

On the Role of CEO Incentives in the Allocation of Managerial Efforts to Macroeconomic Fluctuations

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Abstract

This paper examines whether CEO remuneration schemes distort managerial effort by encouraging CEOs to focus excessively on outcomes driven by macroeconomic conditions rather than on real, competition-enhancing actions. Because macroeconomic shocks differ from competitive shocks in volatility, persistence, and the link between effort and cash flows, compensation structures may unintentionally reward “competing on luck.” Using data on 2,795 U.S. CEOs over 22 years, we find that: (1) compensation contracts dampen incentives to manage firm-specific competitive risks while still rewarding results influenced by macroeconomic factors; (2) macroeconomic conditions significantly affect CEO pay through their impact on shareholder wealth and sales; and (3) short-term performance metrics do not correct this imbalance. Overall, our findings suggest that CEOs may devote disproportionate effort to benefiting from macroeconomic variation at the expense of real competitiveness.

Keywords: Macroeconomic Shocks, Competitive Shocks, Effort Allocation, CEO Compensation, Luck, Asymmetry, Short-termism.

JEL Codes: G30, G32, J33, E00, L14, L16, M21, M52

1. Introduction

In this paper, we investigate whether remuneration schemes result in management devoting excessive efforts to manage macroeconomic shocks instead of spending efforts on managing competitive shocks. According to Fischer (1981), a pure competitive shock is a change in demand or supply conditions that leaves the appropriately defined aggregate real output and price level unchanged although competitive shocks may also have aggregate consequences. In the following we use the concept of a competitive shock as equivalent to a firm-specific or relative shock. The impact of competitive shocks can be measured by the change in a firm's performance relative to the change in the average performance across all firms. Efforts cannot be captured directly so we argue that if the contribution of one type of shock to the volatility of remuneration exceeds the contribution of the same shock to the volatility of firm performance in terms of Q, managers' incentive to spend efforts on that type of shock can be considered excessive. We associate macroeconomic shocks that have low serial correlation with short-term shocks while competitive shocks are assumed to have longer duration and, thereby, greater value effects.¹ We assume the existence of an optimal allocation of efforts between these two kinds of shocks that would maximize shareholder value.²

We posit that there are three reasons to emphasize the distinction between macroeconomic shocks and competitive shocks in the context of effort allocation. First, managers have specific expertise in the management of competitive shocks in demand and supply conditions. The firm's competitive conditions can be affected in a variety of ways through adjustment in operations, organization, marketing, etc. Macroeconomic shocks, on the

¹ Measurement of these shocks and performance effects is discussed in more detail later in the paper.

² We do not ask why boards would allow remunerations schemes to deviate from those maximizing shareholder value, but one explanation could be that managers, who in the view of Bebchuk (2021) prefer for compensation schemes that include short-term performance measures, have a strong influence on the design of remuneration schemes.

other hand, are not strongly related to intrinsic competitive conditions and they may require different or very little managerial responses.

Second, since macroeconomic shocks affect all firms, they can be seen as factors that increase volatility of performance and remuneration. Managers' response to volatility in macroeconomic conditions is likely to depend on their degree of risk-aversion as well as on non-linearity in remuneration schemes. Competitive shocks, on the other hand, have long-term and large value effects so managers respond to these shocks based on the intrinsic competitive conditions.

Third, macroeconomic fluctuations tend to be relatively transitory and, therefore, the value effect of efforts to manage macroeconomic shocks are assumed to be smaller than of efforts to manage competitive shocks.

Asymmetry or non-linearity in compensation contracts and in the relation between shocks and performance may be of importance in the analysis of managerial efforts. Garvey and Milbourn (2006) and Gopalan et al (2010) find executives to be rewarded more for “good luck” than they are penalized for “bad luck” in total compensation.³ However, Daniel, Li and Naveen (2020) find no evidence of asymmetry in incentives when “pay for luck” is measured by changes in CEO's firm-related wealth rather than compensation in a particular period. Daniel, Li and Naveen (2020) argue that changes in firm-related wealth provide a better estimate of incentive effects of various factors as compared to estimates of compensation for a period. In our empirical analysis of managerial efforts, we follow Daniel, Li and Naveen (2020), and use their data on changes in CEOs' firm-related wealth as the measure of remuneration to capture incentives.

