball which leagues have introduced upper limits envelope based on league revenues to moderate team's global compensation and to maintain some competition between teams. Indeed, the cap prevents the concentration of the best players in the wealthiest team.

the talent of the last firm (sc) which benefits from setting freely its CEO compensation at the upper limit, and the highest talent available in the economy t_{max} .

Lemma 1 *If there is some firms who post voluntarily the mandatory upper limit to attract better CEOs, this expected talent or randomized talent is written:*

$$\bar{t}_c = \frac{\varphi(sc) + \beta t_{max}}{1 + \beta} \quad (11)$$

Proof. Appendix A.2 ■

The shareholder profit in case of PAM, $\Pi_{PAM}(\cdot)$, is increasing and convexe in its own-firm size (see Appendix A.1), whereas the shareholder profit when the firm is affected by the mandatory upper limit, voluntarily or not, $\Pi_{NE}(\cdot)$, is a linear function of the firm size, such that the following lemma holds.

Lemma 2 *There always exists a firm sc , with $sc < \bar{s}$, such that firms above sc and under \bar{s} post voluntarily the compensation of their CEO equal to the mandatory upper limit. This firm size sc is a function of the distribution parameters and a function of the size of the first firm that is subjected to the mandatory upper limit unvoluntarily \bar{s} :*

$$sc = \left(\frac{\alpha(1 + \beta)}{1 + \alpha} \right)^{\frac{1}{1-\alpha\beta}} \bar{s} \quad (12)$$

Proof. Appendix A.3 ■

The firm whose size is sc is the smallest firm for which it is profitable to offer voluntarily the maximum wage. The existence of firms which set voluntarily a compensation equals to the wage cap in order to attract a more talented manager depends on the size of their firm and of the level of the cap. When a mandatory upper limit is introduced a new equilibrium stands out.

Proposition 1 *When a mandatory upper limit \bar{w} is introduced a new equilibrium arises:*

(i) *the matching is:*

(a) *a positive assortative matching if $s < sc$ with $t = \varphi(s)$*

(b) *a random matching if $s \geq sc$ with $t = \bar{t}_c$*

(ii) *the wage function maximizes the shareholder value s.t:*

(a) *the wage is determined by the equation (10) if $s < sc$*

(b) *the wage is voluntarily set equal to the maximum compensation \bar{w} if $sc \leq s < \bar{s}$*

(c) *the wage is unvoluntarily fixed to the mandatory upper limit, \bar{w} if $s > \bar{s}$*

Moreover, the participation constraints of the CEO (w_0) and of the owners (π_0) are fulfilled.

4.2 Shareholders' losses

The loss function of the representative shareholder is defined as the difference between the average shareholder profit with the cap policy for firms which are affected, voluntarily or not and the average shareholder profit in the PAM case (initial case). The profit of firms non affected by the policy does not change. The correlation between the market capitalization and the number of shares outstanding is above 0.8, it leads me to assume, for the sake of simplicity, that the distribution of shareholders (number of shares) among firms is similar to the distribution of equities between firms. For this reason, the weight function will be the probability density function of the size denoted by $g(\cdot)$ previously. It gets the following non-linear loss function of the representative shareholder denoted by $L(\cdot)$:

$$\begin{aligned} L(\bar{s}) &= \int_{s_c}^{s_{\max}} \frac{(\Pi_{NE}(s) - \Pi_{PAM}(s))}{1 - G(sc)} g(s) ds \\ L(\bar{s}) &= \alpha s o^{\alpha(1+\beta)} t_{\max} (a \bar{s}^{1-\alpha\beta} - b \bar{s}^{1-\alpha(1+\beta)} - c \bar{s}^{-\alpha\beta} + d) \end{aligned}$$

