

The Effect of Labor Market Demand on U.S. CEO Pay Since 1980

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This paper shows that the rise in U.S. CEO pay from 1980 to 2003 is only partially explained by competition for profit-producing talent in the labor market. This conclusion is obtained by removing unintended data biases from tests of the only theoretical model in the literature that relates labor market competition (measured by large firm size) to CEO pay level. When the biases are removed or minimized, *no more than 33%* of the 600+ percent rise in large firm CEO pay since 1980 is explained by a corresponding increase in large firm size.

Keywords: Executive compensation, CEO wages, labor market demand, extreme value theory, superstars

JEL codes: D2, D3, G34, J3

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1. Introduction

This paper quantifies the effect of labor market demand on the increase in U.S. CEO pay since 1980. Academics (e.g., Dodonova and Khoroshilov, 2009; Gabaix and Landier, 2008; Brookman, Chang, and Rennie, 2007; Murphy and Zabojnik, 2004), professionals, and policy makers have suggested that the 600% increase in pay since 1980 could be largely explained by the demand for CEOs' ability to produce profits. Others (e.g., Bebchuk and Fried, 2004; Sridharan, 1996; Rees, 1993) ascribe the increase to alternative sources. Identifying the source and quantifying it has implications for value creation. If the source of the pay increase is solely the demand for talent, then CEO pay increases should improve firm value; if any portion of the rise is explained by alternate sources, then it comes at the shareholders' expense.

Quantifying the effect of labor market demand on wages is challenging because demand cannot be directly measured. To address the issue, a full equilibrium model of the theoretical effect of labor market demand on CEO pay is required that a) provides directly testable predictions and b) quantifies the overall effect of competition for talent on the increase in CEO pay level. Building on the labor market theory developed since at least Rosen (1982) and up to Tervio (2008), Gabaix and Landier (2008) (hereafter, GL2008) provide the only published model that quantifies the effect of labor market demand on CEO pay with directly testable predictions. The GL2008 model has had a profound impact, perhaps because its rigorous derivation results in intuitively compelling predictions. The time-series prediction is that, due to labor market demand, the percentage increase in large U.S. firm market capitalization since 1980 results in the same percentage increase in top U.S. CEO pay over the same period.

Gabaix and Landier (2008) test their model's predictions and conclude that labor market demand fully explains the increase in top U.S. CEO compensation since 1980. Of practical importance, professionals (e.g., John England, a principal of Towers Perrin) have used GL2008's

results to gain confidence that, overall, CEO pay is negligibly influenced by agency issues (greed, fraud).¹ Finally, policy makers such as the Fed chairman, Ben Bernanke, cite their work.² The present research suggests that due to previously unreported or little known facts, their measures of firm size and CEO pay lead to unintentionally biased conclusions.

Gabaix and Landier (2008) specifically predict that the percentage increase in the average total compensation granted to top U.S. CEOs (from all industries), due to labor market competition, equals the percentage increase in the size of the N^{th} largest U.S. firm (from all industries) since 1980. The N^{th} firm's size is measured by the value of market capitalization of total assets under the assumption that a CEO's actions at date zero (0) affect the firm's earnings permanently. In this case, the CEO's date zero (0) actions create a perpetuity with a payout, a_1 , in each period so the impact on the firm's earnings is (a_1, a_1, a_1, \dots) . Alternatively, a CEO's date zero (0) actions have a duration of one period. The effect on earnings is $(a_1, 0, 0, \dots)$, and size is measured by earnings before interest and taxes (EBIT) or sales. All industries are included when finding the N^{th} firm's size under the assumption that labor market demand crosses industries, and GL2008 suggest that N equals 250 to capture labor market effects. They primarily test their theory by using two widely accepted CEO pay series and the largest firms, by market capitalization of total assets, in the Compustat database. However, their choices can result in four unintended deviations from an ideal test of their prediction, which bias their conclusions.

First, GL2008 use Kevin Murphy's S&P 500 pay series. Jensen, Murphy, and Wruck (2004, p. 25) state that prior to 1992 this pay series only includes CEOs in the Forbes 800 list of large firm CEOs; however, the Forbes 800 excludes 19% of the smallest S&P 500 firms' CEOs

¹ In a private email exchange, John England points to GL2008's research as one reason for being assured that CEO pay is, on average, in shareholders' best interest.

² Bernanke cited a working paper version of GL2008 in his speech before the Greater Omaha Chamber of Commerce in Omaha, Nebraska, on February 6, 2007.

in 1980, the reference year for GL2008's analysis. After 1991, Kevin Murphy's pay series includes all of the S&P 500 CEOs. Comparing all S&P 500 CEOs' pay after 1991 to 81% of S&P 500 firms in the reference year could bias the estimated pay increase for S&P 500 CEOs.

Second, GL2008 use the Frydman and Saks (2005) pay series. Frydman and Saks provide the average value of the top three executives' ex ante compensation in the top 50 firms, not the average of the top CEOs' compensation. Further, the term of options from 1980 onward is usually ten years.³ Frydman and Saks value options in 1980 using a term of ten years; however, after 1991 they usually use ExecuComp compensation data, which values options using a term of seven years.⁴ Option values are affected by the term used to value them so estimated pay increases could be affected.

Third, GL2008 use all large firms in Compustat to measure the aggregate size of top U.S. firms; however, many (37.6% in 2003) of the large firms in Compustat are foreign. Therefore, GL2008's conclusions regarding aggregate U.S. firms' size could be biased.

Fourth, GL2008 aim for the most precise measure of market capitalization of total assets so they use deferred taxes to compute firm size, but Compustat does not report deferred taxes for banks. Therefore, GL2008's computation of aggregate market capitalization excludes the banking industry, which is contrary to their time-series prediction. Their aggregate market capitalization should include all industries, especially since bank CEOs are included in their pay series. Additionally, the market capitalization of total assets excludes the value of off-balance sheet assets.⁵

³ See Frydman and Saks (2005, p. 34) and ExecuComp's Black Scholes "Method."

⁴ ExecuComp's "Black Scholes Methodology" states that options are valued using a term of seven years because "executives rarely wait until the expiration date to exercise their options."

⁵ I thank an anonymous referee for pointing out that the market capitalization of total assets does not include the value of off-balance sheet assets. Alternative theoretical measures of labor market demand (EBIT and sales) proposed by GL2008 reflect the value of off-balance sheet assets.

