Executive Compensation Regulation and the Dynamics of the Pay-Performance Sensitivity

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Abstract

A substantial number of empirical studies on the linear relationship between executive compensation and firm performance for European firms suggest that the pay-performance sensitivity is not significantly positive. We argue that a nonlinear structure fits the data better, because compensation contracts provide for minimum performance benchmarks and an upper limit to the variable component of compensation. We test for such discontinuities in the pay performance relationship, and confirm their existence, using hand collected data from German Prime All Share firms' CEO bonus compensation. It turns out that there is a significant positive relationship between return on assets and CEO bonus for ROA between -3% and +20%. Performance sensitivity is then tested for changes over time between 2006 and 2009. Results reveal that during the first three years after the introduction of a statutory transparency rule in 2005 governing the disclosure of individual CEO compensation, significant changes to compensation contracts did not occur; but that in 2009 the pay-performance sensitivity exhibited a significant increase, which coincides with the passing of a law that requires supervisory boards to ensure that new CEO employment contracts provide for 'reasonable' compensation.

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1 Introduction

The incentives induced by bonus payments have been subject of recent discussions among shareholders and rulemakers in Europe. Unreasonably strong incentives for very high profits under neglect of incentives for sustainable performance were suspected to be one of the causes for the real estate crisis to become a financial crisis. If high profits can only be achieved by taking high risks, and if high losses are not borne by the decisionmakers themselves, aggressive bonus contracts will provoke risk love in CEO decision making. These discussions have led to regulatory action. The European Union has issued a recommendation suggesting to member states to adopt new rules on the remuneration of directors of listed companies, requiring variable compensation to be determined by measurable performance criteria and to be limited by a cap, and requiring that the structure of compensation promotes sustainability of the company.[1] Many member states have followed.[2] For instance, in Germany, a new rule was introduced in 2009 that forces supervisory boards to ensure that remuneration paid to executive directors remains within 'reasonable' bounds and considers more than one financial year when determining variable compensation.

Recent evidence on the relationship between executive compensation and firm performance points at an increasing pay performance sensitivity in the U.S. In contrast, European evidence on the pay performance sensitivity is, at best, mixed: most studies report that the linear relationship between accounting measures of performance and executive compensation is not significantly positive. But, if the pay-performance relationship in Europe were weak, it would be surprising to see such a considerable debate about unreasonably *high* bonus incentives for very high profits.[3] Instead, the debate would probably be focused on the *absence* of incentives for performance, and shareholders would call for a stronger alignment between their interests and the interests of the directors. This calls for a closer look on the relationship between corporate performance and bonus payments in Europe.

We concentrate on the largest European economy - Germany - to provide evidence on a significant and increasing pay performance relationship. In 2005, a law was introduced that forces German corporations to disclose details on executive compensation individually for every director. In particular, this offers the chance to solely concentrate on *CEO* compensation. Regular directors' pay is not exclusively tied to the performance of the entire firm, but is often determined by looking at the performance of some division of the firm that the director is responsible for, and whose performance usually remains undisclosed. In contrast, CEO pay is usually determined by the performance of the entire firm, which can be observed more easily.

Mathematically seen, we treat the relationship between corporate performance and CEO bonus as an inverse problem. Murphy (1999) suggests that there are discontinuities in that relationship, and we account for these by allowing for nonlinearities. Our empirical tests confirm that there is a lower performance benchmark to be reached before any

[1] See Commission (2009), sec. II.

[2] A commission report analyzes the reactions of member states with regard to the recommendation: Commission (2010).

[3] See for instance Fong (2008), Lichfield (2008), Saltmarsh (2009), Thornhill et al. (2008), Treanor (2010).

considerable bonus is paid, and that there is a performance ceiling, where any additional performance beyond that ceiling will not increase the bonus any further. Moreover, the case of Germany provides us with the chance to analyze changes to corporate behaviour subsequently to the introduction of a transparency law. We find that it took until three years after the introduction of the new transparency rules until pay-performance clauses German compensation contracts underwent a statistically significant change. This coincides with the 2009 introduction of the obligation to provide for reasonable structures of compensation in new contracts. These results are consistent to the conjecture that firms have adjusted their existing contracts under consideration of the responsibility to provide for a pay-performance relationship different to that observed before the introduction of the law.

Section 2 provides some theoretical insights into potential determinants of the structure and the changes to CEO compensation contracts and develops seven testable hypotheses. Section 3 explains the empirical methodology. Section 4 shows how the data were retrieved, section 5 discusses the results and section 6 concludes.

2 Theory and Literature Review

2.1 Theory

2.1.1 Goals of the Parties Negotiating Remuneration Contracts

The compensation contract for a German CEO, including the clause regarding the sensitivity of bonus payments with regard to company performance, is the result of a negotiation process between the supervisory board - or a subcommittee of it - and the (future) officer. Once appointed, she is agent, and the supervisory board - representing the shareholders - acts as principal.[4] The supervisory board aims at agreeing on a contract that fulfils the participation condition for high-quality candidates, but that also limits the costs borne by the firm. The director - who usually will be risk averse in her private affairs - aims at maximizing her remuneration. The more convinced she is that the firm will be succesful under her rule, and the less uncontrollable influence on performance she expects, the higher will be the performance sensitivity that she asks for.

The structure of compensation contracts varies between CEOs and regular directors. The CEO has responsibility for the performance of the entire corporation, while regular directors are responsible for an individually limited set of duties. Therefore, CEO compensation will generally be tied to the performance of the entire firm, while regular director compensation will at least in part be determined by a performance measure related to this limited set of duties. We concentrate solely on the bonus payments of CEOs, because measuring entire firm performance is considerably more straightforward than measuring the performance that regular directors have achieved within their limited set of responsibilities.

[4] Jensen/Meckling (1976) introduce this view of the shareholder - manager relationship. Note that during the negotiation process, the supervisory board acts as an agent of the shareholders, and the principal/agent - relationship has three levels.

2.1.2 Outcome of the Negotiation

The parties' goals are in conflict. The form of the contract the two parties eventually agree upon is determined by their relative powers of negotiation. Regarding the bonus, the contract will be in the form of a function that relates an amount in Euro to each possible value of company performance ('bonus function'). It is reasonable to assume that pay-performance sensitivity is nil below a certain performance benchmark, because the minimum bonus payment is zero; and also that contracts provide for a cap to bonus payments, as suggested by the German Corporate Governance Kodex, a code of conduct which the firms are subject to comply with, except if they provide a publicly disclosed explanation why they do not.

Usually, this function is not published. Therefore, an analysis of the performance sensitivity will have to use the realized payments, which have to be published according to German law. Since the Vorstandsverguetungsoffenlegungsgesetz of 2006, the revised section 285 of the Handelsgesetzbuch states that firms have to provide details on director compensation in their annual reports. They have to provide the amount of salary, bonus and long term incentives granted *for* the financial year in question, and they usually have to present the amounts for each board member individually, which is especially important because the payments to the CEO are presented separately.[5] However, such an analysis will have to account for the dynamic nature of remuneration contracts. From time to time, contracts are renegotiated; furthermore, the composition of boards is subject to frequent changes, and new contracts are settled each time a change occurs.

2.1.3 Determinants of Systematic Changes to Remuneration Structures

Long-term systematic changes in new remuneration contracts are induced by changes in the structure of the overall investment opportunity set or by changes in the risk attitude of negotiating parties. Demand and supply on the market for high-potential human capital, in contrast, can change rapidly and has a substantial impact on remuneration, but are hard to be observed directly. Furthermore, the economic climate can influence the outcome of remuneration contracts. For instance, when the perceived economy-wide risk has increased, new directors might be hesitant to accept contracts with a large share of variable compensation. The financial crisis has pointed at a potential effect of high incentives for generating very high profits. Risk aversion of managers *in the office* - as opposed to their risk preferences in private affairs - seems to have increased substantially due to these incentives. After the crisis, there could thus have evolved a practice of limiting incentives for generating unreasonably high profits.