with

$$\begin{aligned} a &= \beta \frac{s_{\max}^{-\alpha}}{1 - \alpha\beta} \\ b &= \left(\frac{\left(\frac{\alpha(1+\beta)}{1+\alpha} + \beta(1 - \alpha(1 + \beta)) \right)}{(1 - \alpha\beta)(1 - \alpha(1 + \beta))} + \frac{\alpha}{1 - \alpha^2} \right) \left(\frac{\alpha(1 + \beta)}{1 + \alpha} \right)^{\frac{-\alpha}{1-\alpha\beta}} \\ c &= \frac{s_{\max}^{1-\alpha} \left(\frac{\alpha(1+\beta)}{1+\alpha} \right)^{\frac{-\alpha\beta}{1-\alpha\beta}}}{(1 + \beta)(1 - \alpha)} \\ d &= \frac{s_{\max}^{1-\alpha(1+\beta)}}{(1 - \alpha\beta)(1 - \alpha(1 + \beta))} \end{aligned}$$

Proof. Appendix A.4 ■

This function is a polynomial function of the magnitude of the cap through \bar{s} and of other parameters of the distributions. This function can be used to find the value of the cap which minimizes losses or maximizes gains.

This loss function corresponds to the profitability of a cap policy for shareholders. There are no welfare dimensions in this loss function. The market value of equities is the present value of future profits and can be used to approximate some rough welfare function. This definition of welfare is regarded as rough given that no additional utility is introduced to

assess the value of ethical behavior in the society through gains in cooperation between workers and their hierarchy due to a less spread scale of compensations. The cap policy induces systematic losses in terms of welfare and should not be implemented from this point of view. The paradox comes from the fact that the request for mandatory upper limit can come from the shareholders themselves rather than from the government. In this case, the regulation can be supported by shareholders whose representants (board of administrators) are in charge of CEOs' compensations. A question arises: why politicians are asking for moderation in CEO compensations although it is not directly welfare-improving (never a first-best) apart from election concern?

Simulations for the values of parameters in 2004 allow me to determine the policy cap which maximizes the shareholder wealth, this cap is about €8.46 million that is quite high. The cap policy provides a positive payoff to shareholders from the €7.69 million cap. Caps which are discussed and viewed as fair by people in general are of lower magnitudes. The following subsection assesses the average losses that the shareholders must be ready to accept to promote ethical behavior in terms of CEO compensations.

4.3 Shareholders' willingness to implement a mandatory upper limit on CEOs' compensations

To assess the loss inferred by the cap policy, the average aggregate losses are simulated for the production (ΔY), the shareholder wealth ($\Delta\pi$) and the CEO compensation (Δw). The global losses are given in proportion of the total market capitalization in the second column of Table 3 and denoted by ΔY_{Global} . The smallest firms affected by the mandatory upper limit, voluntarily or not, obtain a better joint production at the expense of the largest firms. The losses inferred by the cap are always larger for the largest firms. Indeed, the largest firms are matched with a less talented CEO on average than in the positive assortative matching case. The introduction of such a mandatory upper limit benefits firms whose CEO's talent in case of PAM, $\varphi(s)$, is lower than the average talent \bar{t}_c they can attract when there is a cap. The third column gives the average shareholder variation in term of profitability.

The two last columns indicate respectively: in the column intituled "YES", the percentage of shareholders affected by the cap policy who realize gains because of the cap. In the "NO" column, the percentage of shareholders affected by the policy who are losing and are against the setting up of a maximum compensation for CEOs. These two percentages are calculated according to the weight of each firm (capitalization), assuming that the biggest firms have more shareholders. Indeed, the correlation between the market capitalization

and the number of shares outstanding is above 0.8. For a cap which allows the average shareholder to do additional profits, the percentage of shareholders affected by the cap who agree with the cap policy is higher than the percentage of opponents. It leads to an other interpretation which divides the shareholders according to the size of the firm where they own shares. This model gives an interpretation of the increasing proxy fight which have taken place during the annual meetings of some of the largest French firms of the French Stock Exchange. Indeed, shareholders' portfolio can be various for shareholders of one particular firm and it can lead them to different point of views concerning the necessity to cap the CEOs' compensations.

