Executive Compensation and the Market Valuation of Managerial Attributes

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December 2015

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JEL Classification: G3, G32, J24, J31, J33, C23

Keywords: Executive compensation, CEO pay, managerial ability, human capital, fixed effects, manager fixed effects, interactive fixed effects, factor models

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Executive Compensation and Market Valuation of Managerial Attributes

Abstract

The empirical literature on executive compensation often models unobserved managerial attributes as time-invariant fixed effects. The labor market for executives, however, may value these attributes differently over time. We propose and estimate an interactive fixed effects (IFE) model of executive compensation. The IFE model allows for time variation in the market valuation of unobserved managerial attributes. The model can also incorporate multiple managerial fixed effects. We find that two managerial attributes are economically important in explaining executive pay. The first one captures general managerial talent, and the second appears to capture managerial optimism, risk tolerance, and specific human capital. The results show that the market prices of these attributes have substantial time variations. Finally, the IFE model can estimate the coefficients on time-constant variables, while standard fixed effect model cannot because such variables are absorbed in the fixed effects. The IFE model proposed in the paper may have potential applications in other areas in economics and finance.

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1. Introduction

What personal traits are important in determining executive compensation? The literature has long emphasized the role of managerial talent in explaining executive compensation. For example, Rosen (1981) argues that "superstars" should be paid with a premium because exceptional talent is a scarce resource, and Kaplan and Rauh (2010) and Malmendier and Tate (2009) provide evidence consistent with the economics of superstars. Gabaix and Landier (2008) show that a small difference in managerial talent will translate into considerable compensation differentials through the magnifying role of firm size. Murphy and Zabojnik (2004, 2007) argue that general managerial capital (the managerial ability transferable across companies or industries) is priced with a premium relative to specific managerial capital in the labor market, with Custodio, Ferreira, and Matos (2013) providing the empirical evidence. Recent literature also stresses the role of managerial optimism in determining executive pay. For example, Otto (2014) shows that CEOs with optimistic beliefs receive less total compensation than their peers. In addition, previous studies find that a significant fraction of the variation in executive compensation can be explained by unobserved managerial attributes (i.e., manager fixed effects) (Bertrand and Schoar, 2003; Coles and Li, 2013; Graham, Li, and Qiu, 2012). These unobserved managerial traits may include, for example, managerial ability, personality, social connections, risk aversion, among others.

Attempts have been made in the literature to identify and measure unobserved individual traits. One approach to identify unobserved traits is to construct variables that proxy for these traits.[1] Such an approach often can only be used in a relatively small sample of managers because the data required often need to be manually collected. Another approach, used by Bertrand and Schoar (2003), Coles and Li (2013), and Graham, Li, and Qiu (2012), is to estimate manager fixed effects from the executive pay equation and interpret that these fixed effects may capture economically important managerial traits.[2] This approach implicitly assumes that managerial attributes are fixed over time or are priced constantly in the managerial labor market.

The labor market for executives, nevertheless, may value managerial attributes differently over time. For example, the value of general skills versus specific skills may be different in today's executive labor market than twenty years ago (Custodio, Ferreira, and Matos, 2013; Frydman, 2005, 2007, 2009; Frydman and Saks, 2010; Kaplan and Rauh, 2010; Murphy and Zabojnik, 2004 and 2007). Certain management styles (e.g., optimism, risk tolerance) may be more valuable than others under different economic conditions. That is, we argue that the market value of managerial attributes is influenced by economic, cultural, and technological changes, and thus should be modeled as a dynamic process rather than a constant.

In this paper, we propose and estimate a dynamic empirical model of executive compensation which allows the market valuation of unobserved managerial attributes to vary over time. Our empirical model can also separately identify different unobserved

[1] The studies that adopt this approach include but are not limited to Custodio, Ferreira, and Matos (2013) (construct an ability index that measures CEO general ability), Graham, Harvey, and Puri (2013) (obtain managers' risk aversion and optimism using psychometric tests conducted through surveys), Green, Jame, and Lock (2015) (measure managers' extraversion using linguistic algorithms to analyze managers' speech patterns during conference calls), and Otto (2014) (construct optimism measures). These studies then study how the personal traits they measure affect executive pay.

[2] Fee, Hadlock, and Pierce (2013) use exogenous CEO departures to investigate managerial styles in corporate policies.

managerial attributes (for example, talent, optimism, etc.), each of which having its own time-varying market values. The traditional fixed effect model only allows for one manager fixed effects, and thus the manager fixed effects may contain a variety of managerial traits.[3] Specifically, we model unobserved manager characteristics as a linear factor model, where a vector of time-invariant fixed effect parameters (manager characteristics) is multiplied with a time-variant vector of latent factors that represent the market prices of manager characteristics. Our econometric approach allows us to jointly consistently identify one or more unobserved manager effects and their corresponding market prices.

Because the time-invariant fixed effects and the time-variant market prices are interacted (i.e., multiplied) in the model, the econometric literature refers to this model as the Interactive Fixed Effects (IFE) model (Bai, 2009). Our estimation strategy is based on the latest development in econometric theory of factor models. The methodology can be used to determine the optimal number of managerial fixed effects to be included and then empirically identify these managerial fixed effects and their market prices.

The empirical results based on this model show that two managerial fixed effects are economically and statistically important in influencing executive pay. We find that the first managerial fixed effect is correlated with the variables that proxy for general skills and talent. The fixed effect is positively and significantly correlated with the general ability index (GAI) constructed by Custodio, Ferreira, and Matos (2013). This index measures skills transferable across companies or industries. We also find that

[3] The three-way fixed effect model in Graham, Li, and Qiu (2012) and Coles and Li (2012, 2013) includes firm fixed effects, manager fixed effects, and time fixed effects. That is, there is only one fixed effects for each of the unobserved firm, manager, and time characteristics. In contrast, our model allows for multiple manager fixed effects for unobserved managerial characteristics.

managers with a higher value in the first fixed effect achieve a higher level of education, are more likely to CEOs, are more likely to be “superstar” managers, and work in larger and better performing companies.

We argue that the second manager fixed effect could capture managerial overconfidence, risk tolerance, and specific human capital. We find the evidence that the second fixed effect is significantly related to the variables that proxy for managerial optimism and overconfidence. We also find that the managers with a greater value of the second fixed effects are less likely to be female executives, are older, and work in smaller and riskier firms. Moreover, job tenure is positively correlated with the second fixed effect, but has a lower correlation with the first fixed effect. To the extent that tenure proxies for employer-specific human capital (Kambourov and Manovskii, 2009), this result seems to suggest that the second fixed effect may capture specific skills.

Next we study the time evolution of the market prices of the estimated managerial attributes. We find that the market value of talent starts grows since mid-1990s and then declines after the 2008-2009 financial crisis. This is consistent with the rapid growth in executive pay level during the period from late 1990’s to early 2000’s and with the less extreme growth in executive pay since mid-2000s due to enhanced corporate governance. The time-series pattern also seems to be consistent with Frydman and Saks (2010) and Murphy and Zabojnik (2004, 2007), which argue that general managerial skills have become more important. The market price of optimism (the second manager IFE) presents a decline over the sample period from 1992 to 2012, suggesting that the market does not value managerial aggressiveness (e.g., overinvestments, mergers) now as much as twenty years ago. The result is in line with the finding in Otto (2014), who uses the data from 1996 to 2005 and finds that optimistic CEOs receive less total compensation than their peers. To the extent that the second fixed effect captures specific human capital, the declining market price appears to be consistent with Frydman and Saks (2010) and Murphy and Zabojnik (2004, 2007) that specific human capital becomes less important in the labor market.

Overall, we contribute to the literature in several important ways. First, by using the interactive fixed effect model, we are the first to separately identify different unobservable managerial attributes and to estimate how the managerial labor market values these managerial attributes differently over time. The existing empirical literature on executive compensation models the level of executive pay as a function of firm characteristics, such as firm size and performance, and as a function of managerial characteristics, such as job tenure and gender. Firm characteristics are in general observable and thus their effects are easily estimated. Managerial characteristics, such as managerial ability and risk aversion, are often unobservable. Graham, Li, and Qiu (2012) find that unobserved managerial attributes play an important role in determining the level of executive compensation. The conventional way to incorporate the unobserved managerial characteristics into the model is to treat them as fixed model parameters (fixed effects model).[4] This approach implicitly assumes that managerial characteristics and their market values are time invariant. The violation of this assumption, however, will lead to inconsistent model estimation (Bai, 2009). The interactive fixed effect model relaxes the above assumption and permits a more realistic assumption that market values of managerial fixed effects change over time.

[4] See, for example, Aggarwal and Samwick (1999), Coles and Li (2012, 2013), Garvey and Milbourn (2003), Graham, Li, and Qiu (2012), and Perry and Zenner (2001).

Second, the IFE model allows us to estimate the coefficients on time-invariant independent variables while the conventional fixed effect model does not. Time-invariant variables are common in the regressions with person-level characteristics being independent variables. These variables include, for example, gender, race, and education. The standard fixed effects model cannot estimate the coefficient of time-invariant variables because these variables will be absorbed into the time-invariant individual fixed effects. The IFE model, however, provides a way to remove omitted variable bias by controlling unobserved firm and manager heterogeneity and also obtain consistent parameter estimates for time-variant and time-*invariant* independent variables.

Third, our methodology is new not only to the executive compensation literature specifically but also to the empirical corporate finance literature generally. Besides executive compensation, the interactive fixed effect model in this paper can be used in other areas of corporate finance. In the growing literature on how unobservable managerial attributes affect various corporate outcomes, such as Coles and Li (2012, 2013), the market value of unobserved managerial ability is considered constant over time. Our dynamic model can be applied to these studies. The results from the model may be of significant interest to the academic community by shedding light on the under-researched topic on the time evolution of market values of managerial attributes.

Fourth, the use of linear factor models in the fixed effects model is relatively new in the econometrics literature. The conventional fixed effects model developed in Mundlak (1978), MaCurdy (1981), and Chamberlain (1984) has been widely adopted as a treatment of unobservable individual heterogeneity in panel data. The first attempt to introduce time variability to the individual effects is proposed by Holtz-Eakin, Newey, and Rosen (1988), who use a vector autoregressive model to allow for time-variant individual effects (see also Chamberlain, 1984). Chamberlain (1992) accommodates time-variant individual effects using a more general approach: random coefficient model. Ahn, Lee, and Schmidt (2001) is the first to use a factor model to analyze individual unobserved characteristics, and their model is further extended by Bai (2009) for the case of multifactor models. Because Bai's (2009) econometric methodology is flexible and its assumptions are realistic, we use Bai's (2009) setup to model executive compensation. Also, Bai's method can be applied to unbalanced panel data, which is often the type of data available in corporate finance studies.

