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CEO PAY AND FIRM SIZE: AN UPDATE AFTER THE CRISIS*

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In the 'size of stakes' view quantitatively formalised in Gabaix and Landier (*Quarterly Journal of Economics*, 121(1):49–100, 2008), CEO compensation reflects the size of firms affected by talent in a competitive market. The years 2004–11 were not part of the initial study and offer a laboratory to examine the theory with new positive and negative shocks. Executive compensation (measured *ex ante*) did closely track the evolution of average firm value, supporting the 'size of stakes' view out of sample. During 2007–9, firm value decreased by 17%, and CEO pay by 28%. During 2009–11, firm value increased by 19% and CEO pay by 22%.

Executive compensation remains very much at the centre-stage of academic and policy debates. A relative lack of consensus seems to prevail regarding the origins of the large rise of executive compensation observed in the US since 1970s. According to some scholars, see for example Bebchuk and Fried (2004) for a summary of this view, rising compensation is due to a higher ability of CEOs to extract rents from shareholders, for example, by capturing their board (Shivdasani and Yermack, 1999) or appointing compensation consultants that cater to their interests (Murphy and Sandino, 2010). Hermalin (2005) argues instead that the rise in CEO pay reflects tighter corporate governance: pay increases to compensate CEOs for the greater risk of being fired. Others argue that the very function of CEOs has changed over time: they are now more often poached from outside firms than before (Murphy and Zabojnik, 2004; Frydman, 2005); shareholders have become more convinced of the importance of financial incentives (Jensen *et al.*, 2004). In contrast, Gabaix and Landier (2008, henceforth GL) argue that the bulk of variations in CEO compensation across time and across companies can be explained as the result of competitive market forces. They show that under fairly general assumptions, in a market where the impact of CEO talent is scaled linearly by firm size, and where matching CEOs with firms is frictionless (as in Sattinger, 1993; Tervio, 2008), one should expect the compensation of CEOs to follow the following formula:

$$w(n) = DS(n_*)^{\beta/\alpha} S(n)^{1-\beta/\alpha}, \tag{1}$$

where $w(n)$ is the dollar compensation of the CEO of the nth biggest firm by decreasing size, n_* denotes the index of the reference firm (e.g. the 250th largest firm); α is given by the distribution of firm size at the top: $S(n) = An^{-\alpha}$; and β depends on the distribution of talent at the top. GL calibrate $\beta/\alpha \simeq 2/3$. In particular, this formula predicts that if all firm sizes rise (respectively decline) over time by a factor x, compensation should rise (respectively decline) by that same factor. We call the theory of managerial pay proposed by GL the 'size of stakes' view, because it implies that as

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the size of large firms has increased over time, executive compensation has increased by a similar factor, as all firms have a higher willingness to pay for talent. GL, using data from 1970 to 2003, provide evidence consistent with the size of stakes view.

In this article, we examine whether the size of stakes view of executive compensation, proposed by GL, passes the test of time.[1] The years 2004–11, which include the great recession, were not part of the initial study and provide the opportunity to run an informative 'out-of-sample' assessment of the theory. During the financial crisis, the market capitalisation of large companies was strongly negatively impacted. Between 2007 and 2009, the average firm market total value of the largest 500 US firms decreased by 17.4%, which represents the largest two-year drop over the last 40 years. Potentially, this offers an exceptional laboratory to reject the size of stakes view, which predicts that changes in average CEO compensation in the largest firms should follow the changes in the average size of these firms. In line with the theory, we do find that executive compensation at the top did closely track the evolution of average firm value during those years. The recent data thus tend to be supportive of the equilibrium model developed in GL; the estimates that we find for β/α are very close to those of our original study and we confirm the constant linear scaling of talent impact with size. Note that what is particularly non-trivial is the one-to-one relationship between firm size and CEO pay.

Our focus on the years 2004–11 is also motivated by a number of recent developments that affected CEO pay practices, potentially 'distorting' the economic link between CEO pay and firm size identified in GL.[2] In 2004, the end of 'free' accounting for stock options has been followed by a shift towards restricted stock and then, towards the use of performance-based vesting conditions in equity grants (Bettis *et al.*, 2013). In 2006, the SEC promulgated new executive pay disclosure rules. Those rules required the disclosure of compensation consultants, which has potentially affected the incentives of a key player in the pay-setting process (Cadman *et al.*, 2010; Murphy and Sandino, 2010). They also required the disclosure of peers used for benchmarking compensation, another key driver of pay levels (Bizjak *et al.*, 2011; Faulkender and Yang, 2013; Albuquerque *et al.*, 2013). Moreover, after the Enron-type scandals and the burst of the dotcom bubble, there has been a 'change in sentiment' over the usefulness of option-based pay – also related to the option backdating scandal – and an increase in compensation-related shareholder activism through shareholder proposals and vote-no campaigns against compensation committee members (Ertimur *et al.*, 2011). As a result of the above activism, the mandatory adoption of 'say on pay' in 2011 leads firms to change their pay practices both before and after the vote, in an attempt to obtain a favourable voting outcome (Larcker *et al.*, 2012; Ertimur *et al.*, 2013). Finally, incentive pay has been viewed as a potential reason for the excessive risk-taking underlying the financial crisis.

To evaluate the theory, we update the two compensation indices used in GL: between 1980 and 2011, the Jensen–Murphy–Wruck (JMW) compensation index increased by 569%, while the Frydman–Saks (FS) compensation index increased

[1] Of course, any short time sample does not allow us to accept or reject a theory. It simply updates a Bayesian estimate of its predictive power.

[2] Special thanks to the referee for suggesting to us these arguments.

by 341% (here, as everywhere in this article, increases are in real, inflation-adjusted quantities). By taking the average, we obtain a rise in CEO pay of 405%. In the same period, the average firm market value of the largest 500 US firms increased by 425%, while the average equity value of the largest 500 US firms (in terms of equity value) increased by 467%. Thus, the evidence supports the broadly proportional evolution of pay and firm size in the period 1980–2011.

Interestingly, over the recent period 2004–11, firm size successively sharply dropped and then rebounded. This offers a fairly strong test for the size of stakes view. According to this view, proportional changes in compensation should be observed as markets drop and rebound. We find that movements in CEO compensation did indeed closely track movements in firm size: over 2007–9, average total firm values decreased by 17.4%, equity values by 37.9% and compensation indices by 27.7%. During 2009–11, we observe a rebound of firm values by 19%, equity values by 27% and compensation indices by 22%.

We want to highlight that the size of stakes view does not hinge on the fact that stock markets are perfectly efficient. Even if market values were a poor proxy for fundamental values of firms, the market view developed in GL still applies; it states that the market for talents and the market for assets are deeply intertwined. If shareholders overvalue asset prices, it is a natural market outcome that talent be overvalued by the same factor (this is because in a frictionless framework, shareholders, who are the owners of assets, also have control over hiring decisions). If they overvalue assets, they will exhibit a higher than normal willingness to pay for talent.