For sufficiently high level of wage cap, beyond €7.69 million, the shareholders who are in agreement with the implementation of a cap are more numerous than opponents. The final approval depends on the say of the shareholders who are not affected by the policy. If the point of view of a representative shareholder is adopted, there should be shareholders' requests for an upper limit higher than €7.69 million and a consultative vote about such a cap policy should lead to an approval.

CEOs whose talent belongs to the $[\varphi(sc), \varphi(\bar{s})]$ are better paid than before the implementation of a cap policy. But, for a six million cap, the mean compensation of the CEOs affected by the cap runs down by 10.25%. This six million cap (gross) is equivalent to 250 times the average French salary and equivalent to 430 times the French minimum wage in 2004. When a six million cap is implemented, 34% of the sample is affected by the cap policy which represents 25% of the total capitalization of the French Stock Exchange. To induce a scale of compensations from 1 to 250 into French firms, the shareholders willingness to pay for such an ethical behavior must be a pay-off, i.e a loss of 0.007% of their profit on average. The cost of such a cap is computed by using a random matching function instead of a positive assortative matching, but in reality investors and especially board of administrators have information about preferences of the prospective CEOs, those information may help to have a better matching function than the random matching function assumed when the signal of compensation is lost because of the cap.

5 Conclusion

The analysis of the French CEO compensations in a competitive framework is able to reproduce the magnitude of observed compensations and to provide interesting counterfactuals for France. This article helps to understand to what extent the CEO compensations are the results of a competitive process. Indeed, the data generating process needs a wide variety of CEO talents to be able to reproduce the French CEO compensations. The

\bar{w}	ΔY_{Global}	ΔY	Δw	$\Delta \pi$	YES	NO	Affected
3	-0.108%	-0.097%	-32.46%	-0.072%	16.12%	83.88%	86%
6	-0.029%	-0.012%	-10.24%	-0.007%	26.6%	73.4%	34%
7.69	-0.0004%	-0.0007%	-2.72%	0.00004%	52.94%	47.06%	11%
8.38	-0.0009%	-0.0001%	-0.42%	0.00019%	95.28%	4.72%	5%

Table 3: Losses and shareholders' say about the implementation of a maximum compensation

Spearman coefficient which gives the correlation between CEO compensations and the size of firms, is not equal to one, it means that some other mechanisms must play a role in the determination of CEO compensations through a more complex matching technology or due to the fact that this model is static whereas CEOs' compensation should have additional dynamic dimensions (see chapter 4).

In France, once the effect of the reference firm has been disentangled from the effect of the own-firm size, I find a Robert's law coefficient equal to 0.5 which is higher than the results of the literature. Jasso and Meyerson-Milgrom (2008) have worked on macrojustice, through an MBA student survey, and have evaluated that the median elasticity of a fair CEO compensation with respect to the size of his own firm should be in the range of 0.14 to 0.26. But, even in terms of own-firm size elasticity of pay the acceptance of MBA students can be different from the one of stakeholders or shareholders. Without specifying another objective function which takes into account the opinion or utility of stakeholders, the last section gives an assessment of the cost of a compensation cap policy. This cost is moderate for shareholders, especially for sufficiently high caps which can be attractive for shareholders. The existence of shareholder lobbies against large amounts of compensations is explained in this sorting model. Nevertheless, such a policy is always costly in term of production (market capitalization in the long run). In this type of model, an increase of the marginal rate of taxation can reduce the gap between the CEO pay after tax and the average worker pay after tax, without having the costly mismatch effect introduced by the cap. More broadly, the increase in inequalities may be linked to the rising of other professions' compensations, by instance in the financial sector, as Kaplan and Rauh (2010) have shown for the US. The two authors have underscored the centrality of superstar effects along a large panel of professions in the rise of inequality these last twenty years in the United-States. The increase in taxation in general will avoid misallocation of talent which can occur in addition to the mismatch effect described in this model. Murphy, Shleifer and Vishny (1991) were aware of the crucial role of returns of productive professions (which generate wealth like CEOs and more broadly, entrepreneurs