³ The asymmetry may be the result of a conscious effort to affect incentives, or it may be the result of managerial power and rent extraction as suggested by Bebchuk and Fried's (2003). Asymmetry may also reflect “skimming” of shareholders in the words of Bertrand and Mullainathan (2001). We will not take a position on this issue in this paper.

Besides the analysis of incentives to allocate effort and asymmetry in remuneration and performance, this paper contributes to the literature on CEO compensation by identifying and “filtering out” the impact of macroeconomic factors on changes in remuneration.⁴ Thereby, remuneration can be designed dependent on macroeconomic factors causing changes in performance. We use a method proposed by Oxelheim and Wihlborg (2008) to estimate the impact of macroeconomic shocks using macroeconomic price variables such as interest rates, exchange rates and inflation.⁵ One advantage of this method is that remuneration can be adjusted for macroeconomic shocks, as reflected in these price variables, without a considerable time lag. Another advantage is that the method can be applied on firms and subsidiaries for which stock market data is not available.

Our empirical analysis is based on the premise that incentives to devote effort to a particular shock depend on its impact on managers’ remuneration, which has two components, the impact on compensation at the time of the shock and the impact on the value of managers’ holdings of stakes in the firm. The sum of these two components is measured as ‘firm-related wealth’ following Daniel, Li and Naveen (2020). We then identify effort effects through the quadratic terms of shocks in the model we propose. The sign for the quadratic terms should be positive because of the effort effect strengthening the impact of positive shocks while dampening the impact of negative shocks. The incentives to spend efforts on managing competitive and macroeconomic shocks are here captured by decomposing the variances of changes of remuneration and changes in shareholder value. Based on a sample of 2,795 U.S. CEOs during 1993-2014, our empirical analysis reveals that the effort spent by management

⁴ Chiu, Oxelheim, Wihlborg, and Zhang (2016) provides empirical support for the importance of considering macroeconomic fluctuations in designing CEO incentive schemes.

⁵ Oxelheim and Wihlborg (2008) use these variables to identify corporate exposure to macroeconomic uncertainty and to assess a firm’s “intrinsic” competitiveness. In Section 5 below we show that adding changes in GDP to changes in the macroeconomic price variables adds no significant additional information about macroeconomic developments.

on short-term macroeconomic shocks on average are neither excessive nor insufficient in an all-firms' perspective. However, after we conduct detailed industrial studies, we find for half of our 18 studied industries excessive efforts devoted to macroeconomic shocks.

The remainder of the paper is organized as follows. In Section 2 we develop a model to identify factors that determine the optimal allocation of efforts between the two kinds of shocks from shareholders' point of view. This model provides a reference point for development of hypotheses with respect to performance and remuneration effects of competitive and macroeconomic shocks. In Section 3 we derive three hypotheses based on our model. In Section 4 we present data for changes in firm-related wealth as a measure of CEO remuneration and incentives in the U.S. for the period 1993-2014. We also present analysis of remuneration where performance measures are identified and the asymmetry of remuneration with respect to performance variables is studied. Section 5 distinguishes between competitive and macroeconomic factors and analyze how remuneration and shareholder value depend on these factors. In Section 6 we apply variance decomposition to analyze the contribution of macroeconomic variance to the total variances in remuneration and shareholder value. Concluding comments and implications for remuneration policies follow in Section 7.

2. Modeling managerial effort allocation and remuneration schemes

In this section we develop a model to analyze factors affecting the optimal allocation of managerial effort in response to competitive and macroeconomic shocks from the point of view of shareholder wealth maximization.

2.1 *Optimal effort allocation and remuneration for risk neutral managers*

The problem of allocating effort to respond to the two kinds of shocks is similar to the problem of allocating effort to two kinds of tasks but unlike the literature on multi-task effort allocation we assume that the nature of shocks can be observed in the period they occur.⁶

Shareholder value in our model is represented by Q and defined as the present value of economic rents that are generated by shocks in combination with managerial effort. Thus, Q reflects more properly the value of corporate assets. It is assumed that management can observe whether a shock is competitive or macroeconomic and influence the effects on Q of a macroeconomic shock by allocating more effort to respond to this kind of shock. By allocating more effort managers are assumed to enhance the value effects of positive shocks and dampen the impact of negative shocks.