It is difficult to assess whether the recent years, that are the focus of the present study, are compatible with the 'rent-extraction view' of compensation. Indeed without a specific form for the 'stealing technology' used by managers, it is not possible to predict how rents should vary over time. If one believes that the 'outrage constraint' faced by managers is tighter in downturns (Bebchuk and Grinstein, 2005), then one should expect rents to fall as aggregate market performance is negative but it is hard to know by what factor. In contrast, our prediction that pay in the largest firms should change over time in the same proportions as the size of large firms is easy to reject.

Our results are very much in line with Kaplan (2012), who documents that the ratio of average CEO pay to average firm market capitalisation has been constant over time since 1960. Kaplan (2012) uses market capitalisation, whereas our benchmark approach uses total firm value (i.e. debt plus equity market value). We revisit whether total firm value is a better proxy for firm size in our theory than other measures of size such as market capitalisation or sales. Total firm value (debt + equity) yields estimates that are theoretically more appealing (as it is independent of leverage choice), but pure equity has a good explanatory power, especially for short-term movements (see Figure 1). Perhaps, firms that are riskier and that have more upside potential choose to have less debt (to avoid bankruptcy costs). Then, equity is likely to be a better proxy than debt + equity for how much a CEO can impact the firm.

1. Data Description

We incorporate the recent period in the regressions and graphs presented in GL. For this, we follow the methodology of GL. However, there are two noteworthy differences.

First, we restrict our attention to US-based firms. The original study took all firms in Compustat. However, since Compustat has been including many more foreign firms, an additional filtering is in order. Second, the procedure followed to construct total firm value in GL unwittingly excluded some banks because the item deferred taxes is often missing in Compustat for these firms.[3] As shown below, we thus set deferred taxes to 0 when missing before computing total firm value. As a novelty with respect to GL, prompted by interesting results in Kaplan (2012), we introduce equity market value as an alternative measure of firm size. We first describe in detail the data, and then present the results.

1.1. *Data Sets*

We use two data sets. Execucomp provides us with data on CEO compensation. Regressions presented in this article were performed with Execucomp data extracted from WRDS in September 2012. We use Compustat to retrieve information on the size of US-based firms. US-based companies are identified with Compustat variable FIC.

1.1.1. *CEO compensation*

The Execucomp panel provides data on compensation of the five best paid executives of the largest US firms from 1992. We identify the CEO of each firm year in Execucomp with the dummy variable CEOANN. However, using the CEOANN variable, some firm-year observations have no CEO in Execucomp. We are however able in some cases to infer the CEO's identity from the BECAMECEO variable indicating the date at which the individual became CEO. Specifically, when the CEOANN variable indicates no CEOs for a given firm year, we consider an executive as the CEO of the firm in year t when the BECAMECEO variable indicates that the executive was appointed as the CEO in year t or before and the dummy variable CEOANN indicates the executive as the CEO of the firm in year $t + 1$ or after.

CEO compensation is then measured with Execucomp variable, TDC1, which includes salary, bonus, restricted stock granted and the Black–Scholes value of stock-options granted. Finally, CEO compensation is converted into 2,000 constant dollars using the GDP deflator of the Bureau of Economic Analysis.

1.1.2. *Firm size*

We will use different proxies for firm size, namely total firm value, earnings before interest and taxes (EBIT), sales and equity value. We construct these variables from Compustat. Total firm value is the sum of the market value of equity, defined as number of shares outstanding (item CSHO) multiplied by the end-of-fiscal-year stock price (item PRCC_F), and the book value of debt, defined as total assets (item AT) minus the sum of book value of equity (item CEQ) and deferred taxes (item TXDB); we set deferred taxes to 0 when missing. EBIT is (item OIBDP-item DP). Sales are measured with Compustat item SALE. Equity value is (item CSHO×item PRCC_F). All quantities are converted into 2,000 constant dollars using the GDP deflator of the

[3] This effect was noted by Nagel (2010). We obtain very similar results in what follows when deferred taxes are excluded from the computation of total firm value.

Bureau of Economic Analysis. Finally, we construct the 48 Fama–French industry dummies from the conversion table in the appendix of Fama and French (1997) using the firm's four digit SIC industry code.

1.2. *Compensation Indices*

To evaluate changes in CEO pay over the long run, we rely on the same compensation indices used in GL, namely the JMW and FS compensation indices.

The FS compensation index is based on Frydman and Saks (2010). Total compensation is the sum of salaries, bonuses, long-term incentive payments and the Black–Scholes value of options granted. The data are based on the three highest-paid officers in the largest 50 firms in 1940, 1960 and 1990. The data appendix in Frydman and Saks (2010) provides detailed information on the sample selection.

The JMW compensation index is based on the data of Jensen *et al.* (2004). Their sample encompasses all CEOs included in the S&P 500, using data from Forbes and ExecuComp. CEO total pay includes cash pay, restricted stock, payouts from long-term pay programmes and the value of stock options granted from 1992 onwards using ExecuComp's modified Black–Scholes approach. Compensation prior to 1978 excludes option grants and is computed between 1978 and 1991 using the amounts realised from exercising stock options.

Reproducing Figure 1 and table III of GL for the period 1970–2011 requires extending both compensation indices over the recent period, that is, 2004–11. We proceed in the following way: for every year between 2005 and 2011, the FS compensation index (the JMW compensation index) in year t equals the FS compensation index (the JMW compensation index) in year $t-1$ times the annual percentage increase in the mean CEO compensation of the largest 500 US-based firms.

Specifically, for every fiscal year between 2005 and 2011 we first rank US-based companies in terms of total firm value, computed at the end of the previous fiscal year. For every year between 2005 and 2011, we then merge Compustat and Execucomp with the GVKEY identifier and keep the largest 500 US companies for which we can retrieve CEO compensation in Execucomp. We use the procedure mentioned above to identify CEOs in Execucomp. Before computing the annual percentage increase in the mean CEO compensation, we deflate it using the Bureau of Economic Analysis GDP Deflator.

Figure 1 compares the evolution of CEO pay and firm size over the period 1970–2011. We again restrict our attention to firms with non-missing information on CEO pay in Execucomp when computing the average market total value of the largest 500 US-based firms between 1992 and 2011. Before 1992 (the earliest date for the Execucomp database), we simply compute the average market total value of the largest 500 US-based firms present in Compustat. Finally, using a symmetric procedure, we compute the average equity value of the largest 500 US-based firms in terms of equity value. After 1992, as above, we again exclude firms for which Execucomp does not provide information on CEO compensation.