or engineers) in the growth. But taxation does not allow shareholders to save costs as with the implementation of a mandatory upper limit which explains why such a cap can be beneficial for shareholders. Nevertheless, caps can be hardly implemented with the approval of all the shareholders and will still be regarded as a high amount of money for most of the stakeholders, even if they force ethical behaviors without taking away the sovereignty of Boards of administrators on the design of the package and so on incentives.

6 Appendices

A Shareholders' wealth with Positive Assortative Matching

$$\Pi_{PAM}(s) = Y(\varphi(s), s) - w \quad (\text{A.1})$$

$$\Pi_{PAM}(s) = s(1 + t_{\max}) - t_{\max}s^{(1-\alpha\beta)}s_0^{\alpha\beta} - w_0 - \frac{\alpha s_0^{\alpha\beta} K^\beta B}{(1 - \alpha\beta)}(s^{(1-\alpha\beta)} - s_0^{(1-\alpha\beta)}) \quad (\text{A.2})$$

$$\frac{\partial \Pi_{PAM}}{\partial s} = (1 + t_{\max}) - s^{-\alpha\beta}(t_{\max}(1 - \alpha\beta)s_0^{\alpha\beta} + \alpha s_0^{\alpha\beta} K^\beta B) = 1 + \varphi(s) > 0 \quad (\text{A.3})$$

$$\text{with } t_{\max} = \frac{K^\beta B}{\beta} \text{ and } \varphi(s) = t_{\max}(1 - (\frac{s_0}{s})^{\alpha\beta})$$

$$\frac{\partial \Pi_{PAM}^2}{\partial s^2} = \varphi'(s) = t_{\max}\alpha\beta \left(\frac{s_0}{s}\right)^{\alpha\beta} s^{-1} > 0$$

$\Pi_{PAM}(\cdot)$ is increasing in s and convex with s .

B Average talent with cap policy

At new equilibrium with cap policy for CEOs' compensations, the smallest firm who posts freely the cap compensation for its CEO is denoted by sc , such that the average talent expression is the following:

$\bar{t}_c = \int_{sc}^{s_{\max}} \frac{\varphi(s)g(s)}{1-G(sc)} ds$ with $\varphi(s)g(s) = \alpha s^{-1} (\frac{s_0}{s})^\alpha t_{\max}(1 - (\frac{s_0}{s})^{\alpha\beta})$, by integrating this expression:

$$\begin{aligned}
\int_{sc}^{s_{\max}} \varphi(s)g(s)ds &= t_{\max} \left[-\left(\frac{s_0}{s}\right)^\alpha \right]_{sc}^{s_{\max}} - t_{\max} \left[-\frac{\left(\frac{s_0}{s}\right)^{\alpha(\beta+1)}}{1+\beta} \right]_{sc}^{s_{\max}} \\
&= t_{\max} \left(\left(\frac{s_0}{sc}\right)^\alpha - \frac{\left(\frac{s_0}{sc}\right)^{\alpha(\beta+1)}}{1+\beta} + \frac{\left(\frac{s_0}{s_{\max}}\right)^{\alpha(\beta+1)}}{1+\beta} - \left(\frac{s_0}{s_{\max}}\right)^\alpha \right) \\
&= t_{\max} \frac{\left(\frac{s_0}{sc}\right)^\alpha (\beta + (1 - \left(\frac{s_0}{sc}\right)^{\alpha\beta}))}{1+\beta} + t_{\max} \frac{\left(\frac{s_0}{s_{\max}}\right)^\alpha (\beta - (1 - \left(\frac{s_0}{s_{\max}}\right)^{\alpha\beta}))}{1+\beta} \\
&= \left(\frac{s_0}{sc}\right)^\alpha \frac{1}{1+\beta} (\beta t_{\max} + \varphi(sc)) + \left(\frac{s_0}{s_{\max}}\right)^\alpha \frac{1}{1+\beta} (\beta t_{\max} - \varphi(s_{\max}))
\end{aligned}$$