The percent change in Q for firm i in period t is denoted ΔQ_i and expressed as follows:

$$\Delta Q_i = \alpha_i(r_i - \bar{r}_i) + \beta_i(r_i - \bar{r}_i)^2 + \lambda_i(m_i) + \theta_i(m_i)^2 \quad (1)$$

The first two terms capture effects of a competitive shock. The average shock of this kind for firm i ($\bar{r}_i$) has been expected and is therefore incorporated in Q at the beginning of the period and does not affect ΔQ_i . The coefficient α_i shows the ΔQ_i -effect of a positive or negative competitive shock at a threshold level of effort. It describes the linear effect of a positive or negative relative supply or demand shock. The second term is the squared competitive shock.

⁶ The objective of the multi-task agency literature initiated by Holmström and Milgrom (1991) is to analyze how incentive contracts can be designed to resolve a conflict of interest between a principal and an agent when information about task fulfillment is imperfect. These authors view the multitask problem in terms of balancing short-term and long-term profit incentives. An inability to give an agent a long run stake can be compensated for by reducing the power of short-term incentives as also noted in Dewatripont et al (2000). Our analysis has similar implications considering that macroeconomic shocks are relatively short-term and transitory.

If $\beta_i = 0$, managerial effort has no influence on the value effect of the shock. If $\beta_i > 0$, managerial effort strengthens the ΔQ_i -effect of a positive shock and reduces the impact of a negative shock.

The third and fourth terms represent the ΔQ_i -effects of macroeconomic shocks in a similar way. The macroeconomic shock - with mean zero - affects all firms but not necessarily in the same way. The value effect of the shock at a threshold level of effort is represented by the coefficient λ_i . The θ_i -coefficient shows that management effort can strengthen the effect of positive macroeconomic shocks and dampen the effect of negative macroeconomic shocks.

The ΔQ_i -effects of managerial effort through the β_i - and θ_i - coefficients are comparable to real options that create asymmetry in the value-effects of positive and negative shocks. The magnitude of the two coefficients depends on the ability of management to adjust operations in response to each type of shock and, thereby, to improve the performance of the firm, which is exposed to firm-specific and macroeconomic fluctuations. Firms naturally differ in their technological ability to adjust operations in response to shocks and managerial effort can enhance this ability. This view implies that macroeconomic as well as competitive shocks cannot generally be considered pure good or bad “luck”. Shi (2011) uses the term “responsible risk” when there is a return to management’s effort to respond to shocks.⁷ $\beta_i > 0$ and $\theta_i > 0$ implies that firm-specific shocks and macroeconomic shocks are “responsible risks.”

β_i and θ_i coefficients representing the value effects of effort in period t can be specified as follows:

$$\beta_i = \rho_r b_i(e_r), \quad b' > 0; \quad b'' < 0 \quad (2)$$

⁷ Shi’s (2011) empirical analysis shows that the sensitivity of CEO’s firm-related wealth to “responsible risk” is increasing in the flexibility of operations and the availability of resources to respond to risk factors.

$$\theta_i = \rho_m g_i(e_m), \quad g' > 0; \quad g'' < 0 \quad (3)$$

$$e_r + e_m = e \quad (4)$$

where ρ_r and ρ_m are serial correlation coefficients showing how long lasting the two kinds of shocks are. The higher the serial correlation of a shock in period t is, the greater is the ΔQ_t -effect of this shock. We assume that macroeconomic shocks in general have lower serial correlation than competitive shocks.

The factors $b_i(e_r)$ and $g_i(e_m)$ show the degree to which operations can be adjusted to increase cash flows by means of managerial effort. The effort enhances effects of positive shocks or dampens the effects of negative shocks. These performance effects of shocks need not be the same for competitive and macroeconomic shocks. The total amount of effort, e , can be allocated either to the competitive shock, r , or the macroeconomic shock, m . For simplicity it is assumed that available effort, e , is constant. In other words, $\partial e_m = -\partial e_r$. Thereby, we focus on the division of effort between the two kinds of shocks.⁸

To simplify the problem of effort allocation we assume that the available effort must be allocated before shocks are observed based on their expected magnitudes, the relative contribution of the shocks to firm value and the manager's ability to influence the effect of shocks on performance.