Figure 2 plots the firm size distribution confirming a fat-tailed distribution of firms, consistent with a Zipf's law for firm size (Simon, 1955; Gabaix, 1999; Axtell, 2001;

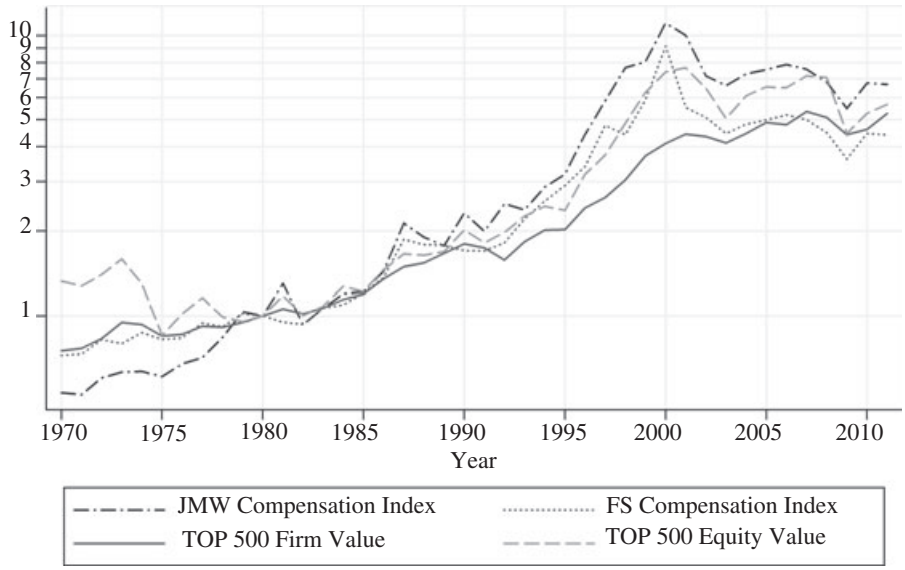

Fig. 1. *Executive Compensation and Size of the Top 500 Firms*

Notes. FS compensation index is based on Frydman and Saks (2010). Total compensation is the sum of salaries, bonuses, long-term incentive payments and the Black–Scholes value of options granted. The data are based on the three highest-paid officers in the largest 50 firms in 1940, 1960 and 1990. The JMW compensation index is based on the data of Jensen *et al.* (2004). Their sample encompasses all CEOs included in the S&P 500, using data from Forbes and ExecuComp. CEO total pay includes cash pay, restricted stock, payouts from long-term pay programmes and the value of stock options granted from 1992 onward using ExecuComp's modified Black–Scholes approach. Compensation prior to 1978 excludes option grants and is computed between 1978 and 1991 using the amounts realised from exercising stock options. Both compensation indices are available until 2004. From 2005 to 2011, the FS compensation index in year t equals the FS compensation index in year $t-1$ times the annual percentage increase in the mean CEOs compensation – defined as ExecuComp variable TDC1 – of the top 500 largest US-based firms (in term of total market firm value, i.e. debt plus equity). We use the same methodology to extend the JMW compensation index. The formula we use for total firm value is (CSHO×PRCC_F+AT-CEQ-TXDB), computed at the end of the previous fiscal year. Deferred taxes (item TXDB) are set to 0 when missing. TOP 500 firm value is the mean firm value of the top 500 largest US-based firms (in terms of firm value). TOP 500 equity value is the mean market equity value – defined as (CSHO×PRCC_F) – of the top 500 largest US-based firms (in terms of equity value). In both cases, after 1992, we exclude firms with missing data on CEO compensation from our computations. All indices are normalised to be equal to 1 in 1980. All quantities were first converted into constant dollars using the GDP deflator of the Bureau of Economic Analysis.

Luttmer, 2007), here firm size being firm total market value rather than the usual 'size' expressed by number of employees.

2. Results

2.1. *CEO Pay and Proxies for Firm Size*

As in GL, we first consider three proxies for firm size – namely total firm value, EBIT and sales. We then regress the logarithms of CEO compensation of the largest 1,000

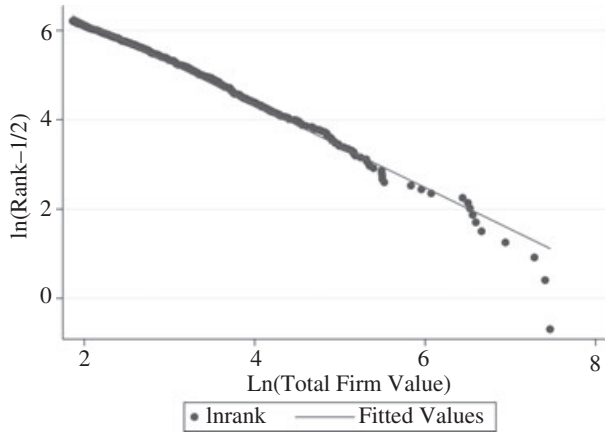

Fig. 2. *Executive Compensation and Size of the Top 500 Firms*
Notes. In 2010, we take the top 500 US-based firms by total firm value with non-missing data on CEO compensation, order them by size, $S_{(1)} \geq S_{(2)} \geq \ldots \geq S_{(500)}$ and plot ln S on the horizontal axis and $\ln(Rank - 1/2)$ on the vertical axis. Gabaix and Ibragimov (2011) recommend the $-(1/2)$ term and show that it removes the leading small sample bias. Regressing $\ln(Rank - (1/2)) = -\zeta \ln(S) + \text{constant}$ yields a Pareto exponent $\zeta = 0.915$ (SE 0.057), $R^2 = 0.99$. ζ close to 1 is indicative of an approximate Zipf's law for firm total value.

US-based companies in terms of firm value on the logarithms of the different size proxies, controlling for year and industry.[4]

In the GL model, the most relevant measure for size depends on the nature of the CEO's job. If the impact of the talent of the CEO hired for year t is to induce a temporary shock on productivity (e.g. via leadership) or sales (e.g. via better marketing), then size can be measured by sales or earnings during that year. However, if one believes that the impact of the CEO hired at time t is long-lasting and affects all future profits, then the relevant measure of size is the net present value of future profits, that is, firm total market value (i.e. the value of its debt and its equity). This view is coherent if one believes that an important role of the CEO is to take strategic decisions that affect the future growth path of the firm, to implement technological (or organisational) innovations that push the firm's product line (or productivity) to a new level (and thus affect all future generations of products (profits)). Such a view of the CEO's job could be for instance formalised in a vertical quality ladder model of innovation *à la* Aghion–Howitt, in which a new innovation permanently impacts productivity. In addition, the full firm value is a measure of size that is neutral to the choice of capital structure: the impact of a CEO should not depend directly on whether the firm is financed with debt or equity. We include results with equity value as a proxy of size because it is a popular measure of firm size – it is used notably by Kaplan (2012). A possible rationale for using equity value, rather than full firm value (equity + debt) may be as follows. It involves a theory of the capital structure; debt largely reflects the 'safe' assets of the firm, whose value the CEO does not directly affect

[4] Note that the selection criterion is not the same as in GL, where CEO compensation of the 1,000 highest-paid CEOs is regressed on the size proxies each year. Running the regression for the largest 1,000 US firms is motivated by the fact that in GL theory, firm size is a more exogenous object than CEO pay.