Four improvements are implemented to mitigate the effects that the four deviations could introduce in testing GL2008's predictions. First, I include all U.S. S&P 500 CEOs in 1980. Second, proxy statements for the top 100 firms in 1980 are obtained, and ExecuComp's method is used to value the CEOs' (not the top three officers') ex ante total compensation in 1980. Third, only U.S. firms are used to compute the size of the 250th largest U.S. firm. Fourth, U.S. banks are included when computing the 250th largest U.S. firm's market capitalization. Further, results are provided for the 250th largest U.S. firm's size measured by EBIT and sales; both reflect the value of all assets, including off-balance sheet assets. All values are reported in 2000 dollars.

After incorporating the four improvements, my direct tests of GL2008's model suggest that the increased labor market demand for CEO talent to produce profits could explain at most one-third of the rise in U.S. CEO total pay since 1980. The remaining two-thirds of the rise in U.S. CEO pay comes at the expense of shareholder value. This result is obtained using the market capitalization measure of firm size and holds for S&P 500 firms as well as the top 50 and top 100 firms. The results also hold if a key GL2008 assumption is relaxed so that demand for talent only originates from a CEO's industry segment (financial firms versus not) rather than from any domestic firm. Approximately 8.8% of the 600+ percent increase in CEO pay since 1980 is explained if conservative measures of firm size (EBIT or sales) are used.

Overall, this paper contributes to the literature by identifying biases associated with widely used compensation pay series and quantifying the long-term effect of labor market demand on top U.S. CEO pay (using GL2008's model assumptions).

2. The Gabaix and Landier (2008) theory and time-series prediction

The Gabaix and Landier (2008) model assumes a strong labor market demand that causes

CEO talent for producing profits to be competitively matched to firms.⁶ The uniqueness of the GL2008 model is to show that, due to labor market demand, average CEO compensation in the largest firms increases over time directly with the increase in median size of large firms. The average wage increase over time results because as larger firms bid for CEO talent, the profits from a given amount of talent increase, due to leveraging of that talent over a larger asset base.

The specific time-series prediction made by Gabaix and Landier (2008, p. 62) is that, “When the size of all large firms is multiplied by λ , the compensation at all large firms is multiplied by λ^γ .” The exponent, gamma, is less than 1.0 if large firms are more difficult for CEOs to transform than small firms. Based on a priori empirical evidence, Gabaix and Landier (2008, p. 56) state that a plausible null hypothesis is that $\gamma = 1$, which means there is a constant return to scale in the CEO production function. Compensation is the average ex ante value of total pay for CEOs of the largest firms (Gabaix and Landier, 2008, p. 67). GL2008 suggest that the “size of all large firms” most consistent with their theory (see p. 61) is the “250th largest firm” (i.e., the median size of the largest 500 firms); in other words, the 250th firm captures the size of firms in the labor market for CEOs of the largest firms. The firm-size measure depends on the duration of the earning increase due to a CEO’s talent (Gabaix and Landier, 2008, p. 55). Assuming an infinite duration implies that market capitalization of all assets is the best measure of firm size. Based on broad empirical evidence, the GL2008 model assumes that the labor market for CEOs is segmented by country (e.g., only U.S. firms compete to hire CEOs from U.S. companies). Within a given country, demand for a CEO is assumed to originate from firms in any industry. This is the usual assumption made for full-equilibrium models and is supported by the fact that approximately 74% of U.S. external hires originate from a different U.S. industry

⁶ There may be sources of demand for talent other than a CEO’s ability to produce profits. For instance, Lucier, Wheeler, and Habel (2007) suggest that hiring externally is driven by a need for expediency.

than the hiring firm (see Fee and Hadlock, 2003).⁷ Therefore, the average wage used in testing the prediction is that of CEOs from the largest firms from all industries. Accordingly, the time-series prediction specific to U.S. CEOs is that the percentage increase in the average ex ante value of wages in the largest firms (from all industries) changes in direct proportion to the percentage increase in the size of the 250th largest U.S. firm (from all industries).

3. Improvements to empirical methods in Gabaix and Landier (2008)

3.1 Improvement #1: Include all U.S. S&P 500 CEOs when analyzing pay increase

In their time-series test, Gabaix and Landier (2008) state that they include all U.S. S&P 500 CEOs in 1980 (the base year) as well as in later years. However, they use Kevin Murphy's S&P 500 pay series to find the average pay of S&P 500 CEOs in 1980. Not all S&P 500 CEOs are included in Kevin Murphy's pay series; details of this concern and the improvement follow.

Kevin Murphy exclusively uses Forbes 800 pay data to obtain the pay of S&P 500 CEOs before 1992, but the Forbes 800 only includes CEOs that are on "Forbes lists of the 500 largest companies ranked by sales, profits, assets, and stock market value."⁸ The Forbes 800 CEOs do not include 96 of the S&P 500 CEOs for the year 1980 (names available from the author). Twelve of the 96 firms are foreign so, in line with GL2008's assumption that labor markets are segmented by country, I exclude them from the analysis, leaving a total of 84 S&P 500 U.S. firms not listed in the Forbes 800.⁹ As expected, these firms are usually small by comparison to the average S&P 500 firm included in the Forbes 800; the average sales of the 84 unreported S&P 500 U.S. firms is 11% of the average sales of the 403 S&P 500 U.S. firms included in the

⁷ In theories based on labor market demand, wage increases in one industry affect all industries if CEOs have valued transportable skills and boards are aware of the pay given to other firms' senior executives. So, even one attempted external hiring of an executive officer (CEO or not) from one industry impacts CEO wages in all industries.

⁸ The criteria for inclusion in the Forbes 800 are given on page 114 of the June 8, 1981 Forbes Magazine.

⁹ Standard & Poor's criteria for adding new firms to the S&P 500 index require that a firm incorporate in the U.S. However, (see www.indicies.standardandpoors.com) continuing index membership is not necessarily subject to this guideline. Also, if the U.S. incorporation criterion "is not met and there is no other major market in which a company would logically be assigned, S&P may deem it a U.S. company for index purposes."

Forbes 800.

To determine the realized (ex post) value of pay for S&P 500 CEOs not reported by the Forbes 800 in 1980, I use proxy statements for 75 of the 84 S&P 500 U.S. firms; the remaining nine proxies cannot be located.¹⁰ The proxies report all elements of top officer pay. Usually proxies identify the CEO; if not, I assume the highest paid executive is the CEO. The value of total pay is then found as the sum of the value of all realized compensation (cash pay, restricted stock, payouts from long-term pay programs, plus the value realized from exercising options); Forbes reports this as total compensation.