And also, possible changes to corporate governance regulation or even to tax law can change the goals of the negotiating parties. Regulation can have a direct impact, for instance by imposing rules of conduct. The Vorstandsverguetungs*angemessenheits*gesetz (statute on the reasonableness of executive compensation) of 2009 is a good example: the revised section 87 of the Aktiengesetz imposes a duty on supervisory boards to ensure that remuneration contracts provide for *reasonable* and sustainable compensation structures.

[5] However, with a 75% majority in the annual general meeting, they can suspend the obligation to present individual directors' payments and grants separately.

This includes a comparison of an individual firm's compensation package to the average package, and also requires that bonus payments be determined by firm performance over a time interval longer than one financial year (the 'sustainability rule'). Regulation can also have an indirect impact: transparency rules, for instance, can induce changes to contracts because monitoring by principals is made less costly. The Vorstandsverguetungs*offenlegungs*gesetz (statute on the disclosure of executive compensation) of 2005 is a good example. A disclosure obligation could lead to increased alignment between the interests of shareholders and the interests of the supervisory board. This could result in higher pay-performance sensitivity. On the other hand, the obligation could lead to a race to the top: Park, Nelson and Huson (2001) present evidence of a Lake Wobegon (see Hayes/Schaefer, 2009) effect in Canada; i.e. directors who observe that they are paid under average request for an increase of their pay. This results in iterative increases of average compensation. However, it is difficult to judge whether changes in remuneration are driven by changes in overall performance, or by changes in remuneration contracts by observing realized salaries. A "race to the top" might, however, be confirmed if the *conditional* remuneration, granted if some fixed performance level were attained, has increased over the years.

Systematic changes can be reinforced by the phenomenon of management fashion. Often, specific changes to corporate governance structures are made by a number of firms at the same time, and this fact attracts the attention of other firms who eagerly follow suit.

2.2 Related Literature

Aggarwal (2008) suggests two measures of the pay-performance relationship. The *implicit* approach uses a regression coefficient where CEO pay is regressed on firm performance. The *explicit* approach uses the fraction of total compensation that is made up of performance-linked components. Similarly, Fahlenbrach (2009) uses stock ownership of the CEO and the change in value of the CEO's stock and option portfolio for a 1% change of the stock price. Such measures are ideal for contracts where the bulk of remuneration consists of stock-based or option-based incentives, which holds for U.S. corporations.[6] However, of the firms in our sample, only a minority use large-scale stock-based incentive schemes, whereas between 30% and 40% of total compensation consist of annual bonus. The total fair value of all long term incentives granted during the year accounts for only less than 10% of total annual compensation. Therefore, for Germany, the relationship between bonus and corporate performance is the pay-performance measure of choice. We choose a regression-based measure which takes into account nonlinearities in the relationship between accounting performance measures and CEO bonus.

Wilson (1992) provides early evidence in support of such nonlinearities for a sample of U.S. firms by including squared regressors. However, in his study, only 13% of variability in CEO compensation can be explained by size and performance. Miller (1995) then finds that there is no evidence consistent to a linear relationship between changes to executive salary and bonus and changes to firm performance among U.S. firms, but he finds that nonparametric rank analysis reveals a positive nonlinear relationship. More

[6]For instance, in Jackson's et al. (2008) sample, one third of total compensation consists of equity-based incentives when considering medians.

recently, Leone et al. (2006) find that changes to cash compensation (salary + bonus) are twice as sensitive to negative stock returns as they are to positive stock returns, pointing to an asymmetric pay-performance relationship. In line with a minor argument already raised in Leone et al., Dechow (2006) argues that a potential reason for this effect is a bonus contract that stipulates an upper bound. In his study using confidential data on bonus schemes, Holthausen et. al. (1995) find that more than 50% of the firms in their sample provide for an upper bound to bonus payments. Gaver et al. (1995) present further evidence on lower and upper bounds to bonus payments.

For the U.S., Hall/Liebman (1998) document that while the pay-performance relationship, measured *explicitly*, has risen dramatically between 1980 and 1994, most of the rise was due to an increase in the value of existing stock and option holdings, but not due to changes in compensation contracts. Jackson et al. (2008), find that generally, there is a positive relationship between accounting earnings and CEO bonus. However, they suggest that the relationship is weak for a low level of total earnings and that, to some extent, alternative accounting based measures act as substitute for return on assets.

In Europe, the empirical evidence up to date, while not as voluminous as in the US, is not consistently supportive of a positive pay-performance relationship. While Elston/Goldberg (2003) find evidence on a positive relationship between return on assets and total compensation of the average board member during the years 1970 to 1986 in a sample of 100 German firms, this relationship is not consistently significant in their specifications. Schmidt/Schwalbach (2007) document a negative relationship between abnormal returns and director compensation for the year 2005. Rapp/Wolff (2010) provide recent evidence on the nonexistence of a positive linear relationship between total director compensation and operating performance for the years 2005 to 2009 for a sample very similar to the one used in this paper. In their specifications, which are linear, operating performance is either significantly negatively or insignificantly related to total compensation.

Bruce et al. (2007) report a significantly positive, but weak linear relationship between firm performance and executive bonus payments in the UK for 2001 to 2003. Duffhues/Kabir (2008) find no positive linear pay performance relationship in their analysis of executive compensation in the Netherlands between 1998 and 2001. In a study on 23 Swiss banks, Wanzenried et al. (2009) find that between 2002 and 2006, executive managements' compensation was negatively related to firm performance. In an earlier study, Firth et al. (1996) find that there is no significant relationship between accounting profitability or stock returns and CEO pay in Norway. Brunello et al. (2001) find that the sensitivity of the amount of incentive payments with regard to corporate performance is low for 1993 to 1996.

To sum up, this evidence suggests that either, the pay-performance relationship is indeed weak, or, the standard linear methodology conceals some of the relationship between performance and executive compensation.

2.3 Hypotheses

For German CEO compensation, the following hypotheses can be derived from the observations above:

H1: There is no relationship between performance and bonus below a minimum performance benchmark.

H2: There is no relationship between (additional) performance and bonus above a performance ceiling.

H3: There is a positive relationship between performance and bonus between the minimum performance benchmark and the performance ceiling.

H4: Pay performance sensitivity has begun to increase after the 2006 disclosure obligation due to the disclosure effect.

H5: Pay performance sensitivity with respect to extremely high performance has decreased after the financial crisis.

H6: The relationship between performance in the *previous* year and the bonus for *this* year is higher in 2009 than before due to the 2009 sustainability rule.

H7: The conditional salary for a fixed level of performance has increased between 2006 and 2009 due to the race to the top.

3 Methodology

3.1 Overview

CEO bonus is used as a dependent variable in a nonlinear regression model with firm performance as an explanatory variable, where pay-performance sensitivity is represented by the resulting coefficient. In order to test hypotheses 1 through 3, the estimation will account for a minimum performance benchmark ('floor') and a performance ceiling ('ceiling') by testing for structural breaks in the performance sensitivity coefficient. In order to analyze the dynamics of performance sensitivity, the estimation of this coefficient (i.e. the slope of the bonus function) will be conducted year by year. In order to compare the slope for different years, constant floors and ceilings are required in each year. Therefore, assuming that the average floor and average ceiling do not undergo substantial change over the years, the location of these two structural breaks ist estimated using the pooled dataset, before conducting the year-by-year estimation.

This requires adjustments due to the panel structure of the data. This is done by accounting for random firm effects. Furthermore, heteroskedasticity is detected, i.e. the residual variance is higher especially for firms that are larger, and for firms that exhibit higher performance. Thus, the test for structural breaks is made robust to both random effects and heteroskedasticity.