More generally, effort may also be adjusted in response to their observed magnitudes. The assumption that efforts need to be allocated or committed before the shocks are observed and can be motivated by a difference in the type of responses that are required. As an example,

⁸ The analysis would be robust to the assumption of a variable degree of total effort and a cost associated with this effort.

a firm facing exchange rate uncertainty can increase the ability to shift between domestic and foreign suppliers of inputs by using effort to keep up commitments to both suppliers. Other firms can choose effort along with the type of physical capital they invest in to enhance flexibility.⁹

The allocation of efforts is determined by the maximization of the expected ΔQ_i with respect to e_r and e_m . The first order condition can be written as:

$$\frac{\partial \Delta Q_i}{\partial e_r} + \frac{\partial \Delta Q_i}{\partial e_m} = 0 \quad (5)$$

The allocation is determined given parameters in expressions (2)-(4). Expression (6) below shows the first order condition for maximization of ΔQ_i with respect to effort, e , considering that $\partial e_m = -\partial e_r$. The derivatives of cash flow effects with respect to effort are b' and g' in (2) and g in (3). They represent impacts on the firm's cash flows of an increase in effort devoted to competitive and macroeconomic shocks, respectively. These derivatives represent the adjustability of operations to the two shocks.

$$\rho_r b' \sigma_r^2 = \rho_m g' \sigma_m^2 \quad (6a)$$

or

$$b'/g' = \rho_m \sigma_m^2 / \rho_r \sigma_r^2 \quad (6b)$$

⁹ If effort were made a function of the magnitude of a shock in each period, the non-linearity of performance effects of effort in each period would be strengthened but qualitatively unchanged.

If the condition in this expression is satisfied, the expected marginal contribution of effort on competitive shocks to ΔQ_i is equal to the expected marginal contribution of effort on macroeconomic shocks. Each marginal contribution depends on the duration of the shock and the marginal cash flow effect of effort while the variance of the shock captures the expected magnitude of the shock. If there is no variance in macroeconomic conditions, all efforts should go to competitive shocks. Similarly, if there is no serial correlation in macroeconomic shocks, they are simply noise, and all efforts should be directed towards the competitive shock. A positive shift in b' , representing the adjustability of operations at a given effort level, increases the effort allocated to competitive shocks. Generally, the wealth maximizing allocation of efforts to the two shocks can be written as:

$$e_r/e_m = f(\rho_r/\rho_m, \sigma_r^2/\sigma_m^2, b'/g') \quad (7)$$

The allocation of efforts towards competitive shocks increases with higher relative magnitude of the serial correlation in these shocks, higher relative variance of competitive shocks and greater relative adjustability of operations to competitive shocks. Correspondingly, increasing serial correlation in macroeconomic shocks, increasing variance of macroeconomic shocks and increasing adjustability to macroeconomic shocks would increase the efforts allocated towards management of macroeconomic shocks.

If managers are risk-neutral, they can be given a linear remuneration contract linked to ΔQ_i to allocate efforts with the objective to maximize shareholder wealth. Defining B' and G' as the marginal contribution to remuneration of competitive and macroeconomic shocks, respectively, the incentive of the manager to allocate effort is consistent with the condition for shareholder wealth maximization in expression (6a) if

$$\rho_r B' \sigma_r^2 = \rho_m G' \sigma_m^2. \quad (8)$$

The left-hand side of expressions (8) can be interpreted as the marginal contribution of effort on competitive shocks to the volatility of ΔQ_i and remuneration, whereas the right-hand side of the expressions are interpreted as those of macroeconomic shocks.