Overall, the ex post value of total pay is known directly from proxies for 480 of the 487 U.S. S&P 500 firms in 1980. The years 1981 to 1991 are excluded from the analysis as ExecuComp data do not begin until 1992; from then onward, Kevin Murphy's pay series uses ExecuComp's value of ex ante total pay (TDC1) for S&P 500 CEOs.

Insert Table 1 about here.

Table 1, Panel A shows total pay for CEOs in 1980 and 2003 using Kevin Murphy's S&P 500 pay data as described by GL2008; this is based on having 404 S&P 500 CEOs in 1980 (one firm is foreign) and 513 CEOs in 2003 (10 are foreign, some are co-CEOs).¹¹ Results using total pay for all available S&P 500 U.S. CEOs in 1980 (480 CEOs in 1980 and 503 in 2003) are also in Panel A. The average increase in total pay using all available firms between 1980 and 2003 is 624% compared to 573% when using Kevin Murphy's S&P 500 pay series.¹²

3.2 Improvement #2: Only use CEO pay and the largest firms

In a test of their time-series prediction for CEOs, GL2008 use the Frydman and Saks (2005) value of average yearly compensation for the three highest paid officers in 50 large U.S.

¹⁰ Harvard's Baker library is the source; 9 of the 84 firms' proxies were not in Harvard's files as of October 2008.

¹¹ I thank Kevin Murphy for providing me with his Forbes 800 pay data set.

¹² Following the construction of Kevin Murphy's S&P 500 pay series, the *ex post* value of pay is used in 1980; the *ex ante* value of pay is used after 1991.

firms. The advantage is that Frydman and Saks (2005) consistently use an ex ante measure of pay. However, a) their average pay value is not specific to CEOs so other officers' pay could distort the average, b) the top 50 CEOs' pay could have increased faster than their officers' pay since the 1970s, c) Frydman and Saks change the method used to value CEO options over time even though the options characteristics (e.g., term) are the same, and d) due to their method of selecting top firms, their top 50 may not be the largest 50 firms by market capitalization.¹³ The suggested improvement is to remove the junior officers and investigate the ex ante pay increase for the U.S. CEOs of the 50 and the 100 largest U.S. firms, while consistently using ExecuComp's method to value options.

To implement the proposed improvement, I find the ex ante total pay (ExecuComp's TDC1) for the CEOs of the largest (by market capitalization) 50 and largest 100 U.S. firms in the ExecuComp database each year between 1992 and 2003. In 1980, proxy data and ExecuComp's Black-Scholes method are used to directly find the ex ante value of options for the CEOs of the 50 and 100 largest firms, by market capitalization. The ex ante value of total pay is found as the sum of the ex ante value of options plus all compensation except options (cash pay, restricted stock, and payouts from long-term pay programs).¹⁴ In 2000 dollars, the average ex ante option pay from all proxy data is \$149,497, which is within 6.3% of the value for large firms in 1980 as reported by Hall and Liebman (1998, p. 661).¹⁵

Gabaix and Landier (2008, p. 73) show that the Frydman-Saks average of the top three executives' pay in the top 50 firms increases approximately 350% from 1980 to 2003; this is

¹³ Frydman and Saks (2005) state that option durations are usually ten years in the 1980s so they use a ten-year duration when valuing options in 1980. After 1991, they use ExecuComp data which uses seven-year durations to value options.

¹⁴ The value of all compensation except options is identical to what the Forbes 800 reports, excluding the value realized from options.

¹⁵ Proxies for 178 large firms are collected; 104 of these firms are the largest firms in Compustat in 1980.

reported in the first column of Table 1, Panel B. The results from applying the improvements discussed in this section are shown in the last two columns of Panel B. The top 50 (100) U.S. CEOs' pay increased by 1,023% (900%) from 1980 to 2003, nearly three times the value found by GL2008 using the Frydman-Saks data.¹⁶

3.3 Improvement #3: Use only U.S. firms when testing predictions about U.S. CEO compensation

Gabaix and Landier (2008) use the largest firms in the Compustat universe to estimate the average and median market capitalization of large U.S. firms. In line with their assumption that labor markets are segmented by country, I suggest excluding foreign firms that are included in the Compustat universe of firms. Although the Compustat database includes all U.S. public firms since 1978, it also contains foreign firms, such as Nippon Telephone & Telegraph, that are traded as American depository receipts (ADRs) on U.S. stock exchanges. In recent years, Compustat has increased its coverage of foreign firms in its North American database. For instance, in 2003 (fiscal year 2002) using GL2008's calculation of market capitalization, 37.6% (188) of the 500 largest firms in the universe of Compustat firms were foreign, up from 9.6% (48) in 1980.¹⁷

The improvement to GL2008's size computation (only use large U.S. firms) is implemented by filtering the universe of Compustat firms to include only those incorporated in the United States. In 2003, foreign firms are identified by Compustat's financial incorporation code, FINC, which is zero for U.S. firms. Compustat states that this code is set based on a company's country of incorporation in the year the database is released so the code may not be accurate looking backward at 1980. To address this, I use two sources to verify the country of

¹⁶ For the year 1980, proxy data is not available to compute ex ante pay for three of the 50 largest firms and for seven of the 100 largest firms. The ex ante pay values for CEOs of these firms are estimated by first regressing known CEOs' ex ante total pay obtained from 178 proxies on firm sales. The regression coefficients, along with the sales of the missing CEO's firm, are used to estimate the ex ante pay of the seven missing CEOs. This follows the method of Core, Holthausen, and Larcker (1999) for estimation of pay in 1980. For the year 2003, the same regression approach is used to estimate pay for one of the 50 largest and three of the 100 largest firms' CEOs.

¹⁷ GL2008's firm size data for year t are based on the closing values in the previous fiscal year.

incorporation for each of the top firms in 1980 identified as foreign by Compustat. The first source is the 1981 edition (v3n1) of *Standard & Poor's Stock Market Encyclopedia of the S&P "500"* and the second source is reference materials at Harvard Business School's library.¹⁸

Insert Table 2 about here.

Table 2, Panel A shows the results for the suggested improvement to the computation of average market capitalization. The first two columns report GL2008's average (600%) and median (400%) increase in market capitalization for the top 500 firms in the universe of Compustat firms. The 3rd, 4th, and 5th columns show the replication of GL2008 using the universe of Compustat firms. The replicated values are similar to those reported by GL2008 (which includes foreign firms), with average and median increases of 574% and 395%, respectively.¹⁹ The 5th column shows the number of foreign firms included in the replication of GL2008's top 500 sample: in 1980, 48 of the 500 are foreign; in 2003, 188 of the 500 are foreign. Finally, the 6th and 7th columns show results for the top 500 without including foreign firms. The average (median) increase in market capitalization for the top 500 U.S. firms is 413% (189%), which is 187 (211) percentage points less than what was reported by GL2008 (p -value < 0.01).