The rest of the paper proceeds as follows. The next section describes our empirical model and estimation methodology. Section 3 discusses the data used in the paper. Main results are given in Section 4. The last section concludes.

2. Model Description and Estimation Methodology

2.1 Model Description

We start with the wage equation (Equation 2.1) in Abowd, Kramarz, and Margolis (1999) and the executive compensation equation (Equation 4) in Graham, Li, and Qiu (2012). Specifically, these studies represent the employee's full-year compensation as

$$Ln(y_{it}) = X_{it}\beta + W_{jt}\gamma + \phi_j + \alpha_i + \mu_t + \varepsilon_{it} \quad (1)$$

Equation (1) shows that the logarithm of an executive's of compensation, $Ln(y_{it})$, is the sum of the market valuation of his or her personal characteristics $X_{it}\beta + \alpha_i$ (observable and unobservable), the specific compensation policies $W_{jt}\gamma + \phi_j$ chosen by the executive's employer, time effects in compensation μ_t, and a noise term ε_{it}.

Our model is based on Equation (1), but allows for time variability in personal characteristics α_i. Specifically, we interpret this time variation in personal characteristics as the time-variant market price of personal traits, and capture this market price using F_t. Standard models use α_i to capture person fixed effects, but not F_t, and thus implicitly assume that the market values of person fixed effects are constant over time. If the time-variant part of the unobserved heterogeneity is correlated with the regressors, the model without modelling time variation in unobserved heterogeneity may lead to inconsistent parameter estimates. For example, managerial ability may be valued differently under different market conditions and market conditions also affect executive pay directly. Without modelling the market price of managerial ability explicitly, the changing market price will be absorbed in the residuals. This leads to a correlation between the regressors and the residual term.

Without loss of generality, we omit the firm fixed effects ϕ_j and the time effects μ_t to focus our attention on estimating the person fixed effects and their time-variant prices. Our model can be extended to include the firm fixed effects and time effects back in the equation. The main equation we will be estimating is below:

$$Ln(y_{it}) = Y_{it} = X_{it}\beta + W_{jt}\gamma + \theta_i F_t + \varepsilon_{it} \qquad (2).$$

Specifically, we model the time-variant market value of unobserved manager characteristics using a linear multifactor model. Factor loadings θ_i correspond to time-invariant managerial unobserved attributes, and the latent factors F_t represent the market prices of these attributes. Our model allows for multiple factors in F_t, and we can define $\theta_i F_t = \theta_{i1} F_{1t} + \ldots + \theta_{ik} F_{kt}$, where k is the number of factors. Equation (2), combined with the general multi-factor specification of the unobserved individual characteristics, is known as the Interactive Fixed Effect (IFE) model (Bai, 2009).

Interestingly, the commonly used fixed-effects model can be seen as a special case of the IFE model. For example, the model used in Graham, Li, and Qiu (2012) (see Equation 1) can be written as an IFE model with two factors:

$F_t = \begin{pmatrix} 1 \\ \mu_t \end{pmatrix}$ and $\theta_i = (\alpha_i \quad 1)$, which give $\theta_i F_t = \alpha_i + \mu_t$.

More importantly, Bai (2009) points out that the usual fixed-effect estimation methods, such as the least square dummy variable (LSDV) and the within-group transformation approaches, cannot be used in the presence of interactive fixed effects. The LSDV method cannot be used when individual fixed effects interact with time-variant market values. The within transformation cannot completely remove the interactive fixed effects in equation (2). We, as a result, introduce the estimation method of the IFE model in the next section.

2.2 Estimation Methodology

According to Bai (2009), we can obtain consistent estimates of the parameters in Equation (2) by minimizing the least squares objective function:

$$SSR(\beta, \gamma, \theta, F) = \sum_{i=1}^{N} \left(Y_i - X_i\beta - W_j\gamma - \theta_i F\right)' \left(Y_i - X_i\beta - W_j\gamma - \theta_i F\right) \qquad (3)$$

, where $Y_i = [Y_{i1}, Y_{i2}, \ldots, Y_{iT}]'$, and X_i and W_j are similarly defined. Bai (2009) shows that under certain conditions, the parameters $\beta, \gamma, \theta,$ and F that jointly minimize the objective function (3) are consistent estimates of the model parameters (see Bai (2009) for details).

Fortunately, the complicated minimization problem described above can be divided into simpler parts. The basic idea is that we can estimate β and γ, assuming a given set of factors F and fixed effects θ. Similarly, we can estimate F and θ, assuming a given set of β and γ. Specifically, following Bai's (2009) iterative procedure, we first estimate β and γ in $Y_{it} = X_{it}\beta + W_{jt}\gamma + \varepsilon_{it}$, ignoring the interactive effects $\theta_i F_t$ and using the usual ordinary least squares approach. Second, we use the residuals $\hat{e}_{it}$ of the OLS regression from the first step to estimate the following factor model:

$$\hat{e}_{it} = \theta_i F_t + \eta_{it}. \qquad (4).$$

Here we can estimate factors $\hat{F}_t$ and loadings $\hat{\theta}_i$ by standard factor analysis methods such as principal component factors. Third, using the estimated factors and loadings, we transform the dependent variable Y_{it} into $Y_{it} - \hat{\theta}_i \hat{F}_t$. We employ this new dependent variable to estimate β and γ, using OLS and ignoring interactive effects again. That is, we estimate the following equation:

$$Y_{it} - \hat{\theta}_i \hat{F}_t = X_{it}\beta + W_{jt}\gamma + \varepsilon_{it}. \qquad (5).$$

Fourth, we obtain new residuals and start a new iteration by estimating Equations (4) and (5) again. We continue such iteration until all the estimated parameters are stable. Formal details on this iterative procedure can be found in Bai (2009), and some practical implementation issues on the estimation are provided in Appendix B.

3. Data

Our sample consists of a manager-firm matched panel dataset from 1992 to 2012. The data on firm characteristics and stock returns over the entire sample period comes from Compustat and CRSP. The data on executive compensation and managerial characteristics of S&P 1500 firms from 1992 to 2012 is from ExecuComp. We merge the manager-level data with the firm-level variables from Compustat and the stock information from CRSP. This dataset allows us to track through time the highest paid executives in firms covered by ExecuComp from 1992 to now.

We follow prior research in selecting regressors X_i and W_j that affect executive pay in the model (Core, Guay, and Larcker, 2008; Core, Holthausen, and Larcker, 1999; Graham, Li, and Qiu, 2012; Murphy, 1999, and Rose and Shepard, 1997). These regressors include firm-level variables such as firm size, growth, stock returns, accounting returns, and return volatility, and manager-level variables such as managerial tenure and whether the manager is a CEO. Our main dependent variable is log(total compensation), where total compensation is ExecuComp data item TDC1 (measured in $thousands) and is comprised of salary, bonus, other annual, total value of restricted stock granted, total value of stock options granted (using Black-Scholes), long-term incentive payouts, and all other total.

4. Empirical Results

This section discusses the results from using the interactive fixed effect model to determine the level of executive compensation. We first present the IFE model estimation results of fixed effects $\hat{\theta}_i$ and the prices $\hat{F}_t$. We then explore the economic importance of the IFE model by comparing its results with those obtained from the OLS and standard fixed effect model. After that, we provide economic interpretations of the estimated fixed effects $\hat{\theta}_i$. We finally analyze the dynamics of prices $\hat{F}_t$.

Specifically, we estimate the parameters β, γ, θ, F in equation (2) following the iterative method explained in Section 2.2. We also use the test in Bai and Ng (2002) to estimate the optimal number of factors (see Appendix B for details) and find that two factors (that is, two interactive fixed effects) are statistically significant. We perform the estimation based on two samples. In Sample 1, we include only executives with ten or more years of data. We impose this constraint to ensure that the IFE model can be properly identified and estimated.[5] Intuitively, this is similar to the standard fixed effect model, in which we require a sufficient number of observations for each individual so that we can have a good estimate of individual fixed effects. The sample based on this constraint includes about 4500 managers who are working or have worked in roughly 1900 different companies. For robustness, in Sample 2, we relax the constraint by including all the managers with five (rather than ten) or more years of data in the regressions. This increases the number of sample managers to 16,000 and the number of firms to 3,000 or so. Including more managers will improve the consistency of estimated factors F_t. However, reducing the minimum number of years of observations for each manager will decrease the reliability of estimated loadings θ_i.

4.1 Estimates of Fixed Effects and Their Prices from the IFE Model

We start by reporting the descriptive statistics of the estimated θ_i and F_t. We standardize the fixed effects (i.e., factor loadings) in Table 1 Panel A to have a mean of 50 and a standard deviation of 25. This standardization is to help us to compare the numbers estimated from Sample 1 with those from Sample 2, and to fairly compare the factor prices on different fixed effects. We can interpret this normalization as that a manager with an average level of a given attribute has an average fixed effect of 50 and a

[5] The number of time series observations for each manager is only important in the estimation of the factor loadings (θ_i).

standard deviation of the fixed effects of 25.[6] Based on the normalization, around 95% of the fixed effects range between 0 and 100 (i.e., within two standard deviations).

Table 1 Panel A shows that the two fixed effects θ_1 and θ_2, which vary across managers but are fixed over time, are quite symmetrical around the mean, with the mean and the median being almost the same for both samples. In Sample 2, the range of the fixed effects is much larger than that in Sample 1. A significant number of managers have fewer than ten observations in Sample 2, which makes the estimates of individual fixed effects noisy. We, therefore, focus on the fixed effects from Sample 1 when further interpreting our results. We also present the results from Sample 2, which serve as robustness checks.

The table also shows that the two fixed effects have generally low correlations with each other (0.08), suggesting that the two fixed effects capture distinctly different attributes. In addition, the estimates of the fixed effects from both Sample 1 and Sample 2 are almost perfectly correlated with each other (0.99).

[Table 1 here]

Table 1 Panel B reports the summary statistics of factor prices, which are the same across managers but vary over time. Recall that in our model specification in Equation (2), executive compensation is defined in the logarithm form. As a result, the percentage change in the average compensation given each additional unit of the factor loading (recall that the factor loadings are normalized and thus the unit is comparable) is equal to $\exp(F_t)$-1. In order to better interpret the results, we report the descriptive statistics of $\exp(F_t)$-1 rather than F_t in Table 1 Panel B.