Table 1

CEO Pay and Different Proxies for Firm Size

	ln(Total compensation)				
	(1)	(2)	(3)	(4)	(5)
ln(Firm value)	0.176	0.383			
	(0.0413)	(0.0178)			
	(0.0311)	(0.0135)			
ln(Income)	0.0772		0.339		
	(0.0218)		(0.0143)		
	(0.0180)		(0.0116)		
ln(Sales)	0.146			0.364	
	(0.0309)			(0.0150)	
	(0.0143)			(0.0115)	
ln(Equity value)					0.338
					(0.0182)
					(0.0174)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	17,949	17,949	17,949	17,949	17,949
R^2	0.295	0.286	0.277	0.282	0.266

Notes. The sample consists of all US-based firms between 1992 and 2011 for which we can retrieve both firm size in Compustat and CEO compensation in Execucomp. For each year we select the top 1,000 largest firms (in terms of total market firm value, i.e. debt plus equity). We then regress the log compensation of the CEO – using the ExecuComp total compensation variable TDC1, which includes salary, bonus, restricted stock granted and the Black–Scholes value of stock-options granted – in year t on the log of the firm's size proxies at the end of year $t-1$. All nominal quantities were first converted into year 2000 constant dollars using the GDP deflator of the Bureau of Economic Analysis. The formula we use for total firm value is (CSHO×PRCC_F+AT-CEQ-TXDB). Deferred taxes (item TXDB) are set to 0 when missing. Income is measured as earnings before interest and taxes, defined from Compustat as (OIBDP-DP). Sales are measured with Compustat item SALE. Equity value is (CSHO×PRCC_F). The industries are the Fama and French (1997) 48 sectors. We report standard errors clustered at the firm level (first line) and at the year level (second line).

– because those safe assets back debt, while equity reflects the 'risky assets', which the CEO does affect.

Table 1 presents the results. The three size proxies have positive and significant coefficients when used together to predict compensation (column (1)). Moreover, as shown in columns (2)–(4), total market value, EBIT and sales have similar predictive power when used alone to predict compensation, as can be seen by comparing R^2, with a slight edge for firm value. In column (5), we introduce equity value as an alternative measure of firm size. Again, equity value turns out to be a valid proxy for firm size.

2.2. *Panel Evidence, 1992–2011*

As in GL, we estimate:

$$\ln(w_{i,t}) = d + e \times \ln(S_{n_*,t-1}) + f \times \ln(S_{i,t-1}), \tag{2}$$

where $w_{i,t}$ is CEO compensation in firm i and year t, $S_{n_*=250,t-1}$ is market total value of the firm number $n_* = 250$ in the sample at the end of fiscal year $t-1$ and $S_{i,t-1}$ is firm i total market value. We cluster standard errors at either the firm level or at the year level. The sample consists of either the top 500 or top 1,000 US-based companies in

Table 2

CEO Pay, Own Firm Size and Reference Firm Size (Size Is Market Total Value)

	ln(Total compensation)					
	Top 1,000			Top 500		
	(1)	(2)	(3)	(4)	(5)	(6)
ln(Firm value)	0.331	0.387	0.251	0.310	0.356	0.129
	(0.0155)	(0.0165)	(0.0500)	(0.0269)	(0.0263)	(0.108)
	(0.0142)	(0.0126)	(0.0292)	(0.0284)	(0.0248)	(0.0420)
ln(Firm value of firm # 250)	0.690	0.611	0.846	0.843	0.736	1.062
	(0.0380)	(0.0362)	(0.0484)	(0.0588)	(0.0580)	(0.0982)
	(0.0701)	(0.0672)	(0.0753)	(0.0720)	(0.0750)	(0.0804)
Industry fixed effects	No	Yes	No	No	Yes	No
Firm fixed effects	No	No	Yes	No	No	Yes
ln(Firm value) + ln(Firm value of firm # 250) −1	0.020	−0.002	0.097	0.153	0.092	0.191
	(0.037)	(0.037)	(0.038)	(0.058)	(0.057)	(0.049)
	(0.067)	(0.063)	(0.069)	(0.071)	(0.072)	(0.072)
Observations	19,909	19,909	19,909	9,989	9,989	9,989
R^2	0.197	0.273	0.574	0.140	0.220	0.561

Notes. The sample consists of all US-based firms between 1992 and 2011 for which we can retrieve both firm size in Compustat and CEO compensation in Execucomp. For each year we select the top n (n = 500, 1,000) largest firms (in term of total market firm value, i.e. debt plus equity). The formula we use for total firm value is (CSHO×PRCC_F+AT-CEQ-TXDB). Deferred taxes (item TXDB) are set to 0 when missing. We retrieve from ExecuComp the total compensation variable, TDC1 in year t, which includes salary, bonus, restricted stock granted and the Black–Scholes value of stock-options granted. All nominal quantities are converted into year 2000 dollars using the GDP deflator of the Bureau of Economic Analysis. The industries are the Fama and French (1997) 48 sectors. We regress the log of total compensation of the CEO in year t on the log of the firm value (debt plus equity) at the end of the year $t-1$, and the log of the 250th firm market value at the end of the year $t-1$. We report standard errors clustered at the firm level (first line) and at the year level (second line).

terms of firm value for which we can retrieve CEO compensation in Execucomp (using the procedure mentioned above). The sample period is from 1992 to 2011.

Columns (1)–(3) (columns (4)–(6)) in Table 2 present the results for the largest 1,000 (500) US firms. Columns (2) and (4) include industry fixed effects, while columns (3) and (6) include firm fixed effects. The results obtained over the sample period 1992–2011 remain consistent with the size of stakes theory. For all specifications, the coefficients (and standard errors) are similar to those in GL. Moreover, p-values for the null hypothesis that $e + f = 1$ are above 0.1 in specifications (1), (2) and (5), which is consistent with the constant returns to scale (CRS) hypothesis in firm size.

Then, we re-estimate (2) using equity value as an alternative proxy for size. Specifically, $w_{i,t}$ is CEO compensation in firm i and year t, $S_{n_*=250,t-1}$ is market equity value of the firm number $n_* = 250$ (in terms of market equity value) in the sample at the end of fiscal year $t - 1$ and $S_{i,t-1}$ is firm i market equity value. Taken together, regression results presented in Table 3 are also consistent with the CRS hypothesis in firm size.