3.4 Improvement #4: Include U.S. financial firms when computing market capitalization

GL2008 suggest that labor markets are segmented by country, not industry. As a result, the 250th largest firm used in testing their time-series prediction should ideally come from all U.S. industries, especially since GL2008's CEO pay series encompasses all industries.

Therefore, to test GL2008's prediction, financial firms must be included when determining the size of the 250th largest U.S. firm. GL2008 compute market capitalization (i.e., size) as $\text{data199} * \text{abs}(\text{data25}) + \text{data6} - \text{data60} - \text{data74}$; however, Compustat item data74

¹⁸ I thank Anthony Thomas De La Puente at Harvard Business School library for help in determining the foreign origin of firms. Altogether, foreign incorporation codes are changed for five firms.

¹⁹ To exactly replicate GL2008's size results, the same vintage of the Compustat database is required.

(deferred taxes) is not reported for banks. So, the consequence of using data74 to compute size is that all banks are excluded from the GL2008 sample used to calculate size. The suggested improvement is to include all industries when finding the 250th largest U.S. firm.

Since deferred taxes account for approximately 2% of total market value for all firms, when data74 is missing, the proposed improvement is implemented by setting its value to zero. This enables computation of market value for 99.8% of all S&P 500 firms. Table 2, Panel B shows that when all U.S. firms from all industries are included, the rise in average (median) market value is 336% (213%) for the top 500 U.S. firms between 1980 and 2003; these values are less than the average (median) increase of 600% (400%) reported by GL2008. Table 2 also shows that using this improvement increases the reported rise in the size of the 250th largest U.S. firm from 189% (Panel A) to 213% (Panel B); therefore, using this improvement biases against my conclusions. Next, the effect of using the four improvements is discussed.

4. Results

4.1 S&P 500 time-series tests for U.S. CEOs, 1980 to 2003

Figure 1 shows the time-series evidence for the test of the GL2008 prediction for the effect of labor market competition on CEO pay: U.S. CEOs' average compensation increases in direct proportion to the increase in the market capitalization of the 250th largest firm. To show the effect of the proposed improvements, a replication of GL2008's results is first shown in Figure 1, Panel A; it is a replication of GL2008's Figure 1 using their procedures for S&P 500 CEOs. The plot shows, as did GL2008, that the measure of S&P 500 average compensation increases in direct proportion to GL2008's measure of average market capitalization. Also as in GL2008, the increase is nearly identical for the years 1992 to 1994 and 2002 to 2004. Figure 1, Panel B shows the results of implementing improvements to directly test their prediction while

maintaining comparability to GL2008's analysis. The improvements implemented for this test are 1) that all S&P 500 U.S. CEOs in 1980 are used, 2) only U.S. firms are used when computing firm size, and 3) all industries are included when computing firm size. In addition, GL2008's prediction is tested, as specified in their Proposition 2, using the 250th largest U.S. firm's size, not the average size of the 500 largest, to measure the increase in size of large U.S. firms.²⁰

With the three improvements and the more accurate test, between 1980 and 2003 the percent increase in average total pay for S&P 500 U.S. CEOs is 2.93 times the percent increase in market capitalization for the 250th largest U.S. firms.²¹

Insert Figure 1 about here.

4.2 Time-series test for the 50 and 100 largest U.S. firms, 1980 to 2003

Table 3 provides results that are closer to an ideal test of GL2008's prediction. I focus on the 50 largest U.S. firms, as GL2008 did, but implement all improvements discussed in Section 3. Table 3, column 1 shows the results. The average ex ante pay increase for CEOs of the 50 largest U.S. firms is 4.80 times the market capitalization increase of the 500 largest U.S. firms from 1980 to 2003. To extend the analysis, Column 2 reports results for the 100 largest U.S. firms, again using all improvements. The average CEO pay increase is 4.28 times the market capitalization increase. Overall, after implementing all suggested improvements, the analysis suggests that the percent increase in top U.S. CEO pay is approximately four times the percent increase in market value of top U.S. firms between 1980 and 2003.

Insert Table 3 about here.

The results for the top 50 and top 100 firms are based on using the size increase of the

²⁰ GL2008 use the 250th largest firm for all of their tests on U.S. firms except this particular test.

²¹ GL2008 state that using ex post pay in 1980 may bias conclusions so proxies for the 100 largest U.S. firms (93 have proxies available) are collected. For the CEOs of the 93 firms, the average ex post pay in 1980 (\$1,516,000) is greater than the average ex ante pay (\$1,331,000). So, using ex post pay in 1980 likely results in finding a lower percentage increase in S&P 500 CEO pay from 1980 to 2003 compared to using ex ante pay. Therefore, using ex post pay in 1980 likely biases against the conclusions of this paper.

250th largest U.S. firm. A natural question is whether a larger firm size (such as the 50th) should be used. GL2008 state that their analysis is not sensitive to using a larger firm, and in robustness tests (see Section 6) using the 50th largest firm, I show that conclusions are not changed.

4.3 Summary of time-series results with improvements, 1980 to 2003

In addition to showing results for the 50 and 100 largest U.S. firms, data for S&P 500 firms obtained from Figure 1, Panel B are shown in the last column of Table 3. For the three samples, the ratio of the percent increase in firm size to the percent increase in compensation ranges from 20.8% to 34.1%. The results for the 50 and 100 largest 100 firms' CEOs (20.8% and 23.7%, respectively) reflect the most accurate test of Gabaix and Lander's prediction. Based on the results, their model suggests that labor market competition explains approximately one-third or less of the increase in top U.S. CEO compensation between 1980 and 2003.

5. Panel evidence for U.S. CEOs, 1992 to 2004, pay increase by source

To further establish the source of rising CEO pay, this section focuses on GL2008's prediction for the cross-section of CEO pay combined with their time-series prediction. Although the data only extend back to 1992, the advantages are that ex ante pay is available for nearly all firms in this period and there is a simultaneous test of cross-sectional and time-series effects. GL2008 develop a novel model (see the caption of Table 4) that predicts how CEO pay should respond to cross-sectional changes in firm size as well as to increases in top firm size over time. Testing this model provides a check against the time-series results just discussed. Their analysis tests whether the sum of coefficients on the two terms of the model is 1.0. A sum of 1.0 for model coefficients "e" and "f" indicates constant returns to scale, which is expected if the increase in U.S. CEO pay is fully explained by rising firm market values and an accompanying competition between large firms for CEO talent. However, a sum greater than one suggests pay is rising at a rate that is greater than can be explained by increasing firm market values.