[6] This normalization eases the interpretation and does not affect the estimation results.

The average value for factor 1 in Sample 1 is 2.81%, indicating that managerial compensation increases by an average of 2.81% when the first factor loading increases by one unit. Recall that in Table 4 Panel A, the standard deviations of the factor loadings are 25. One standard deviation difference in the first managerial attribute is thus associated with the change in executive compensation of 70% (25×2.81%). In other words, all else equal, by comparing a manger who has an average attribute (e.g., ability) with one who has the attribute with one standard deviation higher, the managerial labor market values the latter 70% higher in terms of the pay offered.

The economic effect of factor price 2 is on average smaller, with one standard deviation change in the second managerial attribute being related to the change in executive pay of 1.5% (25×0.06%). The standard deviation of factor 1 is 0.22%, smaller than that of factor 2, 1.73%. This implies that the market value of attribute 2 has a much larger time series variation than that of attribute 1. Finally, as explained earlier, the estimates using Sample 2 are noisier than those using Sample 1, and thus we focus on results from Sample 1.

Table 1 Panel B further shows that the two factor prices are negatively correlated with each other, suggesting that the managerial labor market values different managerial traits at distinct prices. The estimates from the two samples are highly correlated with each other (with correlation coefficients of 0.99).

4.2 Economic Importance of the IFE Model

To evaluate the economic importance of the IFEs in explaining executive compensation, in Table 2 we compare the IFE results with the results from the OLS and standard Fixed Effects regression models (using Sample 1). Regression (1) is an OLS regression, and Regression (2) is the regression with manager fixed effects (MFE). The results from both regressions are similar to those in Graham, Li, and Qiu (2012).

In order to compare the IFE result with the OLS and MFE results, we estimate the following auxiliary regression:

$$Y_{it} = X_{it}\beta + W_{jt}\gamma + \hat{\theta}_{1i}\hat{F}_{1t}\delta_1 + \hat{\theta}_{2i}\hat{F}_{2t}\delta_2 + \varepsilon_{it} \qquad (6)$$

, where $\hat{F}_t$ and $\hat{\theta}_i$ are the factors and loadings estimated from the IFE model with two fixed effects (i.e., the estimates discussed in the previous section). Equation (6) is different from equation (5) in that $\hat{\theta}_i\hat{F}_t$ is moved to the right hand side of the equation and the coefficient δ is added. Compared with the OLS and MFE regressions, Equation (6) has the same dependent and independent variables, and thus estimated coefficients and specially adjusted R-squared are comparable. The coefficients $\delta_1$and δ_2 should be equal to one when two interactive fixed effects are used in the regression.[7]

[Table 2 here]

In Column (3) of Table 1, we report the estimates of the IFE model including only the first IFE. This column improves the adjusted R-squared from 0.53 in model (1) to 0.75. When we add one more IFE in Column (4), the coefficients on $\theta_i F_t$ (δ) become one. The adjusted R-squared is 0.85, a further improvement compared with the model with one IFE only (Column 3). When we include a total of three IFEs in the model (results unreported and available upon request), the improvement in adjusted R-squared is minimal (less than 0.01), and thus we are confident that the Bai and Ng (2002) method

[7] Note that the iterative method in Section 2.2 will give the final estimates of $\beta, \gamma, \theta_i, F_t$ by estimating $Y_{it} - \hat{\theta}_i\hat{F}_t = X_{it}\beta + W_{jt}\gamma + \varepsilon_{it}$ iteratively to arrive at stable parameter estimates. These β and γ estimates are close to the β and γ estimates obtained from Regression (6) (reported in Tables 2-3), and the estimates are almost identical when the estimated δ is very close to one.

gives us a good optimal number of IFEs: two. Comparing the model with two IFEs and the manager FE model, we find that the model with two IFEs has a larger adjusted R-squared (0.85 versus 0.77).

Furthermore, when we add firm fixed effects to the 2-factor IFE model in Column (5), there is no gain on the model fit. We test for the presence of firm fixed effects in all the models using standard Hausman tests and the tests show that firm fixed effects can be eliminated after the inclusion of two interactive fixed effects. As a result, we use Column (4) as our main regression specification and the estimates from this specification are used in subsequent empirical analysis in the paper.

The estimated $\hat{\beta}$ coefficients in the IFE model with two factors are qualitatively similar to those in the MFE model, with the exception of the coefficient on stock return volatility. It is interesting to see that the coefficient on stock return volatility is significantly positive in the OLS, MFE, and one-factor IFE models, but turns significantly negative in the 2-factor IFE model and the 2-factor IFE with firm FE model. The opposite sign perhaps indicates that the second interactive fixed effect captures managerial risk attitude, which is correlated with both managerial pay level and stock return volatility. The positive relation between return volatility and pay level disappears after managerial risk attitude is incorporated by the second interactive fixed effect. The negative relation between return volatility and pay level in the 2-factor IFE models could be consistent with the risk-incentive trade off implied by the standard principal agent model, which states that risk and pay incentive provided to managers should be negatively related.

Finally, an important benefit of the IFE model relative to the standard fixed effect model is that the IFE model can estimate the coefficients for time-invariant variables. In the standard fixed effect model, however, the coefficients on time-invariant variables are absorbed into the fixed effects and thus cannot be estimated. For example, in Table 2, the manager fixed effect model fails in estimating the coefficient on the time-invariant CEO gender (the female indicator), while the IFE model estimates the coefficient on the female indicator to be -0.25. That is, ceteris paribus, female executives make 22% less than male executives.[8]

Results in Table 2 are based on Sample 1, i.e. with executives with ten or more years of data. In Table 3 we report results using Sample 2, i.e. with managers with five or more years of data. Results are very similar.

[Table 3 here]

Table 4 compares the explanatory power of the various regression models we use in the study. The table shows that regressing the dependent variable on the observable determinants together with the two interactive fixed effects improves the model fit significantly, compared with the OLS model and the model with only one interactive fixed effects. The first IFE alone has a much greater explanatory power compared with the second IFE alone (0.43 versus 0.05). Nevertheless, the economic significance of the second IFE can be observed by the large increase in explanatory power of the model when this effect is included in the full model. For example, the explanatory power increases from 0.75 in the model with observable determinants and one IFE only to 0.85

[8] Since the dependent variable is the logarithm of executive pay, the effect of female is exp(-0.25) = 0.78. That is, female executives earn 78% of the male executives' compensation on average.

in the model with observable determinants and two IFEs. This could be due to that the two IFEs are complementary to each other.[9]

[Table 4 here]

Overall, the interactive fixed effect model offers several advantages over the methodologies employed in the extant studies. First, the IFE method may correct the omitted variable bias and provide consistent model estimates, to the extent that the omitted variables cannot be captured by the OLS or the standard fixed effect model but are captured by the interactive fixed effects. For example, the IFE model used in the paper includes two fixed effects, each having a time-variant market price. To the extent that such IFE model specification picks up how the managerial labor market values managerial attributes, the IFE model may offer a way to estimate the model coefficients consistently. Second, using the IFE model, we can estimate the effects of time-invariant regressors (e.g., gender, race) consistently in addition to correcting for omitted variable bias. The effects of time-constant variables, however, will be absorbed and cannot be estimated in standard fixed effect models. Third, the IFE model provides increased explanatory power in explaining executive compensation, highlighting the importance of unobserved managerial attributes. Finally, the IFE model allows us to estimate multiple dimensions of managerial fixed effects and their corresponding market prices, which are not available in standard fixed effect models (which include only one dimension of managerial fixed effects).

4.3 Interpreting the Interactive Fixed Effects

[9] We show in later sections that the first IFE may be interpreted as managerial talent while the second IFE is related to managerial overconfidence. It is possible that managerial overconfidence alone may play a small role in explaining the executive pay. However, the combination of managerial overconfidence with managerial ability and other attributes may explain executive pay significantly.

The previous section suggests that the two interactive fixed effects $\theta_i F_t$ identified by the IFE model have substantial explanatory power in determining the level of executive pay. In this and the next sections, we investigate what these interactive fixed effects are representing. We separately examine the components of IFE: θ_i (this section) and F_t (Section 4.4). We interpret factor loadings θ_i as time-constant managerial attributes, and factors F_t as the corresponding market prices of the time-constant attributes. In other words, the market could value managerial attributes, such as ability, overconfidence, risk aversion, and aggressiveness, differently over different time points and these differences in values are reflected in the pay received by executives.

The literature (see, for example, Custodio, Ferreira, and Matos, 2013; Goel and Thakor, 2008; Graham, Harvey, and Puri, 2013; Kaplan, Klebanov, and Sorensen, 2012; and Murphy and Zabojnik, 2004, 2007) has shown that various managerial traits are important in determining corporate policies. These traits include but are not limited to: 1) managers' talent and ability; 2) managerial overconfidence, optimism, and risk tolerance; and 3) managerial rent extraction abilities. In this section we describe each of these traits and provide suggestive evidence on whether these traits are captured by our IFEs.

4.3.1 Managerial Talent

Theoretical studies have long suggested that talent is a key factor affecting compensation. For example, Rosen (1981), in his theoretical study on the compensation of "superstars", argues that the differences in compensation can partly be attributed to differences in talent because exceptional talent is a scarce resource. Gabaix and Landier (2008) develop a competitive equilibrium model to explain CEO compensation. In their model, a small difference in managerial talent, magnified by firm size, translates into considerable compensation differentials. Murphy and Zabojnik (2004, 2007) argue that general managerial capital (the managerial ability transferable across companies or industries) is priced with a premium relative to specific managerial capital in the labor market over the past decades.

Empirically, Kaplan, Klebanov, and Sorensen (2012) analyze what CEO characteristics and abilities are important in firms involved in private equity (PE) transactions from 2000 to 2006. They find that managers' general ability is an important CEO characteristic determining firm performance. Higher performance, we argue, will be related to higher pay. The empirical evidence provided by Custodio, Ferreira, and Matos (2013) supports the theory in Murphy and Zabojnik (2004, 2007). Specifically, Custodio, Ferreira, and Matos (2013) show that CEOs with higher managerial general skills earn a compensation premium relative to those with only specific skills.