If structural breaks are detected, the model has to be adjusted to account for the benchmark nature of executive compensation. For instance, a bonus ceiling does not imply that above this ceiling, the relationship between performance and bonus will be zero. Rather, the relationship between *additional* performance above the ceiling and bonus will be zero. This structure is accounted for in section 3.3

3.2 Nonlinear Regression Model with Structural Breaks

3.2.1 Pay Performance Sensitivity as an Inverse Problem

While the object of research is the dynamic firm-specific CEO bonus function $bonus_{it} = f_{it}(performance_{it})$ as stated in the remuneration contract, we can only observe realized pairs $(performance_{it}, bonus_{it})$ for firms $i = 1, ..., n$ and years $t = 1, ..., T$. Therefore, we cannot estimate f_{it} from the available data. If we assumed time-constant bonus functions, we could estimate firm-specific functions $\overline{f_i}$ if we had observations for a reasonable number of years; yet four years is not enough. However, it is possible to estimate the average bonus function $\overline{f_t}$ and scrutinize its shape over time to identify systematic changes in compensation practices.

Here, $\overline{f_t}$ is parameterized in order to do so. A widely used approach for modeling compensation is the linear model[7]

$$BON_{it} = \alpha + \beta PROFIT_{it} + u_{it}, \tag{1}$$

where

BON_{it} CEO bonus for firm i paid *for* year t

$PROFIT_{it}$ performance of firm i *in* year t.

Pay-performance sensitivity is represented by β here. $PROFIT$ is a measure of corporate performance, which could be net income, operating income, EBITDA or a similar accounting measure.

In addition to firm performance, firm size is a major determinant of CEO compensation. Generally, performance should be measured independently of firm size, because CEO effort is to be rewarded, and CEO effort is related to relative performance and not to absolute profit. This requires a relative performance measure such as return on assets or return on equity. We denote this size-independent performance measure by $PERF$. Of course, for the same level of return, a large firm will have a higher net income than a small firm. Yet, the impact of size will usually not be explicitly discussed by the negotiating parties, and will not be an argument of the bonus function f. Instead, the supervisory board will implicitly translate the required return bechmark into a profit benchmark for the firm according to its size, and the parties will discuss the relationship between profit and bonus.

Therefore, in the model, the size effect cannot straightforwardly be separated from the performance effect by including size as another linear explaining variable. The 'implicit'

[7] In order to estimate $\overline{f_t}$, the model (1) is estimated once for $t = 1, ..., T$.

size effect might not be linear. Instead, some authors use a log-transformation in order to get rid of nonlinearities. This requires the size effect to be loglinear. We refrain from imposing such a restriction, and use a parametric approach to capture the size effect.

The sustainability rule is accounted for by including lagged performance in the equation. Performance is highly persistent; thus, the difference between lagged performance and performance is used. The coefficient of this difference will be positive if there is a positive reward when performance is high in two consecutive years. This will be the case if lagged performance is considered when determining the bonus.

Apart from that, we include three control variables (leverage, market to book and idiosyncratic risk). If we suspect that risk has a linear impact on the pay-performance *sensitivity*, then the coefficient of the variable $PERF$ will be of the form $(\beta_7 + \beta_8 RISK)$. Hence, an interaction term between risk and performance is included. The resulting model is

$$\begin{aligned} BON_{it} &= SIZE_{it}^{\beta_1} \Big[\beta_2 + \beta_3 LEV_{it} + \beta_4 MTB_{it} + \beta_5 \left(PERF_{it-1} - PERF_{it}\right) \\ &\qquad + \beta_6 RISK_{it} + \beta_7 PERF_{it} + \beta_8 RISK_{it} PERF_{it}\Big]. \end{aligned} \tag{2}$$

Bonus is usually nonnegative. One possible approach to handle the nonnegativity is the linear regression model for censored dependent variables. However, here, we aim at modelling the right hand side so that it reflects the nonlinear, 'asymmetric' shape of the typical bonus function as devised in compensation contracts. Thus, we first confirm the existence of structural breaks in model (2), and then, we set out a model that reflects the two discontinuities in appropriate form and generates fitted values close to zero for that range of independent variables where firms actually pay bonuses close or identical to zero.

3.2.2 Testing for Structural Breaks in the Panel Dataset

H1, H2 and H3 assert that there are two structural breaks in parameters β_7 and β_8, and that the break locations represent a minimum performance benchmark and a performance ceiling. Introducing these breaks into model (2) results in the following model:

$$\begin{aligned} BON_{it} &= SIZE_{it}^{\beta_1} \Big[\beta_2 + \beta_3 LEV_{it} + \beta_4 MTB_{it} + \beta_5 \left(PERF_{it-1} - PERF_{it}\right) \\ &\qquad + \beta_6 RISK_{it} + \left(\beta_7 + \gamma_7 1_{a,it} + \delta_7 1_{b,it}\right) PERF_{it} \\ &\qquad + \left(\beta_8 + \gamma_8 1_{a,it} + \delta_8 1_{b,it}\right) RISK_{it} PERF_{it}\Big], \end{aligned} \tag{3}$$

where

$$1_{a,it} = \begin{cases} 1 & S_a < PERF_{it} \leq S_b \\ 0 & \text{else} \end{cases}$$

$$1_{b,it} = \begin{cases} 1 & S_b < PERF_{it} \\ 0 & \text{else.} \end{cases}$$

We test for the structural breaks S_1, S_2 by following the general idea of the χ^2 test presented by MacKinnon (1989), which was later extended by Lamarche (2003) for the situation of unknown break locations. MacKinnon applies a Gauss-Newton regression to test for *one* structural break, whose potential location is known, for a nonlinear regression model. To test for structural break at the breakpoint S, his test statistic is

$$U'MZ(Z'M\Omega MZ')^{-1}Z'MU, \tag{4}$$

where

U vector of residuals under the null hypothesis,

$M = I - X(X'X)^{-1}X'$,

X vector of partial derivatives, where $X_{ij} = \frac{\partial f_i(\beta_j)}{\partial \beta_j}$ where $f_i(\beta)$ is the right hand side of (2),

Z $\xi * X$, where $\xi_{it} = 1$ if $PERF_{it} > S$ and $\xi_{it} = 0$ else, and $*$is multiplication element by element, and

Ω variance-covariance matrix of residuals.[8]

However, our hypotheses imply *two* structural breaks. Therefore, we test for the first break, confirm that it is significant, and define the model with one break as the model under a *second* null hypothesis. Then, we test for the second break in the parameters and confirm that the second break is significant, too. The location of our two breaks is unknown, leading to two problems:

1. First, the location of our break(s) has to be found. We follow the $\sup F^2$ test approach presented by Lamarche (2003): for each possible location of the break, the test statistic is calculated. The location of the break is determined by searching for the location with the highest test statistic associated to it. As possible location, we consider all observed values of $PERF_{it}$ above the 0.15 quantile and below the 0.85 quantile of the empirical $PERF_{it}$ distribution, which is common practice.

2. The distribution of the test statistic under the null hypothesis is not known, because the location of the break needs to be estimated. Lamarche (2003) tests a bootstrap approach for determining the distribution of the test statistic. We follow his approach, using the wild bootstrap variant, which has been proven to provide a promising level of performance. In particular, we estimate the model under the null hypothesis. Then we draw one random variable x per firm and bootstrap iteration

[8] Note that in MacKinnon's work, Ω is diagonal. In contrast, in our case it is block diagonal due to the panel data structure. Thus, as suggested by Li/Stengos (1994), we transform the residuals into white noise using Ω^{-1} before actually applying the test statistic, so that we can drop Ω from (4). We include Ω here to illustrate the robustness of the statistic with regard to heteroskedasticity in the diagonal elements. See section 3.2.3.

from the Rademacher distribution,[9] i.e. $(P[x = -1] = 0.5, P[x = 1] = 0.5)$, and multiply all actual residuals associated to that firm with x. We then add these simulated residuals to the fitted values from the model under the null. We use 500 iterations.