Insert Table 4 about here.

To show the effect of using only U.S. firms (including banks) when measuring firm size, I first report GL2008's results and then the replication of those results. The first two columns of Table 4 show GL2008's regression results for firms a) ranked in the top 1000 and top 500 by market value in the universe of Compustat firms and b) that are also carried in the ExecuComp database. The next two columns, (3) and (4), show a replication of GL2008, where the universe of Compustat firms is used to compute the "Market cap of firm #250." Here I follow the procedures given by GL2008, which are described in the caption of Table 4. The row labeled "Test: coefficient sum = GL2008" shows that the replication produces results that are not significantly different from GL2008.²²

The final two columns of Table 4 show the results when only U.S. firms from all industries are used, rather than the universe of Compustat firms that includes foreign firms. The sum of coefficients is at least 1.63, whether the top 1000 or top 500 firms are analyzed. The row labeled "Test: coefficient sum = GL2008" shows that the sums are significantly greater (p -value < 0.001) than what GL2008 find. The row labeled "Test: coefficient sum = 1.0" also shows that the sums are significantly greater than 1.0 (p -value < 0.001). Thus, as with the improved tests of GL2008's time-series prediction, the results suggest that CEO pay after 1992 is rising at least 60% more than can be explained by demand for CEO talent among large firms.

6. Robustness tests

The results are checked for robustness to reasonable variants of the model assumptions and empirical methods. First, I investigate the assumption that the CEO labor market is segmented by country alone. Proxy statements for 50 of the S&P 500 firms in 2003 are randomly

²² The coefficients in my replication regressions are close but not identical to the coefficient values reported by GL2008. This is possibly due to version differences of Compustat.

selected. Financial firm proxies often (though not always) state that the board believes demand for their CEOs comes from other financial firms, while boards of nonfinancial firms often state they believe that demand for their CEOs usually comes from other nonfinancial firms. So, the labor market in the U.S. could be partially segmented along these industry lines rather than being homogeneous as GL2008 assume. Table 5, Panel A shows the tests results for the top 100 financial firms and their CEOs, and separately shows test results for the top 100 nonfinancial firms and their CEOs. The percent increase in top financial firms' market capitalization is approximately one-sixth of the percent increase in top financial CEO pay; similarly approximately one-fourth of the rise in top nonfinancial CEO pay is explained by the increase in market capitalization of top nonfinancial firms. Previous conclusions remain unchanged by assuming some segmentation of the labor market along industry lines.

Insert Table 5 about here.

Second, in GL2008's theory, market capitalization captures the maximum possible value of CEO talent by assuming that a CEO's talent contribution in the current year increases a firm's cash flow by a given amount forever; however, this may not occur. Further, the computation of market capitalization does not include the value of off-balance sheet assets. GL2008's more conservative estimates of the value of CEO talent contribution in the current year address these issues. These measures assume that a CEO's talent increases a firm's cash flow for just that year. In this case, size is measured by either sales or earnings before interest and taxes (EBIT); both measures reflect the value of all assets including off-balance sheet assets.²³ Panel B of Table 5 shows the increase in the 250th largest firm's market capitalization (213%); the increase in the 250th largest firm's sales since 1980 (79.3%); and the increase in the 250th largest firm's EBIT

²³ Banks do not have sales, so for banks, Compustat reports a value of "sales" that includes all interest income, fee revenue, total current operating revenue, and net pretax profit or loss on securities sold or redeemed.

(87.3%). The percent increase in the 250th firm's sales and in EBIT suggest that the percent increase in large firm size explains no less than 8.8% of the percent increase in top 100 CEOs' average ex ante pay since 1980.

Finally, Table 6 investigates how robust the results are to using a) the median (not the average) ex ante pay of the top 100 CEOs and b) the 50th (not 250th) largest firm as the reference firm for measuring size increase. The rows labeled, "Ratio: increase ..." show that regardless of using the 50th largest or 250th largest firm or of the measure of total pay (mean or median), the percent increase in market capitalization of total assets does not explain more than approximately one-third of the percent increase in U.S. CEO ex ante compensation since 1980. Therefore, the results are reasonably robust to variations in the measure of large firm size and CEO pay.

Insert Table 6 about here.

7. Conclusions

This article explains inadvertent data-selection biases that have affected earlier research and important consequences for researchers, policy makers, and practitioners aiming to explain the rise of and cross-sectional changes in U.S. CEO pay through time. In view of the impact that some of the biases have on CEO pay estimation, researchers should make the adjustments described in this paper when using Kevin Murphy's S&P 500 CEO pay data or the Frydman-Saks executive compensation series to analyze changes in CEO pay since 1980. When the identified empirical biases are mitigated in testing Gabaix and Landier's (2008) theory for the effect of labor market demand on U.S. CEO pay, a third or less of the rise in their pay since 1980 can be explained by labor market demand. The results suggest that agency issues, increased job risk, or social pressure, as described in Hamermesh (1975), could explain two-thirds or more of the increase in top U.S. CEO pay since 1980.

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Table 1

Increase in S&P 500, top 50, and top 100 CEO total pay between 1980 and 2003: GL2008 vs. improvements 1 and 2

All values are reported in 2000 dollars using the Bureau of Economic Analysis GDP deflator. U.S. firms are identified by the Compustat variable FINC; and in 1980, foreign firms incorporation is verified using sources described in Section 3.3. *Panel A:* In fiscal year 1980, CEO total pay is found from Kevin Murphy's Forbes 800 data or from proxies obtained from Harvard Business School's Baker Library. This ex post value of total pay includes cash pay, restricted stock, payouts from long-term pay programs, and the value realized from exercising stock options during the year, rather than grant date values. In fiscal year 2003, ExecuComp total pay is the ex ante value of total pay (ExecuComp variable TDC1) for CEOs. It is the sum of cash pay, restricted stock, payouts from long-term programs, and the value of stock options granted, using ExecuComp's modified Black-Scholes approach. In 1980, S&P 500 CEOs are identified using the *Standard & Poor's Stock Market Encyclopedia of the S&P "500."* After 1980, Compustat's historical identifier (data276) is used to identify S&P 500 firms. *Panel B:* The % increase in average ex ante total pay of the top three executives of the Frydman-Saks' top 50 firms is given by Gabaix and Landier (2008, p. 73). The largest 50 firms from all U.S. industries are identified as having the largest market capitalization; details of the market capitalization computation are given in Section 3.4. Ex ante total pay is obtained in 1980 by using ExecuComp's valuation procedures and proxy data; in 2003, ex ante total pay is ExecuComp variable TDC1; see Section 3.2 for details. *Notes:*

^A In 1980, one of the 404 S&P 500 firms is foreign; in 2003, ten firms are foreign and some firms have co-CEOs.