2.3. *Times-series US Evidence, 1971–2011*

Figure 1 shows the evolution of CEO pay and firm size for the largest US-based firms between 1971 and 2011. Between 1980 and 2011, the JMW compensation index has increased by 569%, whereas the FS compensation index has increased by 341%. By taking the average, we obtain a rise in CEO pay of 405%. In the same period, the average firm market value of the largest 500 US firms has increased by 425%, whereas the average equity value of the largest 500 US firms (in terms of equity value) has increased by 467%. Thus, the evidence supports the broadly proportional evolution of pay and firm size in the period 1980–2011. Note that since the levels of compensation reflect dollar values on an *ex ante* basis (e.g. values of stock options are evaluated at time granted, as opposed to time exercised), there is no hard wired link between compensation and stock-market values.

As shown in Table 4, over the recent period 2004–11, movements in CEO compensation closely follow movements in firm size. In particular, CEO pay and firm size have both decreased during the crisis (2007–9): average total firm values decreased by 17.4%, equity values by 37.9% and compensation indices by 27.7%. During 2009–11, we observe a rebound of firm values by 19%, equity values by 27% and compensation indices by 22%. We see these fairly proportional changes over successive episodes of market drops and market rebound as a strong validity test for the size of stakes view.

It is important to notice that the size of stakes view does not hinge on the fact that stock markets be perfectly efficient. Even if market values were a poor proxy for fundamental values of firms, the market view developed in GL still applies; it states that the market for talents and the market for assets are deeply intertwined. If shareholders overvalue asset prices, it is a natural market outcome that talent be overvalued by the same factor (this is because in our frictionless framework shareholders have control over hiring decisions).

Table 3

CEO Pay, Own Firm Size and Reference Firm Size (Size Is Equity Value)

	ln(Total compensation)					
	Top 1,000			Top 500		
ln(equity value)	0.388	0.390	0.282	0.338	0.332	0.229
	(0.0197)	(0.0204)	(0.0408)	(0.0393)	(0.0382)	(0.0966)
	(0.0137)	(0.0137)	(0.0238)	(0.0256)	(0.0249)	(0.0346)
ln(equity value of firm no. 250)	0.445	0.420	0.544	0.567	0.548	0.693
	(0.0297)	(0.0303)	(0.0345)	(0.0467)	(0.0491)	(0.0769)
	(0.0716)	(0.0697)	(0.102)	(0.0863)	(0.0825)	(0.104)
Industry fixed effects	No	Yes	No	No	Yes	No
Firm fixed effects	No	No	Yes	No	No	Yes
ln(Equity value) + ln(Equity value of firm no. 250)−1	−0.166	−0.189	−0.173	−0.095	−0.121	−0.079
	(0.028)	(0.029)	(0.031)	(0.044)	(0.044)	(0.043)
	(0.069)	(0.066)	(0.092)	(0.087)	(0.081)	(0.095)
Observations	19,908	19,908	19,908	9,985	9,985	9,985
R^2	0.217	0.243	0.572	0.139	0.175	0.543

Notes. The sample consists of all US-based firms between 1992 and 2011 for which we can retrieve both firm size in Compustat and CEO compensation in Execucomp. For each year we select the top n (n = 500, 1,000) largest firms in term of equity value. The formula we use for equity value is (CSHO×PRCC_F). From ExecuComp we retrieve the total compensation variable, TDC1 in year t, which includes salary, bonus, restricted stock granted and the Black–Scholes value of stock-options granted. All nominal quantities are converted into year 2000 dollars using the GDP deflator of the Bureau of Economic Analysis. The industries are the Fama and French (1997) 48 sectors. We regress the log of total compensation of the CEO in year t on the log of the equity value at the end of the year $t-1$, and the log of the 250th equity value at the end of the year $t-1$. We report standard errors clustered at the firm level (first line) and at the year level (second line).

Table 4

Executive Compensation and Size (2007–11)

Change over	Total firm value (%)	Equity value (%)	FS compensation index (%)	JMW compensation index (%)
(2007–9)	−17.4	−37.8	−27.7	−27.7
(2009–11)	19.0	27.0	22.0	22.0

Notes. This Table presents the evolution of firm size and CEO compensation over the period 2007–11. The sample consists of the top 500 US-based firms (in term of total market firm value) for which we can retrieve both firm size in Compustat and CEO compensation from Execucomp.

Table 5

CEO Pay and the Size of Large Firms, 1970–2011 (Size Is Market Total Value)

	Δln(Total compensation)	
	Jensen–Murphy–Wruck index	Frydman–Saks index
Δln Firm value	1.013***	0.821***
	(0.351)	(0.189)
Constant	0.0137	0.0052
	(0.0282)	(0.0204)
Observations	41	41

Notes. We estimate for $t \geq 1971$, $\Delta_t(\ln w_t) = \hat{\gamma} \times \Delta_t \ln S_{*,t-1}$, where w is either the Jensen–Murphy–Wruck index or the Frydman–Saks index and S_* is the mean equity value of the top 500 largest US-based firms (in terms ot equity value). To be included in the sample after 1992, a firm must have non-missing information on CEO compensation in ExecuComp. We show Newey–West standard errors in parentheses, allowing the error term to be autocorrelated for up to two lags. The Jensen–Murphy–Wruck index is based on the data of Jensen *et al.* (2004). The Frydman–Saks index is based on Frydman and Saks (2010). Both compensation indexes are available until 2004. From 2005 to 2010, the FS compensation index in year t equals the FS compensation index in year $t-1$ times the annual increase in the mean CEOs compensation (ExecuComp variable TDC1) of the top 500 largest US-based firms (in term of total market firm value, i.e. debt plus equity). We use the same methodology to extend the JMW compensation index. The formula we use for firm value is (CSHO×PRCC_F+AT-CEQ-TXDB), computed at the end of the previous fiscal year. Deferred taxes (item TXDB) are set to 0 when missing. Quantities are deflated using the Bureau of Economic Analysis GDP deflator.

As in GL, we estimate the following:

$$\Delta_t(\ln w_t) = \hat{\gamma} \times \Delta_t \ln S_{*,t-1} \tag{3}$$

where w is either the JMW index or the FS index and S_* is the mean firm total value of the top 500 largest US-based firms. Again, we restrict our attention to US-based firms for which we can retrieve CEO compensation from Execucomp. The sample period is 1971–2011.

GL find estimates of $\hat{\gamma} = 1.14$ using the JMW compensation index and $\hat{\gamma} = 0.87$ using FS compensation index over the period 1971–2003. As shown in Table 5, we find extremely close estimates between 1971 and 2011: $\hat{\gamma} = 1.01$ using the JMW compensation index and $\hat{\gamma} = 0.82$ using FS compensation index.