3.2.3 Accounting for Heteroskedasticity and Error Components

Before calculating the test statistic, we adjust the residuals to account for heteroskedasticity and random firm effects. This requires the estimation of a parametric form of the residual variance-covariance matrix. Because not all off-diagonal elements are equal to zero, we cannot use a standard heteroskedasticity-consistent covariance matrix estimator as suggested by MacKinnon (1989). We follow the approach of Li/Stengos (1994), and we parameterize the variance - covariance matrix using a fixed covariance parameter (which is the same for all firms) for the off-diagonal elements associated to one firm and a fully unrestricted vector for the diagonal elements, and we restrict all other elements to zero. This is a reasonable choice for two reasons. First, our determinant variables are likely to capture most economy-wide time-dependent variation in bonus payments. On the other hand, we cannot reasonably assume that we can observe all firm-specific factors that lead to cross-sectional variation. Therefore, estimating random firm effects is a reasonable choice. Second, we cannot rule out heteroskedasticity with respect to the covariance parameter, and a model for constant diagonal elements but varying off-diagonal elements is available.[10] However, for a situation where heteroskedasticity is possible both in the diagonal and the off-diagonal elements, Baltagi/Bresson/Pirotte (2005) show that using a fixed covariance parameter and a fully unrestricted vector of diagonals is the method of choice.

Heteroskedasticity in the diagonal elements is clearly driven by firm- and year- specific factors. However, the attempt to set up a parametric model for the residual variance is risky, because misspecification will result in unreliable inference. Therefore, we apply a semiparametric approach. In particular, we use kernel estimation for the diagonal elements, described in detail by Robinson (1988), implemented by Li/Stengos (1994) for the panel regression case. The element σ^2_{it} is calculated as a weighted average of residuals (from the unrestricted estimation) associated to firm-years whose determinant variables size, risk and performance are close to the values for firm-year it. Weighting is accomplished by using the standard normal density as a kernel function.

We similarly estimate a variance-covariance function for the year-by-year regression, yet here, the covariance parameter is zero. We apply a feasible generalized nonlinear least-squares approach to estimate the models. We estimate the model ignoring the error structure, estimate the variance-covariance matrix, and subsequently use its inverse for the iterative minimization of the objective function. A fast procedure for obtaining the inverse is presented by Li/Stengos (1994), where the block diagonal structure of the variance-covariance matrix is exploited. We follow their advice to use the inverse for transforming the residuals into white noise, which allows for a straightforward implementation of the test for structural breaks, as explicitly stated in their paper. This enables us to drop Ω

[9] Davidson/Flachaire (2008) show that this distribution is the best choice in their simulation study of a heteroskedastic linear regression model.

[10] See Roy (2002).

from (4). Finally, we adjust the Li/Stengos approach for an unbalanced panel by allowing for variable sizes of the blocks in Ω.

3.3 Modelling the Benchmark Structure of Bonus Compensation

If bonus payments are determined by multiplying a sensitivity coefficient with the distance between the benchmark and the actual performance, and the benchmark is not exactly zero, structural breaks are not sufficient for modeling the bonus function. Consider a firm that only has one performance benchmark of 5% for return on assets (ROA), and pays an amount of 0.01 mEuro for each percentage point of ROA above the benchmark. Assume that it is certain that there is no minimum (constant) bonus to be paid independently of firm performance and that the firm's ROA is 12%. The bonus payment is 0.01 mEuro *100*(12%-5%) = 0.07 mEuro. The true pay performance sensitivity is 0.07 mEuro / 7% = 1. Assume the structural break model has found the break at 5%. It tries to estimate the performance sensitivity coefficient β from 0.07 mEuro = β * 0.12, which is $0.58\overline{3}$.[11]

Therefore, we define a performance benchmark model that determines the sensitivity coefficient from the distance between performance and performance benchmarks. We hypothesize that there is a floor benchmark, where no bonus is paid below this benchmark, and a cap benchmark, where any increase of performance beyond this cap does not alter the bonus payment. This hypothesis implies that sensitivity coefficients $\beta_9, \beta_{10}, \beta_{11}$ and β_{12} in the following model are zero.

$$
\begin{aligned}
BON_{it} \quad = \quad & SIZE^{\beta_1}\Big[\beta_2 + \beta_3 LEV_{it} + \beta_4 MTB_{it} + \beta_5\left(PERF_{it-1} - PERF_{it}\right) + \beta_6 RISK_{it} \\
& + \left(\beta_7 + \beta_8 RISK_{it}\right)\min\left\{BM_1, PERF_{it}\right\} \\
& + \left(\beta_9 + \beta_{10} RISK_{it}\right)\max\left\{0, \min\left\{BM_2, PERF_{it}\right\} - BM_1\right\} \\
& + \left(\beta_{11} + \beta_{12} RISK_{it}\right)\max\left\{0, PERF_{it} - BM_2\right\}\Big].
\end{aligned} \tag{5}
$$

Estimation of the location of the benchmarks is slightly more difficult than the search for structural breaks. We treat the benchmarks as parameters and include them in the minimization procedure for the generalized nonlinear least squares objective function. Because derivatives with respect to BM_1 and BM_2 are not continuous, we apply a derivative-free minimization approach (DFMA) for these, while we conduct a complete Levenberg-Marquardt minimization at each iteration of the DFMA. First, we determine the location of the first benchmark, and then, using its location, we determine the location of the second benchmark.

We test for the existence of the first benchmark by applying a standard test for nonlinear nested models.[12] We estimate the model with one benchmark to calculate from it the unrestricted sum of squared residuals ($USSR$), and estimate the restricted model (2) to calculate the restricted sum of squared residuals ($RSSR$). Before calculating the sums,

[11] In regression model (3), this is equivalent to $\beta_7 + \gamma_7$.

[12] See Wooldridge (2002), p. 371 for details.

the residuals are transformed into white noise according to the procedure suggested by Li/Stengos (1994) so as to to account for the panel data structure and heteroskedasticity. To test for the existence of the second benchmark, we proceed similarly, but calculate the $USSR$ from the model with two benchmarks, and calculate the $RSSR$ using the result for the first benchmark and the restriction that there is only one benchmark. We calculate the test statistic

$$\frac{RSSR - USSR}{USSR}\frac{N-P}{Q}, \tag{6}$$

where N is the number of all observations, P is the number of parameters of the unrestricted model and Q is the number of restrictions. The statistic has an $\mathcal{F}(Q, N-P)$-distribution under the null hypothesis, i.e. if the restriction were true.

3.4 Hypothesis Tests for Individual Parameters

In order to test for the signifinance of individual parameters β_j, we test conditional on the assumption that the structural breaks and benchmarks are at the location estimated from the unrestricted model, and thus treat them as fixed. We first estimate the unrestricted model and calculate the $USSR$, then we separately fix each individual parameter to zero, reestimate and calculate the $RSSR$. Before squaring the residuals, these are transformed into white noise following the procedure suggested by Li/Stengos (1994). The test statistic is identical to (6).

3.5 Hypothesis Tests for Changes of Parameters over Time

Once the structural breaks and benchmarks have been found, the pooled panel dataset is split into one set for each year. Parameters are estimated for each year separately. Then, for two consecutive years, the dataset is pooled, and separately for each parameter, a test is conducted for a structural break between the observations in the first year and the observations in the second year. The test is identical to (6), where N is equal to the number of observations in both years.