^B In 1980, the 13 foreign S&P 500 firms are not included in the sample; seven U.S. CEOs are not included as their proxies are not available; and pay for 403 CEOs comes from the Forbes 800, 77 from proxies.

Panel A: Improvement #1 - Use all U.S. S&P 500 CEOs to compute average total pay – compared to GL2008

	<u>GL2008's S&P 500 average total pay series (\$000s)</u>	<u>Average total pay including all S&P 500 U.S. CEOs (\$000s)^B</u>
	1980: S&P 500 CEO total pay from Forbes 800 (N=404 ^A)	1980: S&P 500 U.S. CEO total pay from Forbes 800 plus proxies (N=480)
	2003: Use ExecuComp total pay for S&P 500 CEOs (N=513)	2003: Use ExecuComp total pay for S&P 500 CEOs (N=503)
Year = 1980	1,211	1,126
Year = 2003	8,149	8,155
% increase in pay	573	624

Panel B: Improvement #2 – Include CEOs only and use the 50 or 100 largest firms – compared to GL2008

	<u>GL2008's Frydman-Saks' average ex ante total pay for the top 50 firms' top 3 executives</u>	<u>Largest 50 firms' CEOs average ex ante total pay (\$000s)</u>	<u>Largest 100 firms' CEOs average ex ante total pay (\$000s)</u>
Year = 1980	--	1,443	1,333
Year = 2003	--	16,203	13,326
% increase in pay	350	1,023	900

Table 2

Percent increase in firm size between 1980 and 2003: GL2008 vs. improvements 3 and 4

All values are reported in 2000 dollars using the Bureau of Economic Analysis GDP deflator. Following GL2008, market capitalization size data for year t are based on the closing price of the previous financial year. U.S. firms are identified by the Compustat variable FINC; and in 1980, foreign firm incorporation is verified using sources described in Section 3.3. In *Panel A*, Market-cap-GL2008 is computed as described in GL2008 using Compustat variables: $\text{data199} \cdot \text{abs}(\text{data25}) + \text{data6} - \text{data60} - \text{data74}$. Data74 is deferred taxes (balance sheet); data199 is end of fiscal year stock price; data25 is common shares outstanding; data6 is total assets; data60 is common shareholder's book equity. Columns labeled "Reported by GL2008" provide the values reported in their Appendix 1. Columns labeled "Replication" report the market capitalization for the 500 largest firms in 1980 and 2003 using the universe of firms (including foreign firms) in the 2005 Compustat database. Columns labeled "Improvement #3: Use only the 500 largest U.S. firms" report the market capitalization of the 500 largest U.S. firms in Compustat (using the GL2008 measure of market capitalization). The t -test is used to find significant differences between the replication average market cap and the other averages; the Kruskal-Wallis test is used to find significant differences between the replication median and other medians. *Panel B* shows the market capitalization of the largest 500 U.S. firms including all banks. This is done by modifying the GL2008 computation of market capitalization. When data74 is missing, the market cap equals $\text{data199} \cdot \text{abs}(\text{data25}) + \text{data6} - \text{data60}$. When data74 is not missing, market cap is the same as the GL2008 measure of market capitalization (see page 94 of GL2008).

Panel A: Improvement #3 – Use only U.S. firms when estimating size increases for the top 500 U.S. firms – compared to GL2008

	GL2008 sample: The universe of Compustat firms (includes foreign firms)				Number of foreign firms in top 500	Improvement #3: Use only the 500 largest U.S. firms	
	Reported by GL2008		Replication			Average	Median
	Average	Median	Average	Median			
Market-cap-GL2008 in the year 1980 (\$ millions)	--	--	8,061	4,324	48	7,169	3,933
Market-cap-GL2008 in the year 2003 (\$ millions)	--	--	54,294	21,411	188	36,771***	11,379***
% increase in market-cap	600	400	574	395		413	189
Sample size	500		500			500	

Panel B: Improvement #4 – Include all industries (e.g., banks) when computing the size (market cap) of top firms – compared to GL2008

	Reported by GL2008 (excludes banks)		U.S. firms including all industries	
	Average	Median	Average	Median
Market cap in the year 1980 (\$ millions)	--	--	11,087	5,425
Market cap in the year 2003 (\$ millions)	--	--	48,356	16,985
% increase in market cap	600	400	336	213
Sample size	500		500	

***, **, * indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.

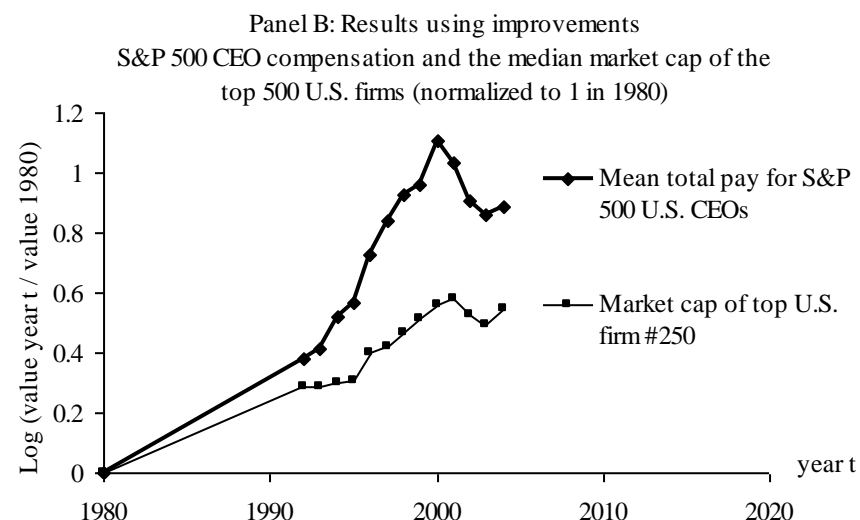
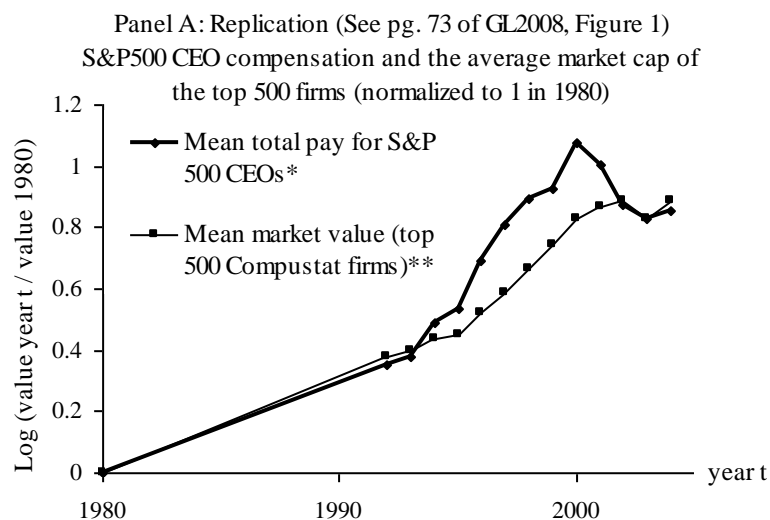