We employ two tests to evaluate whether our IFEs are associated with managerial talent. The first test is to correlate our IFEs with the manager-level variables that in theory should be related to managerial talent. We use the general ability index (GAI) developed by Custodio, Ferreira, and Matos (2013). The general ability index measures managerial general skills that are transferable across firms and industries. In addition, education is often used in the literature as a proxy for talent (Abowd, Lengermann, and McKinney, 2003; Becker, 1993; Mincer, 1974). We thus predict that talent will be correlated with the education level received by managers. We use three proxies for education. Education 1 is the highest level of education achieved by managers, Education 2 is the number of years of education, and MBA is an indicator variable equal to one for MBA-educated managers. In addition, CEOs may have higher abilities than non-CEO executives, and thus we examine the indicator variable that takes the value of one if the manager is a CEO. Moreover, to examine whether “superstar” managers with exceptional talent are captured by the interactive fixed effects, we construct two variables that measure how famous a manager is (considering that superstar managers may be more famous). The first one, Fame wiki, is an indicator that equals one if a manager has a Wikipedia page. The second variable, Fame picture, is an indicator equaling one if a picture of the manager is displayed as the first result of a Google search.

Table 5 Panel A shows the correlations between the two IFE loadings and the manager-level variables mentioned above. The first IFE loading θ_1 is strongly correlated with the general ability index, with a correlation coefficient of 0.23. All the three education variables, the CEO indicator, and the two fame variables are significantly and positively related to θ_1. Overall, the result provides suggestive evidence that the first interactive fixed effect θ_1 captures managerial talent. Interestingly, these variables, although significantly correlated with θ_1, have low, and in most cases, insignificant correlations with the second IFE loading θ_2. This suggests that the second IFE loading seems to reflect the attributes distinct from managerial talent (we will explore the second IFE in detail in the next section).

[Table 5 here]

Our second test relates the IFEs with firm characteristics. According to the competitive assignment theories in Tervio (2008) and Gabaix and Landier (2008), even though all firms want to hire the most able individuals, it is the companies where the ability is the most productive that can pay the most for the scarce high ability and thus attract the best human capital. This indicates that the best managers match with the largest firms. As a result, if θ_1 reflects managerial talent, then we should observe that θ_1 is positively related to firm size. In addition, as shown in Kaplan, Klebanov, and Sorensen (2012), managerial talent should be positively associated with firm performance. In Table 5, Panel B, the correlations confirm that the first IFE is indeed positively correlated with firm size and stock returns. We also find that the first IFE is positively related to return volatility, investment, and R&D, which is in line with the evidence in Custodio, Ferreira, and Matos (2015) that generalist mangers are more tolerant for risking failure and that they spur corporate innovation.

[Table 6 here]

In Table 6, we sort IFEs by quartiles and report the mean values of the variables (such as generable ability index, firm size, etc.) for managers that fall into each quartile of IFEs. This strategy will avoid the problem that the correlations between IFE loadings and other variables examined in Table 5 are caused by non-linearity or outliers. We use Sample 1 in Panels A and B for θ_1 and θ_2 respectively, and Sample 2 in Panels C and D. Table 6 confirms our previous evidence that managers with a larger θ_1 have significantly higher general ability, tend to be CEOs, are more famous, and work in companies that are larger and have higher stock returns. Managers' education levels monotonically increase with θ_1, and the differences between the fourth and the first quartiles are significant in Sample 2 (Panel C). Overall, the results in Table 6 provide further suggestive evidence that the first interactive fixed effect may capture managerial ability.

4.3.2 Managerial Optimism, Risk Tolerance, and Specific Human Capital

In this section we argue that our second IFE θ_2 could capture managerial attributes related to overconfidence, optimism, risk tolerance, and specific human capital.

Optimism and overconfidence have been well studied in the psychology literature (see, e.g., Taylor and Brown, 1988) and have lately received more attention in economics and finance.[10] Otto (2014) studies the effect of optimism on CEO compensation contract, and shows that optimist CEOs receive smaller stock option grants, fewer bonus payments, and less total compensation than their less optimist peers. The intuition is that the principal can compensate an optimistic agent with fewer incentive claims because an optimist overestimates the claims' future payoffs.[11]

In addition, optimism is related to risk tolerance, as suggested by Goel and Thakor (2008), who show that overconfident managers tend to make riskier project choices. Empirically, using the data from psychometric tests, Graham, Harvey, and Puri (2013) find that CEO optimism and managerial risk-aversion are related to corporate financial policies, and that risk averse CEOs are less likely to be compensated with performance-based pay. This is because it is more costly to provide pay-performance incentives to more risk-averse managers.

We follow a similar strategy as in the previous section to evaluate if our second IFE captures managerial optimism, by showing the correlations between the IFE loadings with the variables that proxy for managerial overconfidence and optimism. We adopt two optimism measures that are used in the literature (see, for example, Ahmed and Duellman,

[10] For instance, Malmendier and Tate (2005a&b, 2008) and Malmendier, Tate, and Yan (2011) investigate how CEO overconfidence affects corporate investment and financial policies. Landier and Thesmar (2009) show how entrepreneurial optimism affects the choice of debt maturity. Ben-David, Graham, and Harvey (2013) find that financial executives are overconfident, and overconfident managers follow more aggressive corporate policies by investing more and using more debt financing.

[11] Gervais, Heaton, and Odean (2011) study the effect of overconfidence on compensation theoretically. They consider a model with an overconfident agent who overestimates the precision of a privately available signal regarding the quality of an investment opportunity. If the principal optimally adjusts the agent's pay to this bias, mildly overconfident agents are compensated with less convex contracts, whereas extremely overconfident agents are compensated with more convex contracts.

2013; Campbell, et al., 2011; Hirshleifer, Low, and Teoh, 2012; Hribar and Yang, 2015; Malmendier and Tate, 2005a,b, 2008, 2015; Malmendier, Tate, and Yan, 2011; Otto, 2014). The first measure, Optimism 1, is the LongHolder measure first proposed by Malmendier and Tate (2005a,b). This measure categorizes a manager as optimistic if the manager exercises her options within one year of their expiration date and these options are at least 40% in the money at the end of the preceding year.[12] The second measure, Optimism 2, is a press-based variable of CEO overconfidence. The variable is based on outsiders' perceptions of the managerial optimism, using popular press characterizations.[13] This second measure is first proposed by Malmendier and Tate (2008), and used by Hirshleifer, Low, and Teoh (2012), Hribar and Yang (2015), Malmendier, Tate, and Yan (2011), and Malmendier and Tate (2015), among others.

The results reported in Tables 5-6 show that both measures of managerial optimism are significantly correlated with second managerial fixed effect, θ_2. Optimism 1 is not significantly correlated with the first IFE θ_1. Optimism 2, however, is correlated with the first IFE significantly, and the correlation coefficients are smaller in magnitude compared with the correlations between Optimism 2 and the second IFE. This could be that managers with higher ability are also more likely to become overconfident. The quartile analysis in Table 6 provides further evidence that both optimism measures are significantly related to the second IFE, but not the first IFE.

[12] Managers are classified as overconfident if they exercise options later than the optimal date, hold their options until expiration, or increase their holdings of company stock. The idea is that managers are overconfident if they overexpose themselves to the idiosyncratic risk of their firms.
[13] One concern with the option-based measure is the potential endogeneity because option exercising is endogenously determined by managers. Another concern is that option exercising may proxy for inside information. The press-based measure, however, is less likely to have the above issues (Hirshleifer, Low, and Teoh, 2012). We thus also use the press-based measure in the paper.

In addition to the variables that directly proxy for managerial optimism, we also investigate other variables that may be correlated with optimism. The literature shows that males tend to be more overconfident than females (e.g., Barber and Odean, 2001). Graham, Harvey, and Puri, (2013) find that male CEOs are more likely to adopt riskier financial policies (such as using more debt) than their female counterparts. The results in Table 5 Panel A and Table 6 Panel D show that the female indicator is negatively related the second IFE, suggesting that the second IFE may capture overconfidence.

Optimism may be related to risk tolerance. For example, Goel and Thakor (2008) show that overconfident managers make riskier project choices and these managers are also more likely to be selected as CEOs. As a result, the second IFE could also capture managerial risk tolerance in addition to optimism. We thus investigate the role of CEO indicator, manager age, and tenure. According to Graham, Harvey, and Puri, (2013), younger CEOs may be bolder. On the other hand, age and tenure can reflect experience, allowing managers to take more risks. Our results in Tables 5-6 show that θ_2 is positively correlated with the CEO indicator, managers' age, and job tenure.[14] This is consistent with that CEOs are more overconfident and risk-tolerant than non-CEOs (Graham, Harvey, and Puri (2013), for example, show that CEOs are more optimistic and risk-tolerant than the lay population). The results are also consistent with that older and more experienced managers are more overconfident and risk-tolerant than younger managers with less experience.

[14] Table 5 also shows that age is positively correlated with the first IFE, but at a much lower correlation compared with that between age and the second IFE. One possible reason could be managers many develop their managerial abilities over time and thus older managers may present higher talent than their younger counterparts, all else equal.

Moreover, job tenure is positively correlated with the second IFE, but has a lower correlation with the first IFE. To the extent that tenure proxies for employer-specific human capital (Kambourov and Manovskii, 2009), this result seems to suggest that the second IFE may also capture specific skills (while the first IFE captures general skills).

Next, we examine whether the IFEs capture managerial optimism, based on the relations between the IFEs and firm-level characteristics. Goel and Thakor (2008) show that overconfident managers tend to make riskier project choices. Malmendier and Tate (2005) find that overconfident managers overinvest when they have abundant internal funds, but curtail investment when they require external financing. Hirshleifer, Low, and Teoh (2012) find that firms with overconfident managers have greater return volatility, invest more in innovation, and obtain more patents and patent citations. Ben-David, Graham, and Harvey (2013)'s empirical results also suggest that overconfident managers follow more aggressive corporate policies, such as investing more. The results in Table 5 Panel B and Table 6 find that θ_2 is positively correlated with stock return volatility, investment as measured by capital expenditure, and R&D investment. Interestingly, Tables 5-6 show that θ_2 is negatively related to firm size. This could be due to that smaller companies are riskier (with higher return volatilities) and more overconfident and risk-tolerant managers are sorted into such companies. Also, specific human capital may be more valuable in smaller companies.