and so:

$$\begin{aligned}
\bar{t}_c &= \frac{1}{1+\beta} (\beta t_{\max} + \varphi(sc)) - \left(\frac{s_0}{s_{\max}}\right)^\alpha \left(\frac{sc}{s_0}\right)^\alpha t_{\max} \\
&= \frac{\varphi(sc)}{1+\beta} + t_{\max} \left(\frac{\beta}{1+\beta} - \left(\frac{sc}{s_{\max}}\right)^\alpha \right) \\
&= \frac{\varphi(sc)}{1+\beta} + t_{\max} \left(\frac{\beta}{1+\beta} - \left(\frac{sc}{s_0}\right)^\alpha \left(\frac{s_0}{s_{\max}}\right)^\alpha \right)
\end{aligned}$$

with $\left(\frac{s_0}{s_{\max}}\right)^\alpha \rightarrow 0$ when s_{\max} tends to infinity:

$$\bar{t}_c = \frac{\varphi(sc) + \beta t_{\max}}{1+\beta} \quad (\text{A.4})$$

C Determination of the smallest firm who wishes to offer the wage cap voluntarily

The smallest firm who posts freely the cap compensation for its CEO is denoted by sc is such that:

$$\Pi_{PAM}(sc) = \Pi_{NE}(sc) \quad (\text{A.5})$$

$$(1 + \varphi(sc))sc - w(sc) = (1 + \bar{t}_c)sc - \bar{w} \quad (\text{A.6})$$

$$\left(\varphi(sc) - \frac{\varphi(sc) + \beta t_{\max}}{1+\beta} \right) sc = \frac{\alpha\beta}{1-\alpha\beta} s_0^{\alpha\beta} t_{\max} (sc^{(1-\alpha\beta)} - \bar{s}^{(1-\alpha\beta)}) \quad (\text{A.7})$$

$$\frac{sc^{1-\alpha\beta}}{1+\beta} = \frac{\alpha}{1-\alpha\beta} (\bar{s}^{(1-\alpha\beta)} - sc^{(1-\alpha\beta)}) \quad (\text{A.8})$$

$$sc = \left(\frac{\frac{\alpha}{1-\alpha\beta}}{\frac{1}{1+\beta} + \frac{\alpha}{1-\alpha\beta}} \right)^{\frac{1}{1-\alpha\beta}} \bar{s} \quad (\text{A.9})$$

$$sc = \left(\frac{\alpha(1+\beta)}{1+\alpha} \right)^{\frac{1}{1-\alpha\beta}} \bar{s} \quad (\text{A.10})$$

D Shareholders' losses according to the mandatory upper limit

Recall:

$$\begin{aligned} \int_{sc}^{s_{\max}} \frac{\pi_{NE}(s)g(s)}{G(s_{\max}) - G(sc)} ds &= \int_{sc}^{s_{\max}} \frac{((1 + \bar{t}_c)s - \bar{w})g(s)}{G(s_{\max}) - G(sc)} ds \\ &= \frac{1}{G(s_{\max}) - G(sc)} \left((1 + \bar{t}_c) \int_{sc}^{s_{\max}} sg(s) ds - \int_{sc}^{s_{\max}} \bar{w}g(s) ds \right) \end{aligned}$$

$$\int_{sc}^{s_{\max}} \pi_{NE}(s)g(s) ds = so^\alpha \left(s_{\max}^{-\alpha} \left((1 + \bar{t}_c) \frac{\alpha}{1 + \alpha} s_{\max} + \bar{w} \right) - sc^{-\alpha} \left((1 + \bar{t}_c) \frac{\alpha}{1 + \alpha} sc + \bar{w} \right) \right)$$