4 Data

Compensation data was hand collected from the annual reports for the years from 2006 to 2009. The initial sample consisted of all firms the shares of which were listed in the Prime All Share Index of the German Stock Exchange, Frankfurt am Main. This index represents all corporations who chose to comply with the advanced listing standards as set out by the Deutsche Boerse AG.[13] The index includes all members of the benchmark indices DAX, MDAX, SDAX and TecDAX. i.e. the German *blue chips*, and (in 2009) 195 other firms. For a considerable number of firms, relevant compensation data was not available in spite of the general disclosure obligation, especially for those firms who

[13] Most of the firms in the Prime All Share Index are German, but 27 firms are incorporated in another European country.

	n	BON	Net Income	$SIZE$	$RISK$	$PERF$	LEV	MTB
2006	167	0.69	439.8	30,474.5	10.2%	8.0%	57.29%	3.47
2007	181	0.83	461.1	29,418.9	11.0%	4.8%	55.59%	2.89
2008	202	0.53	136.2	28,815.7	14.8%	1.3%	58.52%	1.46
2009	222	0.46	121.5	22,721.7	16.9%	-1.5%	57.07%	1.96
total	772	0.62	273.8	27,563.5	13.5%	2.8%	57.15%	2.38
std.d.		1.02	1,072.96	148,989.72	25.86%	22.69%	23.13%	3.45

Table 1: Summary Statistics

chose to take advantage of the opt-out clause: The firm can abstain from disclosure of individual directors' compensation data if a 75% majority of shareholders chooses to give their consent in the AGM. The number of firms for which data was available increases over the years. Firms with a financial year end between January and June of year X were assigned to year X-1, and firms with a financial year end between July and December of year X were assigned to year X.

We included only those firms where information on the individual bonus payment for the CEO was available. For firms where only one director was appointed, this sole director was treated as CEO. When a CEO was in charge for less than 12 months during the financial year, we annualized her bonus by simply extrapolating it to a 12-months interval, except if she was regular director before. According to the disclosure statute, we count as bonus all performance-related remuneration that is not explicitly of a 'long-term' nature. Bonus data (BON) is measured in millions of Euros.

Accounting data - which are from the consolidated accounts - are from Compustat Global, where available. Missing accounting data was retrieved by hand from annual reports. Net income and total assets ($SIZE$) is measured in terms of millions of Euros. As performance measure $PERF$, net income is divided by total assets to provide for a performance measure independent of size. This is common practice in the executive compensation literature.[14] Capital market data for retrieving $RISK$ and MTB is from Datastream. Table 1 provides general information on the firms in the sample. $RISK$ is the idiosyncratic fraction of stock price return volatility, i.e. a measure of idiosyncratic risk, which also serves as proxy for the level of information asymmetry between shareholders and management.[15] MTB is the market value of equity divided by the book value of equity. LEV is total assets minus book equity divided by total assets.

[14]See, for instance, Jackson et al. (2008), who discuss alternative measures of performance.

[15]This measure has also been used in the analysis of linear determinants of total board compensation in German firms by Rapp/Wolff (2010).

5 Results

5.1 Panel Regression Model

5.1.1 Base Model

Table 2 provides parameter estimates for the base model (2) without structural breaks or benchmarks, estimated from the pooled data from 2006 through 2009. The estimate for β_7 provides support for a significantly positive relationship between performance and CEO bonus compensation. However, the explanatory power of all regressors appears weak in that model. The data exhibit further small but significantly positive (+) respectively negative (-) relationships between bonus and leverage (-), bonus and the market to book - ratio (+) and bonus and risk (-). Previous year net income is not a significant determinant of CEO bonus. Firms with higher risk exhibit lower pay-performance sensitivity, consistent to the hypothesis of risk-averse directors. The squared correlation between fitted values and observed bonus is low (8.2%) and points at potential weaknesses of model (2). This weakness could, for instance, be due to nonlinearities in the performance - bonus relationship, or due to instability of parameter estimates over time. We focus on these weaknesses by considering our hypotheses H1 to H3 with regard to the nonlinearities, and considering H4 to H7 with regard to the dynamic nature of compensation contracts.

parameter	value	stat.	p-value
β_1	0.4038	826.9	<0.0001
β_2	0.0532	244.28	<0.0001
β_3	-0.0439	141.51	<0.0001
β_4	0.0015	23.34	<0.0001
β_5	-0.012	0.79	0.3744
β_6	-0.0132	7.76	0.0055
β_7	0.0686	37.02	<0.0001
β_8	-0.0783	3.73	0.0538
n	772		
SSE	4,091.17		
TSSE	1,865.06		
ρ^2	8.2%		

Table 2: Parameter Estimates for the Base Panel Regression Model

Parameter estimates for the regression model

$$\begin{aligned} BON_{it} &= SIZE_{it}^{\beta_1}\Big[\beta_2 + \beta_3 LEV_{it} + \beta_4 MTB_{it} + \beta_5 \left(PERF_{it-1} - PERF_{it}\right) \\ &\quad + \beta_6 RISK_{it} + \beta_7 PERF_{it} + \beta_8 RISK_{it} PERF_{it}\Big], \end{aligned}$$

where BON is the bonus paid to the CEO, LEV is leverage, MTB is market to book, $PERF$ is return on assets and $RISK$ is the portion of stock return volatility not explained by the one-factor market model. Estimation is accomplished using a feasible generalized nonlinear least squares procedure. Random firm effects and heteroskedasticity in the residuals are accounted for by adjusting the first-stage residuals. Test statistic (6) is calculated for testing individual parameters, where in the restricted model the parameter in question is set to zero. SSE is the sum of squared residuals, TSSE is the sum of squared transformed residuals where a semiparametric approach is used for estimating the parameters of the variance-covariance matrix of residuals, and the transformation (following the Li/Stengos (1994) approach) is done by using the estimate of Ω^{-1} obtained after the first stage of estimating model (3), so that the TSSE of model (2) and model (3) can be compared. ρ^2 is the squared correlation between the fitted values of the model and the realized bonuses.

5.1.2 Structural Breaks in the Panel Regression Model

The tests for structural breaks in parameters β_7 and β_8 in model (2) show that both S_1 and S_2 in model (3), estimated from the pooled 2006-2009 dataset, are significant. The first break is at a ROA level of -5.2%; the second break is at +7.1%. This indicates that firms allow for a bonus payment even if net income is negative. 28% of the firms in the pooled sample exhibit a ROA above 7.1%. This is surprisingly low, because we would generally expect that the performance ceiling is identical to a level of performance which can only be reached by top performing firms, for instance by the top 10%. However, except for 2006, S_1 is considerably higher than the annual average of ROA over all firms.

Break	location	stat.	bootstrapped p-value
S_1	-0.0520	7.1189	0.036
S_2	0.0705	6.3433	0.020

Table 3: Location and Test Results for Structural Breaks in the Base Panel Regression Model

Structural breaks in parameters β_7 and β_8 of regression model (2) are estimated and tested for, where the break is assumed to occur in the domain of $PERF$. Estimates and separate test statistics for S_1 and S_2 are obtained by maximizing a modified version of Lamarche's (2003) test for unknown structural breaks. Heteroskedasticity and Random firm effects are accounted for by adjusting the residuals after estimating the error component parameters using a semiparametric approach. Under the null hypothesis of no break, the test statistic for break S_1 follows the bootstrapped distribution shown in 1. The distribution is very similar for S_2. P - values are equal to the fraction of bootstrapped values above the test statistics shown in the table.

Figure 1 shows the bootstrapped distribution of the test statistic for the lower break S_1 under the null hypothesis of no break. Its shape is - to some extent - similar to that of a χ^2- distribution. While the test statistic is 7.12, 96.4% of the simulated values under the null hypothesis are below it. Similar results on the shape and on the p-value hold for the test for the second break.