4.3.3 Managerial Rent Extraction

We have shown that the first IFE captures managerial talent and ability and the second IFE captures managerial overconfidence and optimism. The literature show that executive compensation can be related to managers' ability to extract rents (for example, Bertrand and Mullainathan 2001; Bebchuk and Fried 2004; and Kuhnen and Zwiebel 2008). According to this view, poor corporate governance allows managers to skim profits from the firm. Rent extraction could be correlated with managerial general and execution abilities, overconfidence, and risk tolerance. For example, talented managers may skim more profits because they can better hide their opportunistic behavior. Overconfident managers may extract more rent because they believe that they will not be caught. Also, aggressive managers may take more risk in extracting rent.

To exclude the possibility that our IFEs capture rent extraction rather than managerial abilities and risk attitude, we examine the relation between IFEs and corporate governance. If the IFEs capture rent extraction rather than managerial talent and overconfidence, then we should see that IFEs are larger in firms with weaker corporate governance. We use the fraction of inside directors, CEO chair indicator, number of blockholders, blockholder indicator, and institutional ownership to measure corporate governance. Our unreported results (available upon request) show that the correlations between IFEs and corporate governance do not present consistent patterns, suggesting that IFEs possibly do not capture rent extractions in a systematic way.

4.3.4 Interactive Fixed Effects Compared with Standard Manager Fixed Effects

We also compare the estimates from the IFE model with the manager fixed effects in Graham, Li, and Qiu (2012). Graham, Li, and Qiu (2012) interpret the manager fixed effects estimated from their three-way fixed effect model as a mix of various managerial attributes, which include, for example, managerial talent and aggressiveness. At the bottom of Table 5 Panel A, we present the correlations between IFE loadings and the manager fixed effects estimated from the three-way fixed effect model. The correlations show that the first interactive fixed effect is correlated with the managerial fixed effects from Graham, Li, and Qiu (2012), with the correlation coefficients being 0.3-0.4. The second interactive fixed effect is weakly correlated with the managerial fixed effects from Graham, Li, and Qiu (2012), with the correlation coefficients being around 0.05. The correlations suggest that the two IFEs estimated by the IFE model possibly reflect some economically important attributes which cannot be captured by the standard three-way fixed effect model in Graham, Li, and Qiu (2012).

4.4 The Dynamics of the Prices of Managerial Attributes

In this section, we examine time-variant factors F_t, which represents how the managerial labor market prices the time-invariant managerial traits θ_i. Given the results in the previous sections, we interpret the first factor F_{1t} as the market price of managerial talent and ability, and the second factor F_{2t} as the market price of managerial optimism, risk tolerance, and firm specific skills.

To examine the evolution of the factors over time, we plot time-series graphs of the two factors in Figures 1-2. The factor in Figure 1, representing the market valuation of “talent”, is the percentage increase in managers’ compensation for a one unit increase in talent, which is scaled to a mean of 50 and a standard deviation of 25 and mostly takes the values from 0 to 100. The results suggest that the market value of talent starts to grow in mid-1990s and the value reaches the highest in early 2000’s. The price then declines after the 2008-2009 financial crisis. This is consistent with the rapid growth in executive pay level during the period from late 1990’s to early 2000’s and with the less extreme growth in executive pay since mid-2000s due to enhanced corporate governance. The time-series pattern also seems to be consistent with Murphy and Zabojnik (2007) and

Frydman and Saks (2010), which argue that general managerial skills have become more important than specific skills in the past thirty years. In addition, as shown in Figure 1, the market value of talent moves closely with the market represented by the S&P500 index.[15] These results are consistent with that talented managers are valued more in better market. It is also consistent with that the same number of option grants (as a large proportion of total executive compensation) is worth more in a stronger market.

[Figure 1 here]

In Figure 2, we plot the market valuation of managerial optimism. The plot shows a decline over the sample period from 1992 to 2012, suggesting that the market does not value managerial aggressiveness now as much as twenty years ago. As also shown in Figure 2, we find that the U.S. Consumer Confidence Index from the OECD presents a pattern similar to the price of optimism.[16] In other words, the managerial labor market values managerial optimism more when the market sentiment is higher, and less when the sentiment is lower.

Another interesting result from Figure 2 is that after the year 2000, the percentage increase on manager's compensation for a unit increase in optimism turns from positive to negative. This implies that optimistic managers will on average receive less compensation than pessimist managers. The result appears to be aligned with the finding in Otto (2014), who use the data from 1996 to 2005 and find that companies can take advantage of optimistic agents by appropriately adjusting their compensation contracts and provide them with less total compensation than their peers.

[15] The correlation of factor 1 with SP500 is 0.62 for sample 1 and 0.75 for sample 2. The correlations between the changes (i.e., returns) in both variables are also significant.

[16] The correlation coefficient is 0.70 for sample 1 and 0.69 for sample 2 in levels. It is also significant in changes.

[Figure 2 here]

In order to better provide an economical interpretation of the effects of our IFE on compensation, in Figure 3 we plot the difference in predicted pay (fitted values of the model) between a talented CEO (with the first managerial attribute being one standard deviation higher than the average level) and an average CEO. The figure also shows the difference in predicted pay between an overconfident CEO (with the second managerial attribute being one standard deviation higher than the average level) and an average CEO over the sample period. The figure shows that talented CEOs earn much higher than average CEOs. The gap in the pay has been climbing since 1990s and starts to decrease after the financial crisis. For example, in 2012, a talented manager earns 1,750,000 dollars more than an average manager. In addition, an overconfident CEO earns more than an average CEO by approximately 500,000 dollars per year in the first half of 1990s. Starting in early 2000s, overconfident CEOs earn less than the average CEOs and the gap widens in the past decade. In 2012, overconfident CEOs earn about 850,000 dollars less than average CEOs.

[Figure 3 here]

5. Conclusions

In this paper, we introduce time variation in the market valuation of unobserved managerial attributes to standard empirical models of executive compensation. Our model suggests that the following managerial attributes are important in explaining executive pay: managerial talent, optimism, and risk attitude. Our results show that the market values for these attributes vary over time substantially, and justify the need to incorporate interactive fixed effects into the regression of executive pay. Our results are in line with the latest development in the compensation literature, which shows that general talent is priced in manager compensation but specific skills are not as valued now as before, and that optimist managers receive smaller compensation than their peers.

Our modeling strategy, based on the latest developments in econometric theory of factor models, are new to the executive compensation literature specifically and the empirical corporate finance literature generally. The model proposed in the paper may have potential applications in a number of areas in economics and finance.

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Table 1

Descriptive Statistics of Estimated Interactive Fixed Effects

The table presents descriptive statistics of the estimated interactive fixed effects. Panel A contains the statistics of fixed effects (i.e., factor loadings) θ_i, and Panel B contains the statistics of prices (i.e., factors) F_t. Sample 1(2) includes executives with 10 (5) or more years of data. In Panel A, fixed effects are standardized to have a mean of 50 and a standard deviation of 25. In Panel B, the numbers are not standardized. However, because executive compensation is defined in the logarithm form in the regressions, the percentage change in the average compensation for each additional unit of the fixed effects (note that the factor loadings are normalized and thus the unit is comparable) is equal to $\exp(F_t)$-1. We thus report the descriptive statistics of $\exp(F_t)$-1 rather than F_t in Panel B.

Panel A: Descriptive Statistics of Fixed Effects $\boldsymbol{\theta_i}$

	Sample 1 (managers with ≥10 years of data)			Sample 2 (managers with ≥5 years of data)		
	θ_1	θ_2		θ_1	θ_2	
Mean	50	50		50	50	
Median	49.57	49.66		50.99	50.80	
Standard Deviation	25	25		25	25	
Minimum (before standardization)	-140.59	-72.46		-506.30	-516.58	
Maximum (before standardization)	136.92	237.831		354.10	337.53	
% of managers at the mean	8.39%	8.77%		13.84%	14.69%	
% of managers between 0-100	96.39%	95.50%		96.14%	95.87%	
Number of managers	4492	4492		15940	15940	
Correlations						
θ_1, Sample 1	1					
θ_2, Sample 1	0.08	1				
θ_1, Sample 2	**0.99**	0.11		1		
θ_2, Sample 2	0.13	**0.99**		0.15	1	

Panel B: Descriptive Statistics of Prices F_t

	Sample 1 (managers with ≥10 years of data)			Sample 2 (managers with ≥5 years of data)		
	F_1	F_2		F_1	F_2	
Mean	2.81%	0.06%		5.99%	0.31%	
Median	2.90%	0.38%		6.16%	-0.06%	
Standard Deviation	0.22%	1.73%		0.46%	4.87%	
Range	0.78%	4.73%		1.47%	12.82%	
Minimum	2.34%	-2.15%		5.02%	-5.70%	
Maximum	3.11%	2.58%		6.48%	7.12%	
Correlations						
F_1, Sample 1	1					
F_2, Sample 1	-0.26	1				
F_1, Sample 2	**0.96**	-0.42		1		
F_2, Sample 2	-0.30	**1.00**		-0.46	1	

Table 2

Executive Compensation and Interactive Fixed Effects: Regressions Using the Sample of Executives with 10 or More Years of Data

The table presents the regression results on the determinants of the level of total executive compensation, using the sample of executives with 10 or more years of data, from 1992 to 2012. The sample includes 4,492 executives and 1,876 companies. The dependent variable is *log(total compensation)*. (1) is a pooled OLS regression without firm or manager fixed effects. (2) is the manager fixed effect (MFE) regression. (3) is the interactive fixed effect (IFE) regression with one factor. (4) is the IFE regression with 2 factors. (5) is the IFE regression with 2 factors plus firm fixed effects. All regressions include year dummies. The detailed definitions of all the variables are reported in the Appendix. Heteroskedasticity robust t-statistics are in parentheses. Significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