Table 6

CEO Pay and the Size of Large Firms, 1970–2011 (Size Is Equity Value)

	Δln(Total compensation)	
	Jensen–Murphy–Wruck index	Frydman–Saks index
Δ ln Equity value	0.642***	0.412***
	(0.149)	(0.106)
Constant	0.0390*	0.0296
	(0.0204)	(0.0185)
Observations	41	41

Notes. We estimate for $t \geq 1971$, $\Delta_t(\ln w_t) = \hat{\gamma} \times \Delta_t \ln S_{*,t-1}$, where w is either the Jensen–Murphy–Wruck index or the Frydman–Saks index and S_* is the mean equity value of the top 500 largest US-based firms (in terms ot equity value). To be included in the sample after 1992, a firm must have non-missing information on CEO compensation in ExecuComp. Equity value is defined as (CSHO×PRCC_F). We show Newey–West standard errors in parentheses, allowing the error term to be autocorrelated for up to two lags. The Jensen–Murphy–Wruck index is based on the data of Jensen *et al.* (2004). The Frydman–Saks index is based on Frydman and Saks (2010). Both compensation indexes are available until 2004. From 2005 to 2010, the FS compensation index in year t equals the FS compensation index in year $t-1$ times the annual increase in the mean CEOs compensation (ExecuComp variable TDC1) of the top 500 largest US-based firms (in term of total market firm value, i.e. debt plus equity). We use the same methodology to extend the JMW compensation index. The formula we use for firm value is (CSHO×PRCC_F+AT-CEQ-TXDB), computed at the end of the previous fiscal year. Deferred taxes (item TXDB) are set to 0 when missing. Quantities are deflated using the Bureau of Economic Analysis GDP deflator.

Table 6 presents the result of the estimation of (3) when S_* is the mean firm equity value of the top 500 largest US-based firms in terms of equity value. The fit is rather less good. This may be because the method puts all the weight on the contemporaneous changes in firm size and pay. Of course, while the economics predicts that pay will track size one-for-one, there could be some delay in that relation. Kaplan (2012) has proposed a graphical device that captures the medium-frequency relation between pay and size (represented by firms size) better than regression (3). Interestingly, he finds good support for a stable ratio between average pay and average firm size since 1960.

2.4. *Application of the Model to Non-CEO Executives*

We see the GL model as particularly adapted to studying CEO pay because the top job in a firm clearly has firm-wide implications: this makes the hypothesis that the impact of CEO talent increases in firm size particularly natural. The question of how the impact of other high-paid executives depends on firm size is highly interesting but opens several debates on the production function of these executives: the relevant size variable for the impact of non-CEO talent might be that of a division that the executive is managing; in the cross-section, it might be that some positions

Table 7

Average Non-CEO Pay, Own Firm Size, and Reference Firm Size (Size Is Market Total Value)

	ln(Total compensation)					
	Top 1,000			Top 500		
	(1)	(2)	(3)	(4)	(5)	(6)
ln(Firm value)	0.356	0.415	0.322	0.370	0.418	0.281
	(0.0108)	(0.00973)	(0.0162)	(0.0189)	(0.0161)	(0.0262)
	(0.0103)	(0.00883)	(0.0224)	(0.0113)	(0.00949)	(0.0225)
ln(Firm value of firm no. 250)	0.566	0.456	0.580	0.712	0.556	0.717
	(0.0301)	(0.0262)	(0.0319)	(0.0409)	(0.0373)	(0.0488)
	(0.0710)	(0.0686)	(0.0654)	(0.0705)	(0.0733)	(0.0656)
Industry fixed effects	No	Yes	No	No	Yes	No
Firm fixed effects	No	No	Yes	No	No	Yes
ln(Firm value) + ln (Firm value of firm no. 250)−1	−0.077	−0.130	−0.098	0.082	−0.026	−0.002
	(0.027)	(0.023)	(0.025)	(0.036)	(0.032)	(0.036)
	(0.067)	(0.065)	(0.064)	(0.071)	(0.070)	(0.065)
Observations	19,753	19,753	19,753	9,929	9,929	9,929
R^2	0.359	0.509	0.742	0.326	0.490	0.730

Notes. The sample consists of all US-based firms between 1992 and 2011 for which we can retrieve both firm size in Compustat and the identity of the CEO in Execucomp. For each year we select the top n ($n = 500$, 1,000) largest firms (in term of total market firm value, i.e. debt plus equity). The formula we use for total firm value is (CSHO×PRCC_F+AT-CEQ-TXDB). Deferred taxes (item TXDB) is set to 0 when missing. For each executive present in ExecuComp we retrieve the total compensation variable, TDC1 in year t, which includes salary, bonus, restricted stock granted and the Black–Scholes value of stock-options granted. All nominal quantities are converted into year 2000 dollars using the GDP deflator of the Bureau of Economic Analysis. The industries are the Fama and French (1997) 48 sectors. We regress the log of the average compensation of non-CEO executives in year t on the log of the firm value (debt plus equity) at the end of the year $t - 1$, and the log of the 250th firm market value at the end of the year $t - 1$. We report standard errors clustered at the firm level (first line) and at the year level (second line).

that are held by a single individual in small firms are transformed into two distinct positions in larger firms; last, in the time-series, organisational trends might have changed the composition of the executive suite, such as the elimination of intermediate hierarchical layers (e.g. the elimination of the CEO function in many firms: see Rajan and Wulf (2006)). But, beyond these caveats, we find that estimating the GL model on non-CEO executives is an interesting and natural empirical question. Thus, we provide a version of our benchmark regression on non-CEO executives (see Tables 7 and 8). To do this, we simply compute the average non-CEO compensation as reported in Execucomp for each firm; we use the same definitions of compensation and market value as those used in the CEO comp regressions. We find results that are highly similar to those on CEOs: in particular, we do not reject the fact that the sum of coefficients on firm total value and reference firm value is one. In the time series, it turns out that non-CEO pay has followed an evolution strikingly similar to that of CEO pay: between 1992 (which is the first year in Execucomp) and 2011, it has increased by a factor of 2.5, while CEO pay has increased by a factor of 3 (see Figure 3). These results suggest that the GL model can be used to describe the market for non-CEO executives.