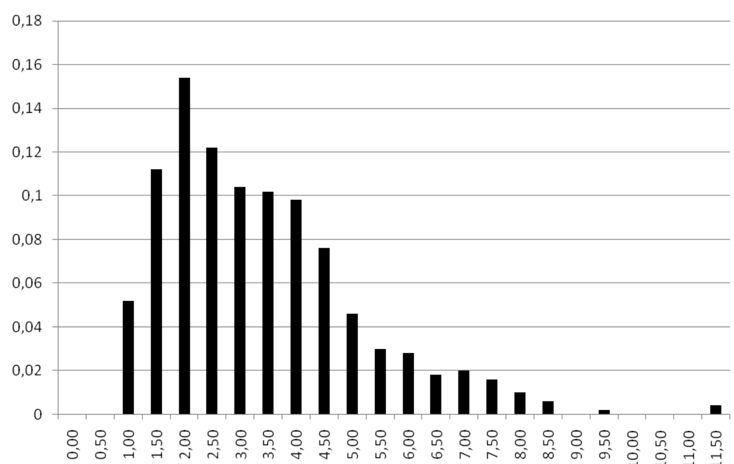

Figure 1: Bootstrap Distribution of the Test Statistic under the Null Hypothesis for Break S_1

The histogram shows the distribution of bootstrapped values of the statistic for testing for one structural break in parameters β_7 and β_8 in model(2), in the $PERF$ domain, under the null hypothesis of no break.

Table 4 shows parameter estimates for model (3) which provides for two structural breaks at S_1 and S_2. The inclusion of breaks doubles the explanatory power of the model, which is still rather low (16%). There is strong evidence in support of hypotheses H1, H2 and H3: while the pay-performance sensitivity for performance levels below S_1 and above S_2 is close to zero (parameters β_7 and β_{11}), it is roughly 0.45 for performance levels between S_1 and S_2. This means that one additional percentage point of ROA would be rewarded with an amount of 450.000 Euros multiplied with $SIZE^{0.4}$. This result is remarkably different from the results obtained by Rapp/Wolff (2010) in their recent study of a similar sample of German executive compensation data, who find that the pay-performance relationship is either insignificant or negative (depending on the specification of their model). The reasons for this difference are: (a) the relationship between performance and executive compensation varies among the different components of remuneration. The salary is usually independent of performance. While long term incentives are measured based on the fair value of the options and other instruments granted during the financial year in the Rapp/Wolff study, the economically significant pay-performance relationship for long-term incentive programs only realizes some years after the grant. Only the bonus payment will exhibit a straightforward relationship to performance measured based on accounting profit. (b) The relationship between performance and bonus is clearly positive only for a limited interval of corporate performance, but not for very high or very low performance. Therefore, forcing the relationship into a linear form over the complete domain will conceal most of the pay performance sensitivity.

The low explanatory power of model (3) could, for instance, be due to misspecification or be related to instability of compensation patterns over time. We will address both potential reasons in the following paragraphs.

parameter	value	-stat.	p-value
β_1	0.3769	971.04	<0.0001
β_2	0.0534	211.70	<0.0001
β_3	-0.0417	95.92	<0.0001
β_4	0.0015	20.24	<0.0001
β_5	-0.0008	3.37	0.0668
β_6	-0.0225	11.92	0.0006
β_7	0.0543	19.98	<0.0001
β_8	-0.0960	6.3	0.0123
γ_7	0.4491	134.61	<0.0001
γ_8	-1.1781	4.94	0.0265
δ_7	0.0065	3.32	0.0688
δ_8	0.1571	8.36	0.0039
n	772		
SSE	1,843.43		
TSSE	1,711.12		
ρ^2	15.9%		

Table 4: Parameter Estimates for the Base Panel Regression Model with Two Structural Breaks

Parameter estimates for the regression model

$$\begin{aligned} BON_{it} \quad = SIZE_{it}^{\beta_1} \quad & \Big[\beta_2 + \beta_3 LEV_{it} + \beta_4 MTB_{it} + \beta_5 \left(PERF_{it-1} - PERF_{it}\right) \\ & + \beta_6 RISK_{it} + \left(\beta_7 + \gamma_7 1_{a,it} + \delta_7 1_{b,it}\right) PERF_{it} \\ & + \left(\beta_8 + \gamma_8 1_{a,it} + \delta_8 1_{b,it}\right) RISK_{it} PERF_{it}\Big], \end{aligned}$$

where BON is the bonus paid to the CEO, LEV is leverage, MTB is market to book, $PERF$ is return on assets and $RISK$ is the portion of stock return volatility not explained by the one-factor market model. $1_{a,it}$ is an indicator variable equal to 1 if $S_1 < PERF_{it} \leq S_2$, otherwise 0, and $1_{b,it}$ is equal to 1 if $S_2 \leq PERF_{it}$, else zero. S_1 and S_2 are estimated by maximizing a modified version of Lamarche's (2003) test statistic. Estimation of all other parameters is accomplished using a feasible generalized nonlinear least squares procedure. Random firm effects and heteroskedasticity in the residuals are accounted for by adjusting the first-stage residuals. Test statistic (6) is calculated for testing individual parameters in β, γ and δ, where in the restricted model the parameter in question is set to zero, and where S_1, S_2 are treated as fixed. SSE is the sum of squared residuals, TSSE is the sum of squared transformed residuals where a semiparametric approach is used for estimating the parameters of the variance-covariance matrix of residuals, and the transformation (following the Li/Stengos (1994) approach) is done by using the estimate of Ω^{-1} obtained after the first stage of the estimation. ρ^2 is the squared correlation between the fitted values of the model and the realized bonuses.

5.1.3 Year-by-year Estimation

When considering the results for the parameter estimates of model (3) when estimated year by year, three remarkable observations can be made. First, performance sensitivity factors change over time. Second, the pay-performance relationship becomes stronger over time; in 2006, the coefficients of $PERF$ were not significant, in 2009, the coefficients for adjusted performance above the first structural break are both significantly positive. Third, variability over time is substantial, because the use of year-specific estimates substantially increases explanatory power. However, it is difficult to draw further conclusions from the observed values of parameters. The existing literature points at lower and upper benchmarks for performance, and this calls for incorporating the benchmark structure into the econometric model.

5.2 Benchmark Model

5.2.1 Panel Dataset

The estimates for the lower and upper performance benchmarks are -0.03% and 20%, and both estimates are significantly different from the highest value of ROA among all firms in the sample. That means that indeed, firms use a minimum benchmark and an upper limit to the bonus. Principal - agent theory would suggest that the minimum benchmark be above zero, possibly equal to the return provided by an investment into a diversified portfolio. However, the lower benchmark is below zero, indicating that some portion of the CEO bonus is paid despite of performance lying below the opportunity cost of capital. The upper limit to the bonus when a performance ceiling of 20% ROA is reached can be seen as a reasonable cap to the bonus. In a competitive environment, a return on assets above that limit would usually be an indicator of an unsustainable strategy.

Benchmark	location	stat.	p-value
BM_1	-0.0314	47.7324	$<$0.0001
BM_2	0.2012	30.8373	$<$0.0001

Table 6: Locations and Test Statistics for the Performance Benchmarks

Estimates of BM_1 and BM_2 in model 5. Estimates are obtained by minimizing the sum of weighted squared residuals in a feasible generalized nonlinear least squares approach. Test statistics are separately obtained by calculating 6, where the restiction is identical to nonexistence of the benchmark, implying a flat bonus function. Before calculating the statistic, residuals have been adjusted so as to reflect heteroskedasticity and random effects after applying a semiparametric estimator for the error components.

Under consideration of the explanatory power of the pooled benchmark model, this model specification can be seen as a more plausible approach than the structural break approach (3). Its explanatory power is 48.4%, when measured in terms of the squared correlation between fitted right hand side values and observed bonus payments. The values of the performance sensitivity parameters is in line with our hypotheses H1 through H3: the relationship between ROA and bonus when ROA is below BM_1 is insignificant (β_7), the coefficient between the lower and the upper benchmark is 0.23 and significantly positive (β_9), and above the performance ceiling, the relationship is insignificant as well (β_{11}). There is a significant relation between the bonus and leverage (negative) and between the bonus and the market to book ratio (positive). The coefficient for lagged performance is insignificant (β_5). Between 2006 and 2009,firms on average determine their bonus solely with regard to performance in one financial year.