	(1) OLS	(2) MFE	(3) IFE1	(4) IFE1+IFE2	(5) IFE1+IFE2+FFE
$Log(Assets)_{t-1}$	0.39***	0.26***	0.27***	0.24***	0.24***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Market to $Book_{t-1}$	0.15***	0.10***	0.10***	0.09***	0.09***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Stock $Return_t$	0.23***	0.18***	0.18***	0.15***	0.15***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Stock $Return_{t-1}$	0.11***	0.11***	0.12***	0.10***	0.10***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Return on $Assets_t$	0.56***	0.57***	0.57***	0.52***	0.54***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Return on $Assets_{t-1}$	0.36***	0.37***	0.37***	0.25***	0.27***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Stock Return $Volatility_t$	0.76***	0.13***	0.03	-0.12***	-0.13***
	(0.00)	(0.00)	(0.25)	(0.00)	(0.00)
CEO Chair $Indicator_{t-1}$	0.07***	0.03***	0.01*	0.01***	0.01*
	(0.00)	(0.00)	(0.06)	(0.00)	(0.08)
$Log(Tenure)_t$	0.05***	0.04***	0.03***	0.03***	0.04***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CEO $Indicator_t$	0.82***	0.45***	0.42***	0.29***	0.29***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Female	-0.10**		-0.21***	-0.25***	-0.25***
	(0.04)		(0.00)	(0.00)	(0.00)
Interactive Fixed Effect 1 ($\theta_{i1}F_{1t}$)			0.84***	1.00***	1.00***
			(0.00)	(0.00)	(0.00)
Interactive Fixed Effect 2 ($\theta_{i2}F_{2t}$)				1.00***	0.99***
				(0.00)	(0.00)
Constant	2.78***	3.96***	4.06***	4.21***	5.43***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
N	57,951	57,951	57,951	57,951	57,951
Adj. R-squared	0.53	0.77	0.75	0.85	0.84

Table 3

Executive Compensation and Interactive Fixed Effects: Regressions Using the Sample of Executives with 5 or More Years of Data

The table presents the regression results on the determinants of the level of total executive compensation, using the sample of executives with 5 or more years of data, from 1992 to 2012. The sample includes 15,939 executives and 2,928 companies. The dependent variable is *log(total compensation)*. (1) is a pooled OLS regression without firm or manager fixed effects. (2) is the manager fixed effect (MFE) regression. (3) is the interactive fixed effect (IFE) regression with one factor. (4) is the IFE regression with 2 factors. (5) is the IFE regression with 2 factors plus firm fixed effects. All regressions include year dummies. The detailed definitions of all the variables are reported in the Appendix. Heteroskedasticity robust t-statistics are in parentheses. Significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

	(1) OLS	(2) MFE	(3) IFE1	(4) IFE1+IFE2	(5) IFE1+IFE2+FFE
Log(Assets)$_{t-1}$	0.38***	0.24***	0.34***	0.25***	0.24***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Market to Book$_{t-1}$	0.16***	0.09***	0.15***	0.08***	0.08***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Stock Return$_{t}$	0.23***	0.17***	0.21***	0.15***	0.15***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Stock Return$_{t-1}$	0.08***	0.10***	0.08***	0.09***	0.08***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Return on Assets$_{t}$	0.44***	0.46***	0.45***	0.45***	0.46***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Return on Assets$_{t-1}$	0.30***	0.30***	0.33***	0.22***	0.23***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Stock Return Volatility$_{t}$	0.70***	0.10***	0.52***	-0.08***	-0.10***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CEO Chair Indicator $_{t-1}$	0.06***	0.02***	0.05***	0.01***	0.01**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)
Log(Tenure)$_{t}$	0.03***	0.04***	0.03***	0.04***	0.04***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CEO Indicator$_{t}$	0.87***	0.40***	0.75***	0.27***	0.27***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Female	-0.11***		-0.15***	-0.24***	-0.24***
	(0.00)		(0.00)	(0.00)	(0.00)
Interactive Fixed Effect 1 ($\theta_{i1}F_{1t}$)			0.23***	1.00***	1.00***
			(0.00)	(0.00)	(0.00)
Interactive Fixed Effect 2 ($\theta_{i2}F_{2t}$)				1.00***	1.00***
				(0.00)	(0.00)
Constant	3.55***	4.06***	4.09***	5.24***	5.32***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
N	132,271	132,271	132,271	132,271	132,271
Adj. R-squared	0.51	0.77	0.57	0.86	0.85

Table 4

Explanatory Power of Interactive Fixed Effects

The table presents the adjusted R-squared for the regressions on the determinants of the level of total executive compensation. Columns (1) and (2) use the sample of executives with ≥10 years of data (57,951 observations) and with ≥5 years of data (132,271 observations) from 1992 to 2012. The dependent variable is *log(total compensation)*. The observable determinants are the independent variables used in Tables 1 and 2. The detailed definitions of all the variables are reported in the Appendix.

Adjusted R-squared	(1) Sample of managers with ≥10 years of data	(2) Sample of managers with ≥5 years of data
Sample size	57,951	132,271
OLS model of observable determinants	0.53	0.51
Manager fixed effect model (observable determinants + manager fixed effects)	0.77	0.77
Interactive fixed effect 1 ($\theta_{i1}F_{1t}$) only	0.43	0.14
Observable determinants + IFE1	0.75	0.57
Interactive Fixed Effect 2 ($\theta_{i2}F_{2t}$) only	0.05	0.01
Observable determinants + IFE2	0.55	0.51
IFE1 + IFE2 only	0.59	0.60
Observable determinants + both IFEs	0.85	0.86
Observable determinants + both IFEs + firm fixed effects	0.84	0.85

Table 5

Correlations between Interactive Fixed Effects and Observable Characteristics

The table presents the correlation coefficients between the estimated interactive fixed effects loadings θ_i and managerial and firm characteristics. P-values are in parentheses. At the bottom of Panel A, we present the correlations between IFE loadings and the manager fixed effects estimated from the three-way fixed effect model in Graham, Li, and Qiu (2012).

Panel A: Correlations between IFEs and Managerial Characteristics

	Sample 1 (managers with ≥10 years of data)			Sample 2 (managers with ≥5 years of data)		
	N	θ_{1i}	θ_{2i}	N	θ_{1i}	θ_{2i}
Managerial characteristics:						
GAI Index	1840	0.23***	0.00	3533	0.16***	0.03*
		(0.00)	(0.87)		(0.00)	(0.06)
Education 1	397	0.13**	-0.05	595	0.11**	-0.02
		(0.01)	(0.30)		(0.01)	(0.69)
Education 2	397	0.14**	-0.05	595	0.12***	-0.02
		(0.01)	(0.30)		(0.00)	(0.60)
MBA	397	0.13**	-0.07	595	0.07*	-0.01
		(0.01)	(0.16)		(0.08)	(0.89)
CEO	4492	0.38***	0.02	15940	0.16***	0.03***
		(0.00)	(0.19)		(0.00)	(0.00)
Fame wiki	1840	0.20***	0.03	1840	0.20***	0.03
		(0.00)	(0.16)		(0.00)	(0.16)
Fame picture	1840	0.10***	-0.01	1840	0.10***	-0.01
		(0.00)	(0.16)		(0.00)	(0.16)
Optimism 1	3086	0.02	0.08***	9570	-0.01	0.03***
		(0.38)	(0.00)		(0.39)	(0.01)
Optimism 2	695	0.09**	0.16***	1153	0.03**	0.05*
		(0.01)	(0.00)		(0.02)	(0.10)
Female	4492	0.00	-0.01	15940	0.01	-0.02**
		(0.77)	(0.47)		(0.18)	(0.02)
Age	4224	0.07***	0.23***	13534	0.04***	0.12***
		(0.00)	(0.00)		(0.00)	(0.00)
Tenure	2024	0.03	0.12***	5989	0.02*	0.03**
		(0.21)	(0.00)		(0.09)	(0.01)
Manager Fixed Effects from Graham, Li, and Qiu (2012)	2317	0.42***	0.03	7274	0.30***	0.06***
		(0.00)	(0.21)		(0.00)	(0.00)

Panel B: Correlations between IFEs and Firm Characteristics

	Sample 1 (managers with ≥10 years of data)			Sample 2 (managers with ≥5 years of data)		
	N	θ_{1i}	θ_{2i}	N	θ_{1i}	θ_{2i}
Firm characteristics:						
Ln(assets)	4492	0.20***	-0.17***	15940	0.09***	-0.09***
		(0.00)	(0.00)		(0.00)	(0.00)
Ln(sales)	4492	0.30***	-0.16***	15940	0.12***	-0.09***
		(0.00)	(0.00)		(0.00)	(0.00)
Ln(market value)	4492	0.32***	-0.15***	15940	0.14***	-0.08***
		(0.00)	(0.00)		(0.00)	(0.00)
Stock return	4492	0.10***	0.035**	15940	0.04***	0.01
		(0.00)	(0.02)		(0.00)	(0.13)
Return volatility	4492	0.07***	0.15***	15940	0.02**	0.02**
		(0.00)	(0.00)		(0.01)	(0.02)
Investment	4370	0.17***	0.15***	15480	0.05***	0.06***
		(0.00)	(0.00)		(0.00)	(0.00)
R&D	4492	0.16***	0.15***	15940	0.07***	0.06***
		(0.00)	(0.00)		(0.00)	(0.00)

Table 6

Quartile Analysis of Interactive Fixed Effects

The table reports the mean value of each variable for each quartile of factor loadings. IFEs are estimated using the sample of managers with 10 or more years of data (Panels A and B) and with 5 or more years of data (Panels C and D) from 1992-2012.

Panel A: Quartiles based on Factor Loading 1 (θ_{1i}) (Sample of managers with ≥10 years of data)

	Q1	Q2	Q3	Q4	Q4-Q1	t-stat
Managerial characteristics:						
GAI Index	-0.33	-0.32	-0.15	0.22	0.55***	7.07
Education 1	2.43	2.64	2.79	2.78	0.35	1.52
Education 2	16.64	17.36	17.72	17.66	1.02	1.56
MBA	0.50	0.57	0.62	0.65	0.15	1.06
CEO	0.23	0.34	0.53	0.76	0.53***	29.73
Fame wiki	0.22	0.17	0.23	0.41	0.19***	5.35
Fame picture	0.66	0.57	0.63	0.74	0.08**	2.05
Optimism 1	0.22	0.22	0.22	0.24	0.02	1.01
Optimism 2	1.89	0.44	1.48	3.55	1.66	1.14
Female	0.03	0.04	0.04	0.04	0.01	0.78
Age	52.19	52.82	52.93	53.67	1.48***	4.77
Tenure	19.49	18.24	17.98	20.14	0.65	0.92
Firm characteristics:						
Ln(assets)	7.34	7.48	7.75	8.34	1.00***	14.99
Ln(sales)	6.80	7.10	7.49	7.98	1.18***	20.29
Ln(market value)	7.00	7.26	7.67	8.27	1.28***	22.90
Stock return	0.15	0.16	0.17	0.18	0.03***	6.06
Return volatility	0.41	0.43	0.44	0.43	0.03***	4.87
Investment	0.22	0.25	0.27	0.29	0.08***	11.07
R&D	0.01	0.02	0.03	0.04	0.02***	10.80