Figure 1: S&P 500 CEO compensation and market capitalization of top 500 Firms

All values are reported in 2000 dollars using the Bureau of Economic Analysis GDP deflator. Log is to the base ten. In 1980, S&P 500 CEOs are identified by using *Standard & Poor's Stock Market Encyclopedia of the S&P "500."* From 1992 to 2004, Compustat's historical identifier for S&P 500 firms (data276) is used to identify S&P 500 firms. *Panel A* replicates GL2008's analysis. For the year 1980 the ex post value of total pay (defined in Table 1) for S&P 500 CEOs is found for the 404 S&P 500 CEOs in Kevin Murphy's S&P 500 CEO data set. From 1992 to 2004 the ex ante value of total pay as reported by ExecuComp, TDC1, is used for S&P 500 CEOs. "Mean total pay for S&P 500 CEOs" is the average of the ex post total pay values for the 404 S&P 500 CEOs in 1980 and the average, each year, of the ex ante total pay for the S&P 500 CEOs after 1991. Market cap is the same as the GL2008 measure of market capitalization ($\text{data199} \times \text{abs}(\text{data25}) + \text{data6} - \text{data60} - \text{data74}$). "Mean market value (top 500 Compustat firms)" is the average market capitalization of the 500 largest firms in the universe of Compustat firms. In *Panel B*, Forbes 800 data and hand-collected proxy data from 1980 are used to determine the ex post total pay of 480 of the 487 S&P 500 U.S. CEOs. After 1980, calculation of average total pay is the same as in Panel A. "Mean total pay for S&P 500 U.S. CEOs" is the average of the ex post total pay values for the 480 S&P 500 CEOs in 1980 and the average, each year, of the ex ante total pay for the S&P 500 U.S. CEOs after 1991. Market cap in Panel B is set equal to $\text{data199} \times \text{abs}(\text{data25}) + \text{data6} - \text{data60}$ when data74 is missing (so banks are included), otherwise market cap is the same as the GL2008 measure of market capitalization. "Market cap of top U.S. firm #250" is the median market capitalization of the 500 largest U.S. firms in the Compustat database. Market value data for year t are based on the closing price and asset values of the previous financial year.

* Following GL2008, only the 404 S&P 500 CEOs reported in the Forbes 800 are included in 1980.

** Following GL2008, the percent of foreign firms varies by year.

Table 3

Summary of time-series results from 1980 to 2003 with improvements

All values are reported in 2000 dollars using the Bureau of Economic Analysis GDP deflator. All improvements (see Section 3) for testing GL2008's theory are used for tests involving the 50 and 100 largest firms. Ex ante total pay is obtained for CEOs in 1980 by using ExecuComp's valuation procedures and proxy data. In 2003, ex ante total pay is ExecuComp variable TDC1; see Section 3.2 for details. Mean total compensation for the 50 largest firms is the average of the ex ante total pay for the CEOs of the largest (measured by market capitalization) 50 U.S. public firms; mean total pay for the 100 largest firms is similarly defined. Market cap = $\text{data199} * \text{abs}(\text{data25}) + \text{data6} - \text{data60}$ when data74 is missing, otherwise market cap = $(\text{data199} * \text{abs}(\text{data25}) + \text{data6} - \text{data60} - \text{data74})$. Median market cap of the 500 largest U.S. firms is the median market capitalization of the 500 largest U.S. firms from all industries in the Compustat database, based on the closing price and asset values of the previous financial year. The S&P 500 sample is described in Figure 1, Panel B.

	CEO group		
	50 largest firms (ex ante compensation)	100 largest firms (ex ante compensation)	S&P 500
Percentage increase in median market cap of the 500 largest U.S. firms (1980 – 2003)	213%	213%	213%
Percentage increase in top U.S. CEOs' mean total compensation (1980 – 2003)	1,023%	900%	624%
Ratio of percentage increase in median market cap to percentage increase in CEO mean compensation	213 / 1,023 =20.8%	213 / 900 =23.7%	213 / 624 = 34.1%

Table 4

Panel evidence: U.S. CEO pay, own firm size, and reference firm size

The first four columns of *Panel A* report the results of GL2008's novel cross-sectional time-series model: $\ln(\text{CEO total compensation for the CEO of firm } i \text{ at time } t) = d + e * \ln(\text{market cap for firm } i \text{ at time } t-1) + f * \ln(\text{Market cap of firm \#250 at time } t-1)$. In the last two columns of Panel A, the regression is nearly identical to the regression in the first four columns; however, only U.S. firms are used to find the market cap of firm #250. CEO total compensation for firm *i* at time *t* is the total value of ex ante pay given by ExecuComp variable TDC1 (i.e., the sum of cash pay, restricted stock, payouts from long term programs, and the value of stock options granted). "Top 1000 (Top 500)" is the sample of the 1000 (500) largest firms in the Compustat database by market capitalization; market cap for each regression is defined below. The columns labeled "Reported by GL2008" gives the values from GL2008's Table II for the regression. In the columns labeled "Replication," a) Market cap is measured using GL2008's measure of total firm value (defined in Table 2), and b) "Market cap of firm #250" is the 250th largest firm, by GL2008's measure of total firm value, in the universe of Compustat firms, which includes foreign firms. In the columns labeled "All U.S. firms in Compustat," the measure of each firm's market cap used to find the "Market cap of top U.S. firm #250" is the same as is used by GL2008 unless data74 is missing, then market cap = data199*abs(data25)+data6-data60. The "Market cap of top U.S. firm #250" is then the 250th largest firm among all U.S. firms in Compustat. In *Panel B*, in the row labeled "Test: coefficient sum = GL2008," the Wald test is used to determine whether the sum of coefficients (i.e., coefficients *e* + *f*) for the Top 1000 (Top 500) equals 1.09 (1.11). In the row labeled "Test: coefficient sum = 1.0," the Wald test is used to determine whether the sum of coefficients for the Top 1000 (Top 500) equals 1.0 (1.0). All quantities are converted to 2000 dollars using the Bureau of Economic Analysis GDP deflator. ^^ I compute these values from the coefficients reported by GL2008 (ex. $1.09 = .37 + .72$). Standard deviations are reported in parenthesis; they are clustered at the firm level (first line) and at the year level (second line).