Recall:

$$\int_{sc}^{s_{\max}} \frac{\pi_{PAM}(s)g(s)}{G(s_{\max}) - G(sc)} ds = \int_{sc}^{s_{\max}} \frac{((1 + \varphi(s))s - w(s))g(s)}{G(s_{\max}) - G(sc)} ds$$

$$\begin{aligned} \int_{sc}^{s_{\max}} \pi_{PAM}(s)g(s) ds &= \frac{\alpha so^\alpha}{1 - \alpha} (s_{\max}^{1-\alpha} - sc^{1-\alpha}) + \alpha so^\alpha t_{\max} s_{\max}^{1-\alpha} \left(\frac{1}{1 - \alpha} - \frac{so^{\alpha\beta} s_{\max}^{-\alpha\beta}}{1 - \alpha(1 + \beta)} \right) \\ &\quad - \alpha so^\alpha t_{\max} sc^{1-\alpha} \left(\frac{1}{1 - \alpha} - \frac{so^{\alpha\beta} sc^{-\alpha\beta}}{1 - \alpha(1 + \beta)} \right) \\ &\quad - \left(wo - \frac{\alpha sok^\beta B}{1 - \alpha\beta} \right) (sc^{-\alpha} - s_{\max}^{-\alpha}) \\ &\quad - \frac{\alpha^2 so^{\alpha\beta} K^\beta B}{1 - \alpha\beta} \left(\frac{s_{\max}^{1-\alpha(1+\beta)} - sc^{1-\alpha(1+\beta)}}{1 - \alpha(1 + \beta)} \right) \end{aligned}$$

with $sc = \left(\frac{\alpha(1+\beta)}{1+\alpha} \right)^{\frac{1}{1-\alpha\beta}} \bar{s}$.

The loss function is written as the difference between the shareholders' wealth of the firm concerned (voluntarily or not) by the cap policy at the new equilibrium with a mandatory upper limit and at the positive assortative matching equilibrium:

$$\begin{aligned} L(\bar{s}) &= \int_{s_c}^{s_{\max}} \frac{(\Pi_{NE}(s) - \Pi_{PAM}(s))}{1 - G(sc)} g(s) ds \\ L(\bar{s}) &= \alpha s_0^{\alpha(1+\beta)} t_{\max}(a\bar{s}^{1-\alpha\beta} - b\bar{s}^{1-\alpha(1+\beta)} - c\bar{s}^{-\alpha\beta} + d) \end{aligned}$$

with

$$\begin{aligned} a &= \beta \frac{s_{\max}^{-\alpha}}{1 - \alpha\beta} \\ b &= \left(\frac{\left(\frac{\alpha(1+\beta)}{1+\alpha} + \beta(1 - \alpha(1 + \beta)) \right)}{(1 - \alpha\beta)(1 - \alpha(1 + \beta))} + \frac{\alpha}{1 - \alpha^2} \right) \left(\frac{\alpha(1 + \beta)}{1 + \alpha} \right)^{\frac{-\alpha}{1-\alpha\beta}} \\ c &= \frac{s_{\max}^{1-\alpha} \left(\frac{\alpha(1+\beta)}{1+\alpha} \right)^{\frac{-\alpha\beta}{1-\alpha\beta}}}{(1 + \beta)(1 - \alpha)} \\ d &= \frac{s_{\max}^{1-\alpha(1+\beta)}}{(1 - \alpha\beta)(1 - \alpha(1 + \beta))} \end{aligned}$$