Panel B: Quartiles based on Factor Loading 2 (θ_{2i}) (Sample of managers with ≥10 years of data)

	Q1	Q2	Q3	Q4	Q4-Q1	t-stat
Managerial characteristics:						
GAI Index	-0.01	-0.03	-0.04	-0.07	-0.05	-0.85
Education 1	2.75	2.85	2.80	2.68	-0.07	-0.68
Education 2	17.60	17.82	17.70	17.41	-0.19	-0.68
MBA	0.62	0.70	0.66	0.56	-0.06	-0.87
CEO	0.50	0.43	0.42	0.52	0.02	0.89
Fame wiki	0.29	0.45	0.26	0.47	0.18***	8.21
Fame picture	0.69	0.67	0.66	0.66	-0.03	-1.11
Optimism 1	0.19	0.21	0.25	0.26	0.06***	4.01
Optimism 2	1.23	2.21	2.89	4.40	3.17***	3.11
Female	0.04	0.03	0.04	0.03	-0.01	-0.68
Age	51.10	52.01	53.42	55.21	4.11***	13.12
Tenure	16.26	18.80	20.03	20.46	4.20***	6.18
Firm characteristics:						
Ln(assets)	8.18	7.84	7.54	7.36	-0.82***	-12.18
Ln(sales)	7.73	7.42	7.21	7.02	-0.71***	-11.30
Ln(market value)	7.92	7.58	7.44	7.26	-0.66***	-11.01
Stock return	0.16	0.16	0.17	0.17	0.01*	1.68
Return volatility	0.40	0.41	0.43	0.46	0.06***	9.93
Investment	0.23	0.23	0.26	0.30	0.07***	9.30
R&D	0.02	0.02	0.03	0.04	0.02***	9.46

Panel C: Quartiles based on Factor Loading 1 (θ_{1i}) (Sample of managers with ≥5 years of data)

	Q1	Q2	Q3	Q4	Q4-Q1	t-stat
Managerial characteristics:						
GAI Index	-0.33	-0.20	-0.14	0.18	0.51***	9.04
Education 1	2.44	2.67	2.73	2.76	0.32**	2.69
Education 2	16.79	17.39	17.56	17.63	0.84**	2.73
MBA	0.47	0.58	0.62	0.63	0.16*	1.73
CEO	0.18	0.19	0.31	0.50	0.33***	32.85
Fame wiki	0.30	0.16	0.20	0.39	0.09*	1.70
Fame picture	0.74	0.58	0.61	0.73	-0.01	-0.20
Optimism 1	0.19	0.18	0.17	0.18	-0.01	-0.86
Optimism 2	1.28	0.85	0.93	2.91	1.63**	2.28
Female	0.05	0.05	0.06	0.06	0.00	0.89
Age	51.57	52.16	52.37	52.45	0.88***	4.97
Tenure	14.14	14.96	14.06	15.01	0.88**	2.15
Firm characteristics:						
Ln(assets)	7.34	7.35	7.61	7.99	0.65***	17.28
Ln(sales)	6.82	7.03	7.33	7.59	0.77***	22.43
Ln(market value)	7.02	7.10	7.50	7.88	0.86***	27.03
Stock return	0.14	0.15	0.16	0.17	0.03***	7.22
Return volatility	0.43	0.43	0.45	0.46	0.03***	7.57
Investment	0.26	0.25	0.29	0.32	0.06***	11.64
R&D	0.02	0.02	0.03	0.04	0.02***	13.42

Panel D: Quartiles based on Factor Loading 2 (θ_{2i}) (Sample of managers with ≥5 years of data)

	Q1	Q2	Q3	Q4	Q4-Q1	t-stat
Managerial characteristics:						
GAI Index	-0.02	-0.02	-0.04	0.02	0.04	0.83
Education 1	2.71	2.82	2.71	2.65	-0.06	-0.63
Education 2	17.56	17.77	17.50	17.33	-0.23	-0.89
MBA	0.55	0.68	0.61	0.57	0.02	0.26
CEO	0.28	0.28	0.29	0.33	0.06***	5.55
Fame wiki	0.28	0.29	0.29	0.32	0.04	1.03
Fame picture	0.69	0.69	0.64	0.69	0.00	0.05
Optimism 1	0.15	0.17	0.22	0.18	0.03***	3.54
Optimism 2	1.12	1.99	2.20	3.11	1.99***	2.85
Female	0.07	0.05	0.05	0.04	-0.02***	-4.26
Age	50.34	51.78	52.96	53.63	3.28***	18.46
Tenure	12.21	15.18	16.14	14.29	2.08***	5.29
Firm characteristics:						
Ln(assets)	7.87	7.79	7.39	7.25	-0.63***	-16.80
Ln(sales)	7.44	7.38	7.07	6.89	-0.54***	-15.51
Ln(market value)	7.61	7.51	7.22	7.15	-0.46***	-14.11
Stock return	0.15	0.15	0.16	0.16	0.01	1.58
Return volatility	0.45	0.42	0.44	0.47	0.02***	6.46
Investment	0.27	0.25	0.28	0.32	0.05***	10.41
R&D	0.02	0.02	0.03	0.04	0.01***	10.54

Figure 1
Factor 1 of the Interactive Fixed Effect Model

The figure presents a time series plot for the estimated Factor 1 (F_{1t}) of the Interactive Fixed Effect Model. Estimation is performed using the principal components method on the sample of managers with 10 or more years of data from 1992 to 2012. The factor F_1 is the market valuation of the factor loading θ_1. The figure plots $\exp(F_t)$-1. That is, the value of the factor represents the percentage increase on manager's compensation for a unit increase in the first managerial attribute, which is scaled to a mean of 50 and a standard deviation of 25 and mostly takes the values from 0 to 100.

Market Price of Talent

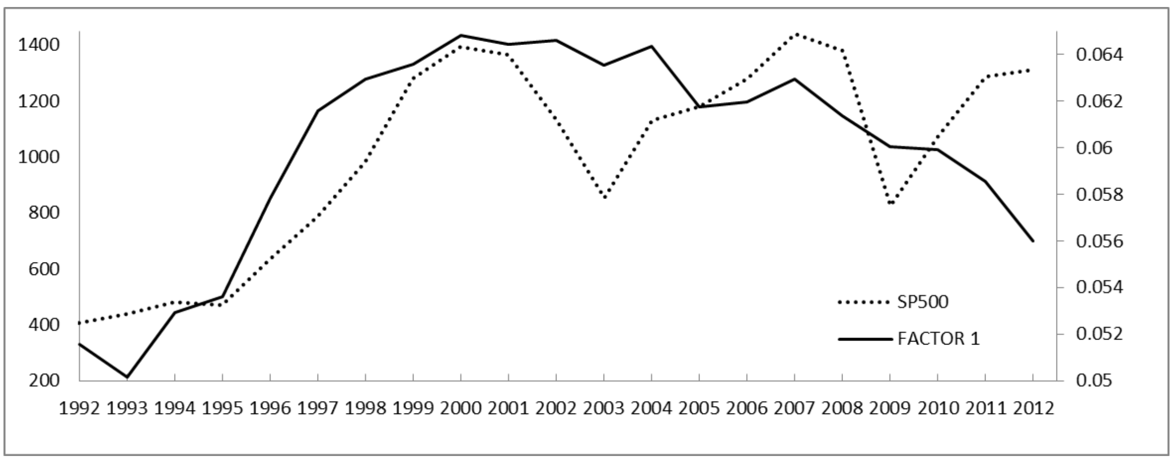


Figure 2
Factor 2 of the Interactive Fixed Effect Model

The figure presents a time series plot for the estimated Factor 2 (F_{2t}) of the Interactive Fixed Effect Model. Estimation is performed using the principal components method on the sample of managers with 10 or more years of data from 1992 to 2012. The factor F_2 is the market valuation of the factor loading θ_2. The figure plots $\exp(F_t)$-1. That is, the value of the factor represents the percentage increase on manager's compensation for a unit increase in the second managerial attribute, which is scaled to a mean of 50 and a standard deviation of 25 and mostly takes the values from 0 to 100. The dotted line represents the U.S. consumer confidence index from the OECD.

Market Price of Overconfidence

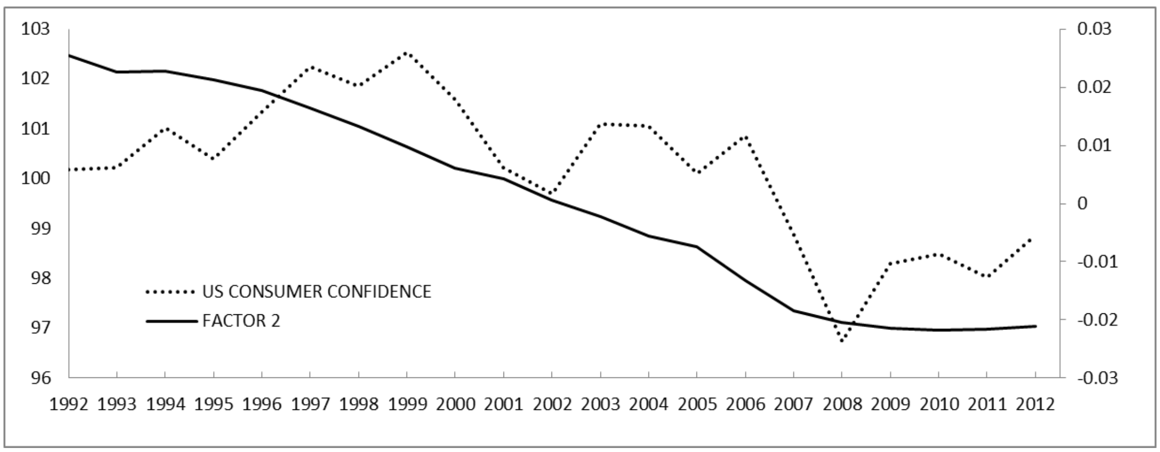
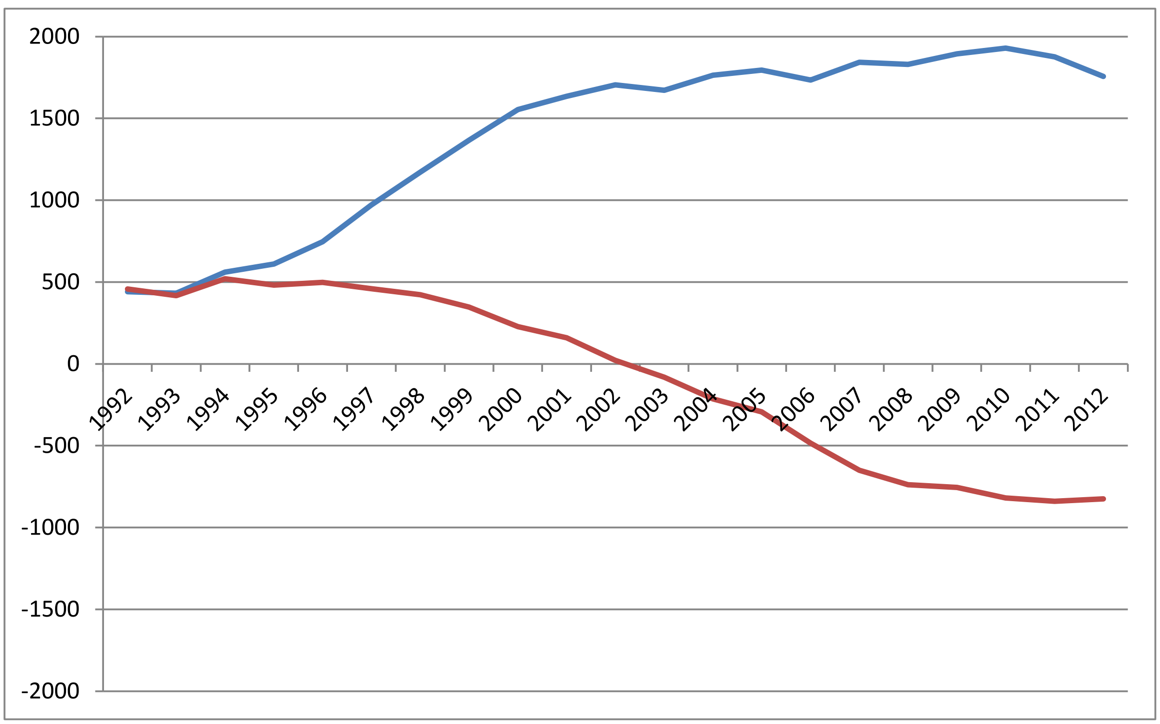