Table 8

Average Non-CEO Pay, Own Firm Size, and Reference Firm Size (Size Is Equity Value)

	ln(Total compensation)					
	Top 1,000			Top 500		
	(1)	(2)	(3)	(4)	(5)	(6)
ln(Equity value)	0.413	0.414	0.315	0.393	0.390	0.297
	(0.0116)	(0.0110)	(0.0127)	(0.0210)	(0.0167)	(0.0208)
	(0.00963)	(0.00859)	(0.0169)	(0.00899)	(0.00827)	(0.0228)
ln(Equity value of firm no. 250)	0.350	0.302	0.389	0.453	0.394	0.475
	(0.0218)	(0.0214)	(0.0221)	(0.0321)	(0.0313)	(0.0335)
	(0.0727)	(0.0698)	(0.0810)	(0.0838)	(0.0779)	(0.0806)
Industry fixed effects	No	Yes	No	No	Yes	No
Firm fixed effects	No	No	Yes	No	No	Yes
ln(Equity value) + ln (Equity value of firm no. 250)−1	−0.237	−0.283	−0.296	−0.154	−0.216	−0.228
	(0.018)	(0.017)	(0.018)	(0.026)	(0.025)	(0.025)
	(0.069)	(0.066)	(0.080)	(0.082)	(0.075)	(0.082)
Observations	19,750	19,750	19,750	9,931	9,931	9,931
R^2	0.410	0.466	0.727	0.336	0.412	0.697

Notes. The sample consists of all US-based firms between 1992 and 2011 for which we can retrieve both firm size from Compustat and the identity of the CEO from Execucomp. For each year we select the top n ($n = 500$, 1,000) largest firms in term of equity value. The formula we use for equity value is (CSHO×PRCC_F). We retrieve for each executive present in ExecuComp the total compensation variable, TDC1 in year t, which includes salary, bonus, restricted stock granted and the Black–Scholes value of stock-options granted. All nominal quantities are converted into year 2000 dollars using the GDP deflator of the Bureau of Economic Analysis. The industries are the Fama and French (1997) 48 sectors. We regress the log of the average compensation of non-CEO executives in year t on the log of the equity value at the end of the year $t - 1$, and the log of the 250th equity value at the end of the year $t - 1$. We report standard errors clustered at the firm level (first line) and at the year level (second line).

2.5. *Robustness Checks*

In the online Appendix, we present robustness checks of the regression results in Tables B2 and B3.[5]

2.5.1. *Sticky equity awards*

Some firms follow a 'fixed number' policy for the design of the CEO long-term incentive plan (Hall, 1999) – that is, the same number of, say, options is granted to the CEO over a certain number of years. For these firms, an increase in the stock price mechanically increases the value of equity grants. Accordingly, part of the association between CEO pay and firm size presented in Table 2 might be 'mechanical'. We address this concern by excluding the observations for which we suspect the presence of a 'fixed number' policy. For this, we look at the number of options (execucomp variable OPTION_AWARDS_NUM), the number of performance shares (execucomp variable SHRTARG in the pre-2006 format, and EQ_TARG in the new format), and the number of shares granted under

[5] We thank the referee for suggesting to us these robustness checks.

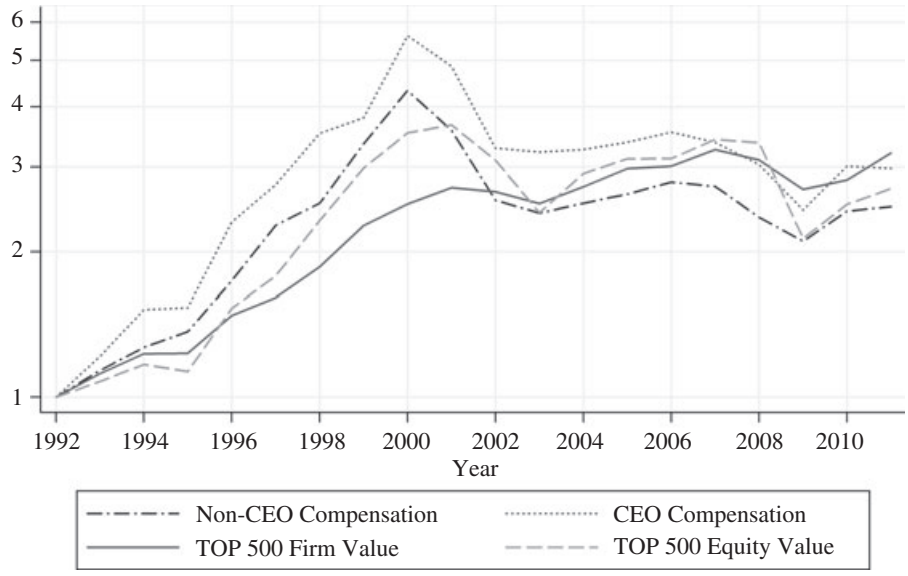

Fig. 3. *Executive Compensation and Size of the Top 500 Firms*

Notes. CEO compensation in year t is the mean CEO compensation of the top 500 largest US-based firms (in terms of firm value). Non-CEO compensation in year t is the average non-CEO compensation of the top 500 largest US-based firms (in terms of firm value). We compute non-CEO compensation for each firm-year by taking the average compensation of non-CEO executives present in Execucomp. TOP 500 firm value is the mean firm value of the top 500 largest US-based firms (in terms of firm value). TOP 500 equity value is the mean market equity value – defined as (CSHO×PRCC_F) – of the top 500 largest US-based firms (in terms of equity value). All indices are normalised to be equal to 1 in 1992. All quantities were first converted into constant dollars using the GDP deflator of the Bureau of Economic Analysis.

non-performance-based plans (Execucomp variable SHARES_GRT, available only from 2006) to capture 'fixed number' policies.

Specifically, we exclude from the estimation of (2) the observations for which the number of options (respectively performance shares, shares granted under non-performance-based plans) granted to the CEO in year t is positive and the same as in year $t-1$. This criterion excludes around 9% of the observations. As shown in online Appendix Tables B1 and B2, the coefficients remain very similar to those in Tables 2 and 3.

2.5.2. *Changes in the definition of TDC1*

In 2006 Execucomp changed the definition of TDC1 to reflect new reporting rules mandated by the SEC. FAS 123 (R) required equity compensation to be based on the *ex ante* value of the awards. In the pre-2006 format, the execucomp variable TDC1 included the *ex post* value of performance shares. To deal with this problem, we follow Walker (2011) and construct a consistent definition of CEO pay over the whole sample period: when measured in its pre-2006 format, we subtract from TDC1 the amount paid under the company's long-term incentive plan (execucomp variable LTIP). We then add the *ex ante* value of performance shares by multiplying the target number of performance shares granted (execucomp variable SHRTARG) by the

stock price at the end of the fiscal year. When missing, the variable SHRTARG is replaced by 0.[6]

Online Appendix Tables B1 and B2 reproduce the regressions presented in Tables 2 and 3 when TDC1 is adjusted as mentioned above. Again, the coefficients turn out to be very similar.

3. Conclusion and Some Open Questions

The crisis offered new events for seeing the reaction of compensation to firm size, and the GL theory appears to pass the test. We highlight that there are still many things about this view to explore, enrich or perhaps correct. For instance, behavioural factors in the perception of CEO talent could be important (Malmendier and Tate, 2009). Because of this possibility, GL works out how contagion effects could potentially strongly affect CEO pay. Bereskin and Cicero (2013) present some evidence in support of that effect.