<i>Panel A: Regressions</i>						
Reference group sample	Reported by GL2008		Replication (Market cap of firm #250 is from the universe of Compustat firms)		Market cap of U.S. firm #250 is from all U.S. firms in Compustat	
	Top 1000	Top 500	Top 1000	Top 500	Top 1000	Top 500
Ln(Market cap)	0.37 (0.022) (0.016)	0.38 (0.039) (0.020)	0.321 (0.023) (0.013)	0.320 (0.040) (0.016)	0.333 (0.023) (0.015)	0.300 (0.035) (0.010)
Ln(Market cap of firm #250)	0.72 (.053) (.066)	0.73 (.084) (.089)	0.839 (0.057) (0.078)	0.868 (0.086) (0.107)	1.301 (0.087) (0.124)	1.397 (0.091) (0.150)
Ln(Market cap of top U.S. firm #250)						
Observations	7,963	4,156	7,857	4,120	8,170	4,223
R-squared	0.23	0.20	0.200	0.177	0.196	0.211
<i>Panel B: Analysis for differences</i>						
Sum of coefficients	1.09^^	1.11^^	1.159	1.188	1.634***	1.696***
Test : coefficient sum = GL2008			<i>p</i> -value = .101	<i>p</i> -value = .224	<i>p</i> -value < .001	<i>p</i> -value < 0.001
Test: coefficient sum = 1.0					<i>p</i> -value < .001	<i>p</i> -value < 0.001

***, **, * indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.

Table 5

Robustness to labor market segmentation and to the measure of large firm size

All values are reported in 2000 dollars using the Bureau of Economic Analysis GDP deflator. All improvements to testing GL2008's theory are included (see Section 3). The sample in each panel is the CEOs of the top 100 U.S. firms ranked by market capitalization (defined in Figure 1, Panel B). The size of firm #250 in each panel is based on the industries indicated for that panel; for instance for nonfinancial firms, the 250th largest firm is selected from among U.S. nonfinancial firms. Financial firms have Standard Industry Identification codes from 6000 to 6999; nonfinancial firms are all other firms. Sales is Compustat's data12. For banks, sales includes all interest income, all fee revenue, total current operating revenue, and net pretax profit or loss on securities sold or redeemed. The value of earnings before interest and taxes, EBIT, is data13 – data14. Data13 is operating income before depreciation; data14 is depreciation and amortization. Ex ante total pay is obtained (when available) in 1980 using ExecuComp's valuation procedures and proxy data; in 2003 ex ante total pay is ExecuComp variable TDC1. When proxies are not available, missing CEO pay is estimated by first regressing known CEO total ex ante pay on firm sales in 1980. Then the regression coefficients along with the sales of firms employing CEOs with missing pay are used to estimate the missing pay values (the regression specification follows Core, Holthausen and Larcker, 1999). Total ex ante pay estimates are made for seven of the 100 largest firms from all industries in 1980, 53 of the 100 largest financial firms in 1980, and 45 of the 100 largest nonfinancial firms in 1980. "Ratio: increase in size of firm #250 / pay increase" is $100 * (\% \text{ increase in size of firm \#250} / \% \text{ increase in mean ex ante total pay for the 100 largest firms' CEOs})$.

Panel A: Labor market segmentation by industry

	Nonfinancial firms		Financial firms	
	Mean ex ante total pay (\$000s)	Market cap of top U.S. non-financial firm #250 (\$millions)	Median ex ante total pay (\$000s)	Market cap of top U.S. financial firm #250 (\$millions)
1980	1,380	3,592	840	1,435
2003	11,296	10,172	10,533	4,155
Sample size in 1980	100	500	100	500
Sample size in 2003	100	500	100	500
% increase	718.6	183.2	1,154.1	189.5
Ratio: increase in size of firm #250 / pay increase		183.2 / 718.6 = 25.5%		189.5 / 1,154.1 = 16.4%

Panel B: Robustness to measuring firm size by sales and operating income (of all industries)

	Mean ex ante total pay (\$000s)	Sales U.S. firm #250 (\$millions)	EBIT for U.S. firm #250 (\$ millions)	Market cap of top U.S. firm #250 (\$millions)
	1980	1,333	4,777	481
2003	13,326	8,563	901	16,985
Sample size in 1980	100	500	500	500
Sample size in 2003	100	500	500	500
% increase	899.8	79.3	87.3	213.1
Ratio: increase in size of firm #250 / pay increase		79.3 / 899.8 = 8.8%	87.3 / 899.8 = 9.7%	213.1 / 899.8 = 23.7%

Table 6

Robustness to mean / median pay and to 250th / 50th largest firm size

All values are reported in 2000 dollars using the Bureau of Economic Analysis GDP deflator. All improvements to testing GL2008's theory are included (see Section 3). The sample is the CEOs of the top 100 U.S. firms ranked by market cap (defined in Figure 1, Panel B). The "Market cap top U.S. firm #250" is the median market cap of the 500 largest U.S. firms; "Market cap top U.S. firm #50" is similarly defined. Ex ante total pay is obtained using the procedures described in Table 5. "Ratio: increase in size of firm #250 / pay increase" is $100 * (\% \text{ increase in size of firm \#250} / \% \text{ increase in mean ex ante total pay for the 100 largest firms' CEOs})$. "Ratio: increase in size of firm #50 / pay increase" is similarly defined.

	Mean ex ante total pay (\$000s)	Median ex ante total pay (\$000s)	Market cap top U.S. firm #250 (\$millions)	Market cap of top US firm #50 (\$millions)
1980	1,333	1,209	5,425	12,547
2003	13,326	11,317	16,985	48,577
Sample size in 1980	100	100	500	100
Sample size in 2003	100	100	500	100
% increase	899.8	835.7	213.1	287.1
Ratio: increase in size of firm #50 / pay increase	287.1 / 899.8 = 31.9%		287.1 / 835.7 = 34.4%	
Ratio: increase in size of firm #250 / pay increase	213.1 / 899.8 = 23.7%		213.1 / 835.7 = 25.5%	