References

- Akerlof, R. (2010). Punishment, compliance, and aggrivement in equilibrium.
- Axtell, R. (2001). Zipf's distribution of the us firm sizes. *Science* 293, 1818–1820.
- Axtell, R. (2006, February). Firm sizes: Facts, fables and fantasies. *CSED Working Paper* (44).
- Becker, G. (1973, August). A theory of marriage. *Journal of Political Economy* 81, 813.
- Berle, A. and G. Means (1932). *The Modern Corporation and Private Property*. New.
- Bertrand, M. and S. Mullainathan (2001). Are ceos rewarded for luck? the ones without principales are. *The Quaterly Journal of Economics* 116, 901–932.
- Bertrand, M. and A. Schoar (2001). Are ceos rewarded for luck? the ones without principals do. *Quarterly journal of economics* 116, 901–932.
- Bertrand, M. and A. Schoar (2003). Managing with style: The effect of managers on firm policies. *Quarterly Journal of Economics* 118(4), 1169–1208.

- Frydman, C. and R. Saks (2010). Executive compensation: A new view from a long-run perspective, 1936-2005. *Review of Financial Studies* 23, 2099–2138.
- Gabaix, X. and A. Ibragimov (2009). Rank-1/2: a simple way to improve the ols estimation of tail exponents. *NBER Technical Working Papers* 0342.
- Gabaix, X. and A. Landier (2008). Why has ceo pay increase so much? *The Quarterly Journal of Economics* 123, 49–100.
- Gregoric, A., P. S. and S. Slapnicar (2010). Pay me right: Reference values and executive compensation. *European Financial Management* 16(5), 778–804.
- Hamilton, J. (1994). *Time Series Analysis*. New Jersey: Princeton University Press.
- Himmelberg, C. and G. Hubbard (2000). Incentive pay and the market for ceos: An analysis of pay-for-performance sensitivity. Presented at Tuck-JFE Contemporary Corporate Governance Conference.
- Jasso, G. and E. Meyersson-Milgrom (2008). Distributive justice and ceo compensation. *Acta Sociologica* 51, 123–143.
- Kaplan, S. and J. Rauh (2010). Wall street and main street: What contributes to the rise in the highest incomes? *The Review of Financial Studies* 23, 1004–1050.
- Kleiber, C. and S. Kotz (2003). *Statistical size distributions in economics and actuarial sciences*. New Jersey: Wiley.
- Kramartz, F. and D. Thesmar (2007). Networks in the boardroom. *CEPR Working paper* 5496.
- Murphy, K., S. A. and R. Vishny (1999). The allocation of talent: implications for growth. *The Quarterly Journal of Economics* 106, 503–530.
- Murphy, KM., S. A. and R. Vishny (1991). The allocation of talent: Implications for growth. *The Quarterly Journal of Economics* 106(2), 503–530.
- Rose, N. and C. Wolfram (2000). Has the million dollar cap' affected ceo pay? *The American Economic Review* 90, 197–202.
- Rose, N. and C. Wolfram (2002). Regulating executive pay: using the tax code to influence executive compensation. *Journal of Labor Economics* 20, 138–175.

- Rosen, S. (1981, December). The economics of superstars. *The American Economic Review* 71(5), 845–858.
- Rosen, S. (1990, December). Contracts and the market for executives. *NBER Working Papers series*.
- Sattinger, M. (1979, Mars). Differential rents and the distribution of earnings. *Oxford Economic Papers* 31(1), 60–71.
- Sattinger, M. (1993, Juin). Assignment models of the distribution of earnings. *Journal of Economic Literature* 31(2), 831–880.
- Schoar, A. and M. Bertrand (2003, November). Managing with style : The effect of managers on firm policies. *The Quarterly Journal of Economics* 118, 1169–1208.
- Shleifer, A. (2004). Does competition destroy ethical behavior? *AEA Papers and Proceedings* 94, 414–418.
- Tervio, M. (2008). The difference that ceos make: an assignement model approach. *the American Economic Review* 98, 642–668.
- Wooldridge, M. (2001). *Econometric analysis of cross section and panel data*. The MIT Press.