On the theoretical side, it would be good to extend the model to incentives (Edmans *et al.* (2009) and Edmans and Gabaix (2011) for static models that integrate well with GL and Dittmann *et al.* (2010) for a behavioural approach), in particular with dynamic incentives and CEO turnover (Eisfeldt and Kuhnen, 2012; Jenter and Kanaan, 2006). This remains difficult, though perhaps within reach.

Also, integrating the CEO market with other talent markets (as in Kaplan and Rauh, 2010; and the spirit of Rosen, 1981) would be good. Conceptually, we would expect some integration with the market for CEOs of private companies and that for hedge fund managers, for instance. It is likely that studying this integration might shed light on the increase in inequality, particularly with the rise of top incomes (Piketty and Saez, 2003; Lemieux *et al.*, 2009). In that respect, relatedly, progress in the measurement of 'talent' and 'CEO skill' is encouraging (Bertrand and Schoar, 2003; Bennedsen *et al.*, 2012; Falato *et al.*, 2012; Custodio *et al.*, 2013).

Kaplan (2012), building on Frydman and Saks (2010), finds that the GL theory works well in the 1960–2010 sample, but less so before. Why is that? One reason is that stock market values were depressed, so perhaps the full firm value (debt + equity) was higher than pure equity (which is what Kaplan (2012) uses). Another important under-researched channel is the supply of skills. One possibility that would be reasonably researchable would be that the supply of skills was lower before 1960 (perhaps because of technology, GI bill etc.) and that supply of MBA and college graduates increased after the Second World War. That hypothesis seems researchable as more data become available (Goldin and Katz, 2008).

Finally, as many countries now have started forcing the disclosure of pay, investigating pay in those countries seems both doable and informative.

[6] Unfortunately, the variable SHRTARG is often missing. Therefore, we do not know whether this adjustment introduces more or less bias in the estimation of (2).

Appendix A. Summary of Gabaix and Landier (2008)

We summarise the GL model here, paraphrasing in part earlier expositions in GL and Edmans *et al.* (2009).

A continuum of firms and potential managers are matched together. Firm $n \in (0,N)$ has size $S(n)$ and manager $m \in (0,N)$ has talent $T(m)$. Low n denotes a larger firm and low m a more talented manager: $S'(n) < 0$, $T'(m) < 0$. n (m) can be thought of as the rank of the manager (firm), or a number proportional to it, such as its quantile of rank.

We consider the problem faced by one particular firm. The firm has a 'baseline' value of S. At $t = 0$, it hires a manager of talent T for one period. The manager's talent increases the firm's value according to

$$S' = S + CTS^{\gamma}, \tag{A.1}$$

where C parameterises the productivity of talent. If large firms are more difficult to change than small firms, then $\gamma < 1$. If $\gamma = 1$, the model exhibits CRS with respect to firm size.

Let $w(m)$ denote the equilibrium compensation of a CEO with index m. Firm n, taking the market compensation of CEOs as given, selects manager m to maximise its value net of wages:

$$\max_{m} CS(n)^{\gamma} T(m) - w(m). \tag{A.2}$$

The competitive equilibrium involves positive assortative matching, that is, $m = n$, and so $w'(n) = CS(n)^{\gamma} T'(n)$. Let $\underline{w}_N$ denote the reservation wage of the least talented CEO ($n = N$). Hence, we obtain the classic assignment equation (Sattinger, 1993; Tervio, 2008):

$$w(n) = -\int_{n}^{N} CS(u)^{\gamma} T'(u) \mathrm{d}u + \underline{w}_N. \tag{A.3}$$

Specific functional forms are required to proceed further. We assume a Pareto firm size distribution with exponent $1/\alpha$: $S(n) = An^{-\alpha}$. Using results from extreme value theory, GL use the following asymptotic value for the spacings of the talent distribution: $T'(n) = -Bn^{\beta-1}$. These functional forms give the wage equation in closed form, taking the limit as $n/N \to 0$:

$$w(n) = \int_{n}^{N} A^{\gamma} BCu^{-\alpha\gamma+\beta-1} \mathrm{d}u + \underline{w} = \frac{A^{\gamma} BC}{\alpha\gamma - \beta} \left[n^{-(\alpha\gamma-\beta)} - N^{-(\alpha\gamma-\beta)} \right] + \underline{w}_N \sim \frac{A^{\gamma} BC}{\alpha\gamma - \beta} n^{-(\alpha\gamma-\beta)}. \tag{A.4}$$

To interpret (A.4), we consider a reference firm, for instance firm number 250 – the median firm in the universe of the top 500 firms. Denote its index n_*, and its size $S(n_*)$. We obtain Proposition 2 from GL, which we repeat here.

Proposition, Gabaix and Landier, (2008). *In equilibrium, manager n runs a firm of size $S(n)$, and is paid according to the 'dual scaling' equation*

$$w(n) = D(n_*) S(n_*)^{\beta/\alpha} S(n)^{\gamma-\beta/\alpha}, \tag{A.5}$$

where $S(n_*)$ is the size of the reference firm and $D(n_*) = -Cn_* T'(n_*)/(\alpha\gamma - \beta)$ is a constant independent of firm size.

There are strong reasons to have $\gamma = 1$, which is the classic CRS case, which is useful in most firms studies (Luttmer, 2007). Zipf's law for firms sizes leads to $\alpha = 1$. Calibrating in the cross section, like in Table 1, yields $\gamma - \beta/\alpha \simeq 1/3$, hence $\beta = 2/3$. There is no 'intrinsic' reason why we should expect $\beta = 2/3$. It would be very interesting to find some reason (perhaps based on the inference from past performance) for it. This calibration yields the following:

$$w(n) = D(n_*)S(n_*)^{2/3}S(n)^{1/3}. \tag{A.6}$$

Hence, in the cross section, we have $w(n) \propto S(n)^{\gamma-\beta/\alpha} = S(n)^{1/3}$: log wage is proportional to log firm size, with a mild slope of 1/3.

However, in the time series, the average wage behaves like the wage of the reference firm, which satisfies $w(n_*) \propto S(n_*)^{\gamma} = S(n_*)^{1}$. The time series slope of log wage on log size is higher, at 1.

The reason is that in the cross section, the 'effective supply' a given firm faces is quite elastic: if it grows, it can just poach a better CEO from another firms. However, in the 'time series', the supply is not elastic: if all firms grow, they cannot poach new CEOs from elsewhere.[7]

Stern School of Business, CEPR and NBER
Toulouse School of Economics
Toulouse School of Economics and ENSAE-CREST

Additional Supporting Information may be found in the online version of this article:

Appendix B. Additional Tables.
Data S1.

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[7] That is because by assumption we assume a zero elasticity of labour supply from CEOs; however, the more general point of a higher elasticity in the cross-section than in the time series is generally valid.

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