	2006	stat.	p-val.	2007	stat.	p-val.	2008	stat.	p-val.	2009	stat.	p-val.
β_1	0.3933	204.90	<0.0001	0.3348"	170.97	<0.0001	0.4256'	663.33	<0.0001	0.4769	678.52	<0.0001
β_2	0.0527	31.93	<0.0001	0.0866"	11.81	0.0007	0.0210'	10.37	0.0015	0.0159	195.59	<0.0001
β_3	-0.0363	9.17	0.0029	-0.0396'	2.32	0.1296	-0.0259	260.56	<0.0001	-0.0171	571.50	<0.0001
β_4	0.0003	0.23	0.6322	0.0019"	2.42	0.1217	0.0026	8.16	0.0048	0.0013	9.20	0.0027
β_5	0.0425	2.37	0.1257	-0.0048"	5.51	0.0201	0.0136	0.58	0.4473	0.0165	2.47	0.1175
β_6	-0.0307	0.39	0.5332	-0.2560"	3.09	0.0806	0.0625'	106.03	<0.0001	0.0130"	3.63	0.0581
β_7	0.1306	0.97	0.3262	0.3305'	0.24	0.6248	-0.0055	0.08	0.7776	0.0044	0.10	0.7521
β_8	-0.3981	0.53	0.4677	-1.2804	0.27	0.6040	0.3999	6.75	0.0101	0.0418"	2.02	0.1567
γ_7	0.0358	0.10	0.7523	0.3546	0.22	0.6396	0.5459	130.58	<0.0001	0.1202"	10.57	0.0013
γ_8	0.4013	0.19	0.6635	2.0389"	0.32	0.5724	-2.9931	55.57	<0.0001	-0.0490"	0.03	0.8627
δ_7	-0.1320	1.03	0.3117	-0.2386	0.12	0.7259	0.1974	14.65	0.0002	0.3060	22.98	<0.0001
δ_8	0.7081	1.51	0.2210	1.6449'	0.44	0.5080	-1.0480	28.33	<0.0001	-1.3294	4.66	0.0320
n	167			181			202			222		
SSE	83.65			127.83			46.11			47.79		
TSSE	139.59			159.99			189.64			212.68		
ρ^2	61.8%			59.0%			65.9%			63.0%		

Table 5: Parameter Estimates for the Structural Break Model Year by Year

Parameter Estimates for model

$$\begin{aligned} BON_i &= SIZE_i^{\beta_1} \Big[\beta_2 + \beta_3 LEV_i + \beta_4 MTB_i + \beta_5 \left(PERF_i^{(t-1)} - PERF_i\right) \\ &\quad + \beta_6 RISK_i + \left(\beta_7 + \gamma_7 1_{a,i} + \delta_7 1_{b,i}\right) PERF_i \\ &\quad + \left(\beta_8 + \gamma_8 1_{a,i} + \delta_8 1_{b,i}\right) RISK_i PERF_i\Big], \end{aligned}$$

estimated separately for each year, where BON is the bonus paid to the CEO, LEV is leverage, MTB is market to book, $PERF$ is return on assets, $PERF_i^{(t-1)}$ is lagged return on assets, and $RISK$ is the portion of stock return volatility not explained by the one-factor market model. $1_{a,i}$ is an indicator variable equal to 1 if $S_1 < PERF_i \leq S_2$, otherwise 0, and $1_{b,i}$ is equal to 1 if $S_2 \leq PERF_i$, else zero. S_1 and S_2 are estimated by maximizing a modified version of Lamarche's (2003) test statistic using the ensemble of the observations from all years. Estimation of all other parameters is accomplished using a feasible generalized nonlinear least squares procedure. Heteroskedasticity in the residuals is accounted for by adjusting the first-stage residuals. Test statistic (6) is calculated for testing individual parameters in β, γ and δ, where in the restricted model the parameter in question is set to zero, and where S_1 and S_2 are treated as fixed. SSE is the sum of squared residuals, TSSE is the sum of squared transformed residuals where a semiparametric approach is used for estimating the diagonal elements of the variance-covariance matrix of residuals, and the transformation is done by using the estimate of Ω^{-1} obtained after the first stage of the estimation. ρ^2 is the squared correlation between the fitted values of the model and the realized bonuses. *Two (one) dash indicate(s) that the parameter underwent a significant change at the 99% (95%) confidence level compared to its value in the previous year.*

parameter	value	stat.	p-value
β_1	0.3976	922.68	<0.0001
β_2	0.0312	32.38	<0.0001
β_3	-0.0265	21.91	<0.0001
β_4	0.0008	6.27	0.0125
β_5	-0.0015	1.27	0.2601
β_6	-0.0137	1.43	0.2321
β_7	0.0070	0.43	0.5122
β_8	-0.0592	0.83	0.3626
β_9	0.2287	186.21	<0.0001
β_{10}	-0.0433	2.30	0.1298
β_{11}	0.1600	2.19	0.1393
β_{12}	-3.8282	5.06	0.0248
n	772		
SSE	424.15		
TSSE	1,580.03		
ρ^2	48.4%		

Table 7: Parameter Estimates for the Benchmark Model

Parameter estimates for the regression model

$$\begin{aligned} BON_{it} \quad = \quad & SIZE^{\beta_1}\Big[\beta_2 + \beta_3 LEV_{it} + \beta_4 MTB_{it} + \beta_5 \left(PERF_{it-1} - PERF_{it}\right) + \beta_6 RISK_{it} \\ & + \left(\beta_7 + \beta_8 RISK_{it}\right) \min\left\{BM_1, PERF_{it}\right\} \\ & + \left(\beta_9 + \beta_{10} RISK_{it}\right) \max\left\{0, \min\left\{BM_2, PERF_{it}\right\} - BM_1\right\} \\ & + \left(\beta_{11} + \beta_{12} RISK_{it}\right) \max\left\{0, PERF_{it} - BM_2\right\}\Big], \end{aligned}$$

where BON is the bonus paid to the CEO, LEV is leverage, MTB is market to book, $PERF$ is return on assets and $RISK$ is the portion of stock return volatility not explained by the one-factor market model. Parameters, including BM_1 and BM_2, are estimated by using a feasible generalized nonlinear least squares approach. Random firm effects and heteroskedasticity in the residuals are accounted for by adjusting the first-stage residuals. Test statistic (6) is calculated for testing individual parameters in β, where in the restricted model the parameter in question is set to zero, and where $BM_1$and BM_2 are treated as fixed. SSE is the sum of squared residuals, TSSE is the sum of squared transformed residuals where a semiparametric approach is used for estimating the parameters of the variance-covariance matrix of residuals, and the transformation (following the Li/Stengos (1994) approach) is done by using the estimate of Ω^{-1} obtained after the first stage of the estimation. ρ^2 is the squared correlation between the fitted values of the model and the realized bonuses.

5.2.2 Year-by year Estimation

Inspection of parameter estimates from the year-by-year analysis reveals that both the relationship between control variables and bonus and between performance and bonus has only become significant in the later years. The main measure of pay-performance sensitivity, β_9, has been insignificant in 2007, after being significantly positive in 2007. This could be an indication of compensation practices not in line with what standard principal-agent theory would suggest. However, after 2007, the parameter has become significantly positive again. Yet, when looking at the significance of changes, we see that it was not before 2009 that $\beta_9$underwent a significantly positive change. This provides support for H4; however, it was not directly after the introduction of the disclosure obligation, but only three years later that compensation contracts exhibited a significant change towards a stronger pay-performance relationship. This casts doubt as to whether transparency was capable of promoting adjustments to the structure of executive compensation. As pointed out earlier in this paper, in 2009 another law was passed that stipulates a duty of supervisory boards to ensure that compensation practices are within bounds of 'reasonableness'. While it is argued that this law does not require the firms to immediately change existing contracts but only applies to the design of new contracts, some firms probably have begun to adjust their contracts to reflect the notion of reasonableness. The significant change of β_9 thus probably reflects changes in behaviour induced by duties of supervisory boards, and not the disciplining effect of transparency.