Figure 3

Salary Gap Generated by Talent and Overconfidence

The figure presents the market prices of managerial attributes. Estimation is performed using the principal components method on the sample of managers with 10 or more years of data from 1992 to 2012. For every year, we compute the following: A = Pay of an average executive = Predicted pay for an average executive predicted by our model, assuming all variables are at their mean values; B = Pay of a talented CEO = Predicted pay for a talented executive, assuming all variables are at their mean values except that the first managerial attribute is 75 (note that the managerial attribute is normalized to have a mean of 50 and a standard deviation of 25); C = Pay of an overconfident executive = Predicted pay for an overconfident executive, assuming all variables are at their mean values except that the second managerial attribute is 75 (note that the managerial attribute is normalized to have a mean of 50 and a standard deviation of 25). As a result, B-A = Difference in pay between a talented CEO and an average CEO (the top line in the graph), and C-A = Difference in pay between an overconfident CEO and an average CEO (the bottom line in the graph). The unit on Y axis is dollar thousands.



Appendix A: Definition of Variables

Variable Names	Variable Definitions and Corresponding Compustat and ExecuComp Data Items
Firm-level variables	
Log(assets)	Natural log of total assets = log(AT). Assets are measured in $millions.
Market to book	(Market value of equity plus the book value of debt)/total assets = (PRCC_F×CSHO+AT-CEQ)/AT.
Stock return	Annual stock returns from CRSP.
Return on assets (ROA)	Net income before extraordinary items and discontinued operations divided by total assets = IB/lag(AT).
Stock return volatility	Standard deviation of daily log returns over the past five years and then annualized by multiplying by the square root of 254.
CEO chair indicator	A dummy variable equal to one if the CEO of the company is also the board chairman and zero otherwise.
Investment	Capital expenditures/lag one year net property, plant, and equipment = CAPX/lag(PPENT).
R&D	Research and development expense/lag one year net property, plant, and equipment = XRD/lag(PPENT).
Manager-level variables	
Log(total compensation)	Natural log of total compensation, where total compensation is ExecuComp data item TDC1 and is comprised of salary, bonus, other annual, total value of restricted stock granted, total value of stock options granted (using Black-Scholes), long-term incentive payouts, and all other total. Total compensation is measured in $thousands.
Log(salary plus bonus)	Natural log of salary plus bonus, where salary plus bonus is ExecuComp data item TOTAL_CURR. Salary plus bonus is measured in $thousands.
Log(equity-based compensation)	Natural log of total equity-based compensation, where equity-based compensation is equal to the value of options granted as valued using the Black Scholes methodology (OPTION_AWARDS_BLK_VALUE) plus the value of restricted stock grants (RSTKGRNT). Equity-based compensation is measured in $thousands.

General ability index (GAI)	General ability index constructed by Custodio, Ferreira, and Matos (2013). This index is used to measure managerial general skills that are transferable across firms and industries. The measure is based on five aspects of a CEO's professional career: past number of (1) position, (2) firms, and (3) industries in which a CEO worked; (4) whether the CEO held a CEO position at a different company; and (5) whether the CEO worked for a conglomerate. The GAI is the first factor of the principal components analysis of the five variables.
Education 1 and Education 2	Education1 is equal to 1 for below bachelor, 2 for bachelors, 3 for non-MBA masters and MBAs, and 4 for doctorates. Education2 is the number of years of education, with below bachelor being 12 years, bachelor 16 years, non-MBA masters and MBAs, 18 years, and Ph.D. 21 years. The missing degree information is imputed using the mean values of Education1 and Education2, 2.74 and 17.6.
MBA	An indicator variable equal to one if the manager has an MBA degree, and zero otherwise.
Fame wiki	An indicator variable that equals one if a manager has a Wikipedia page.
Fame picture	An indicator equaling one if a picture of the manager is displayed as the first result of a Google search.
Optimism 1	We follow Otto (2014) in defining the optimism measure based on managers' option exercise decisions. The measure is first proposed and named as "LongHolder" by Malmendier and Tate (2005a,b, 2008) and Malmendier, Tate, and Yan (2011). We use the information on executives' option exercises obtained from the Thomson Reuters insider filings database. For each observation, we assign an optimism dummy that takes the value one if the options were exercised within one year of their expiration date and at least 40% in the money at the end of the preceding year. Otherwise, the dummy takes the value zero. Then we average the optimism dummy for each CEO across all observations that pertain to that CEO within a given firm, weighting each exercise observation by the number of options that were exercised. Weighting observations by the profit that was realized in the transaction or giving equal weight to all observations yields similar results. This procedure leads to the variable LongHolder (which is also Optimism 1 we use in the paper), which ranges between zero and one, with higher values indicating more optimistic beliefs.
Optimism 2	We follow Hirshleifer, Low, and Teoh (2012), Malmendier and Tate (2008), and Malmendier, Tate, and Yan (2011), and define the press-based variable of CEO

	overconfidence. The variable is based on outsiders' perceptions of the CEO, using popular press characterizations. Specifically, we search Factiva for articles referring to the S&P500 CEOs in the New York Times, Bloomberg BusinessWeek, Financial Times, the Economist, Forbes, CNNMoney (was Fortune during earlier years in the sample), Time, and the Wall Street Journal. We record four statistics for each CEO each year in our sample: (1) number of articles describing the CEO using the terms "confident" or "confidence" (*Confident*); (2) number of articles describing the CEO using the terms "optimistic" or "optimism" (*Optimistic*); (3) number of articles describing the CEO using the terms "reliable", "steady", "practical", "conservative", "frugal", or "cautious" (*Cautious*); and (4) number of articles describing the CEO using the terms "not confident" or "not optimistic", "pessimistic", or "pessimism" (*Not Confident*). Observations for which there are no press mentions describing the CEO as the above in a given year are assigned a value of 0. The overconfidence measure is defined as (*Confident* + *Optimistic*) – (*Cautious* + *Not Confident*).
Log(tenure)	Natural log of the number of years the manager has been with the company, which equals the difference between the year of the observation and the year when the individual joined the company.
CEO indicator	A dummy variable that equals one if the manager is the CEO in a particular year and zero if the manager is a non-CEO top executive in a particular year. This dummy variable is time variant for a given individual because a specific manager could be a CEO in some years and a non CEO in other years.
Female indicator	A dummy variable that equals one if the manager is a female and zero otherwise.
Age	Age of the manager during the year of observation.

Appendix B: Methodological Details

A few practical implementation issues related to estimating the IFE model are worth mentioning. First, the method we described in the paper is applied to balanced panel data. Our data, however, is an unbalanced panel because the executive pay information is available over different years for different managers. Given the characteristics of the data, an important methodological issue is to ensure that our estimation procedures can be applied to an unbalanced panel. We thus follow Bai's (2009) supplemental material, which provides modifications to his algorithm to deal with unbalanced panels.

Second, to deal with missing values in the data, we apply the iterative maximum likelihood estimation, using the Expectation Maximization Algorithm (EMA) suggested by Truxillo (2005). The EMA is a two-step iteration process. The first step uses the observed data to estimate the missing values and the estimated values are then filled in the missing values as a guess. The second step involves a maximum likelihood estimation of the mean and the covariance of missing values, using the data from the first step. The estimated mean and covariance matrices are used in step one to find a new set of estimates for the missing values. These two steps are repeated until the estimated coefficients remain the same from one iteration to the next. We use the estimated covariance matrix from the EMA method as our input for the factor analysis.

Third, estimating Equation (5) requires defining the number of factors first. We follow Bai and Ng (2002) to estimate the number of statistically significant factors. In particular, we estimate the factor model in Equation (4), assuming the number of factors is k. The optimal number of factors $\hat{k}$ is the value of k that minimizes any of the following criterion functions:

$$PC = V\left(k, \hat{F}\right) + kg(N, T)$$

$$IC = \ln(V\left(k, \hat{F}\right)) + kg(N, T)$$

where $V\left(k, \hat{F}\right)$ is the squared residuals in Equation (4) given the number of factors k, that is, $V\left(k, \hat{F}\right) = \frac{1}{NT}\sum_{i=1}^{N}\sum_{t=1}^{T}\left(\hat{e}_{it} - \hat{\theta}_i\hat{F}_t\right)^2$. $g(N, T)$ is the penalty function defined in Bai and Ng (2002).