Apart from that, the coefficient for lagged performance is insignificant except for 2007, where it was negative. The fact that it has become positive, yet insignificant, shows that there could be a subtle tendency not to reward steep upward surprises in performance. Risk (β_6) has become a significantly positive determinant of bonus, indicating that executives have become increasingly risk averse. This is loosely consistent to Wang et al. (2010) who find evidence of increased risk aversion among executives following an increase in regulatory action in the field of corporate governance.

With regard to H5, we can observe that there was no significant relationship between additional bonus and additional performance above the performance ceiling until 2008. However, in 2009, there is a significantly negative relationship (β_{11}). This is a surprising result, because it implies that the more the performance exceeds the performance ceiling, the more the bonus to be paid to the CEO is *reduced*. Formally, we cannot find support for H5, because changes to β_{11} were not significant (in table 8, dashes indicate variables that underwent a significant change compared to the previous year). Economically, we have to confirm H5 because indeed, the sensitivity parameter has decreased. However, a negative parameter is inconsistent to prior theory. One possible explanation for the phenomenon is that some firms with an extraordinarily high ROA were subject to substantial effects on performance that were eliminated from net income before determining the bonus, and the true determinant of the bonus was indeed lower than the performance ceiling.

H6 cannot be confirmed by the evidence, because neither were changes to β_5 significant, nor was it significantly different from zero itself. Thus, firms seem not to have considered previous year performance for determining the bonus during the financial years 2006 to 2009.

In order to analyze a potential race to the top effect, we calculate the bonus that would be paid to the CEO of a firm that is identical to the average firm of our sample, i.e. whose general characteristics are identical to the last line of table 1. As performance and as lagged performance, we choose the midpoint between BM_1 and BM_2. Because we calculate the bonus for a firm that is hypothesized to have reached this midpoint, we call this measure "conditional bonus". Table 9 shows that this conditional bonus decreased from 2006 to 2007, but began to increase from 2007 on, despite the decreasing levels of actual bonus payments (caused by decreasing levels of firm performance). We conclude that the empirical evidence supports the hypothesis of a race to the top, i.e. our hypothesis H7.

parameter	2006	stat.	p-val.	2007	stat.	p-val.	2008	stat.	p-val.	2009	stat.	p-val.
β_1	0.4299	218.46	<0.0001	0.3522”	146.28	<0.0001	0.4663”	733.84	<0.0001	0.4242	1,396.94	<0.0001
β_2	0.0103	0.89	0.3469	0.1042”	6.86	0.0096	0.0178”	9.51	0.0024	0.0132	18.26	<0.0001
β_3	-0.0072	0.57	0.4514	-0.0450	3.28	0.0719	-0.0248	391.06	<0.0001	-0.0250	1,403.00	<0.0001
β_4	-0.0003	0.51	0.4762	0.0011	0.98	0.3236	0.0026	26.5	<0.0001	0.0028	13.54	0.0003
β_5	0.0253	1.17	0.2811	-0.0059	13.38	0.0003	0.0028	0.04	0.8417	0.0176	1.36	0.2452
β_6	0.0333	0.53	0.4677	-0.2290’	1.48	0.2255	0.0409	46.15	<0.0001	0.0415”	4.12	0.0439
β_7	-0.0244	0.04	0.8417	0.5054	0.32	0.5724	0.0036	0.08	0.7776	-0.0131	0.42	0.5178
β_8	0.1956	0.16	0.6897	-1.9029	0.34	0.5606	0.1920	2.06	0.1531	0.1245	1.70	0.1941
β_9	0.2067	17.54	<0.0001	0.0577	0.15	0.6990	0.1279	16.60	0.0001	0.3135”	29.57	<0.0001
β_{10}	-0.2917	1.02	0.3141	0.5986’	0.13	0.7189	-0.3846	23.81	<0.0001	-0.5914”	1.81	0.1803
β_{11}	0.0647	2.48	0.1173	-0.6546	0.79	0.3754	2.0329	0.20	0.6553	-1.8498	4.02	0.0466
β_{12}	-1.4437	2.24	0.1365	0.3156’	0.09	0.7645	-16.0943	0.20	0.6553	8.6382	1.80	0.1815
n	167			181			202			222		
SSE	72.95			134.18			50.85			48.15		
TSSE	142.81			159.33			188.82			210.54		
ρ^2	66.6%			57.0%			62.8%			62.7%		

Table 8: Parameter Estimates for the Benchmark Model Year by Year

Parameter estimates for the regression model

$$\begin{aligned} BON_i \quad = \quad & SIZE^{\beta_1}\Big[\beta_2 + \beta_3 LEV_i + \beta_4 MTB_i + \beta_5\left(PERF_i^{(t-1)} - PERF_i\right) + \beta_6 RISK_i \\ & + (\beta_7 + \beta_8 RISK_i)\min\{BM_1, PERF_i\} \\ & + (\beta_9 + \beta_{10} RISK_i)\max\{0, \min\{BM_2, PERF_i\} - BM_1\} \\ & + (\beta_{11} + \beta_{12} RISK_i)\max\{0, PERF_i - BM_2\}\Big], \end{aligned}$$

where BON is the bonus paid to the CEO, LEV is leverage, MTB is market to book, $PERF$ is return on assets, $PERF^{(t-1)}$ is lagged return on assets, and $RISK$ is the portion of stock return volatility not explained by the one-factor market model. Parameters, including BM_1 and BM_2, are estimated by using a feasible generalized nonlinear least squares approach. BM_1 and BM_2 are estimated from the ensemble of observations from all years. Heteroskedasticity in the residuals is accounted for by adjusting the first-stage residuals. Test statistic (6) is calculated for testing individual parameters in β, where in the restricted model the parameter in question is set to zero, and where $BM_1$and BM_2 are treated as fixed. SSE is the sum of squared residuals, TSSE is the sum of squared transformed residuals where a semiparametric approach is used for estimating the diagonal elements of the variance-covariance matrix of residuals, and the transformation (following the Li/Stengos (1994) approach) is done by using the estimate of Ω^{-1} obtained after the first stage of the estimation. ρ^2 is the squared correlation between the fitted values of the model and the realized bonuses. *Two (one) dash indicate(s) that the parameter underwent significant change at the 99% (95%) confidence level compared to its value in the previous year.*

year	conditional bonus
2006	2.38
2007	2.14
2008	2.73
2009	2.92

Table 9: Conditional Hypothetical Bonus paid to the CEO of the Average Firm

Using the year-specific parameter estimates for model (5), using average values for the independent variables except return on assets, obtained from the complete 4-year sample, and assuming that return on assets is identical to the midpoint between the lower performance benchmark and the upper performance ceiling, we calculate the bonus that would be paid to the CEO. We call this the 'conditional bonus'. It is a measure of the general level of variable executive compensation, determined independently of realized performance.

6 Conclusion

A nonlinear regression model with structural breaks was presented to show nonlinearities in the relationship between performance and CEO bonus compensation. The common benchmark structure of compensation contracts has been incorporated into the model. German CEO bonus payments exhibit a strong positive relationship to return on assets in the range between ROA of -3% to +20%. Below -3% and above 20%, there is no significant pay-performance relationship. The pay-performance parameter over the intermediate range exhibits insignificant changes between 2006 and 2008, but a significant and substantial increase from 2008 and 2009. The evidence indicates that while a new disclosure obligation for individual CEO pay introduced in 2005 (in force from 2006) was not capable of provoking subsequent significant changes to compensation structures, a law that stipulates reasonableness of remuneration contracts, introduced in 2009, could have led to higher performance sensitivity. We also calculated a measure of a conditional bonus, i.e. the amount of bonus the average firm would pay to its CEO if the performance would be identical to the midpoint between -3% and 20%. This measure has increased each year between 2007 and 2009, while levels of realized bonuses have decreased due to a decrease in realized profits. This indicates that transparency did not lead to a decrease of conditional variable compensation.

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