In the empirical analysis below, we cannot test expressions (8) directly. Instead, we posit managers inclination to adjust efforts to be based on observations of the volatility of remuneration, while in contrast shareholders would want the effort adjustment to be based on the volatility of ΔQ_i . Thus, managers only maximize shareholders' wealth if the contribution of each shock to the volatility to remuneration equals the contribution of each shock to the volatility of ΔQ_i . If the contribution of one type of shock to the volatility of remuneration exceeds the contribution of the same shock to the volatility of ΔQ_i , managers' incentive to exert effort on that type of shock can be considered excessive.

2.2 *Performance measures in remuneration*

The literature on executive compensation reveals that remuneration schemes generally include relatively short-term performance measures such as changes in sales or earnings in addition to changes in shareholder value.¹⁰ We argue that when remuneration is tied to short-term performance measures, CEOs may have excessive incentives to allocate effort toward managing macroeconomic shocks—which exhibit relatively low serial correlation—compared to a setting in which compensation also reflects the long-term value consequences of

¹⁰ References and variables are discussed in Section 4.

managerial effort, rather than only its short-term cash-flow effects.¹¹ Another way to say this is that the relative variance of shocks, σ_r^2/σ_m^2 , and the relative cash flow effects of effort, b'/g' , in expression (7) would have excessive weight in remuneration while the relative serial correlation of shocks would be downplayed.

2.3 *Effects of managers' risk-aversion*

Managers' risk-aversion may affect the previous analysis in some important ways. First, corporate boards may be inclined to offer asymmetric or non-linear remuneration contracts to negate the effects of managers' risk-aversion on shareholder wealth. Second, risk-averse managers have incentives to adjust operations or use financial contracts to reduce the volatility of remuneration. These considerations cannot be neglected in the empirical analysis. Hence, we will first analyze whether remuneration is asymmetric and non-linear in performance variables.

It was shown in expression (1) that the relationship between performance variables and shocks may be non-linear as a result of effort effects. If so, the relationship between remuneration and shocks will be non-linear as well even if the remuneration-performance contract is linear.

According to expression (1) the effort effect implies that the relationships between the change in performance and shocks are concave upwards. Explicit risk-management by risk-

¹¹ We try to do a serial correlation test on the micro and macro factors by using our panel data that contains a yearly frequency of 22 observations in time dimension. However, this sample size is not big enough for us to reject the null hypothesis of no serial correlation. Therefore, we collect another time series sample, which contains monthly observations of the same macro prices variables, i.e. interest rate changes, CPI changes, and exchange rate changes in the same period. This sample has 264 observations. Our test results show that the serial correlations of these macro price variables are very low and the effects last only for one or two months. Unfortunately, we don't have the data for the proxies of the competitive variables to compare with. Besides, we do the correlation tests between our macro and micro factors. The correlations are extremely low, between 0.15 and 0.03.

averse managers may reduce or even negate this non-linearity if they are willing to sacrifice performance in order to reduce the volatility of performance and remuneration.¹²

Financial risk-management utilizes financial contracts linked to macroeconomic price variables, in particular, such as exchange rates, oil prices and interest rates. Forward contracts enable a firm to lock in a price for future sales or deliveries in advance. Thereby, they reduce the volatility of shocks in these prices. As shown in equation (7) a reduction in the volatility of a particular shock reduces the incentive to exert efforts to respond to it by adjusting operations the way risk-neutral managers would. Therefore, financial risk-management contracts may also affect performance and remuneration negatively.¹³ These considerations may be of relevance for interpretation of the results when testing the hypotheses below, which are formulated under the assumption that managers are risk-neutral.

3. Hypotheses

The first hypothesis to be addressed refers to the possible asymmetry or non-linearity in the relation between remuneration and performance measures.

Hypothesis 1: There is a positive linear relationship between remuneration and change in performance variables.

¹² Risk-management operations may take several forms. Operational risk management can take the form of costly diversification with respect to product mix, market presence and supplier, or investment in real options that strengthen the effect of positive shocks and reduce the effect of negative shocks. Risk averse managers have incentives to sacrifice performance to achieve this real option effect while risk-neutral managers make such investments to increase expected performance.

¹³ Akron and Benninga (2013) show that risk-averse managers with equity-linked compensation tend to hedge price risk excessively if hedging is costly for shareholders but not for managers.

This hypothesis implies that corporate boards consider managers risk-neutral. If the non-linearity is not sufficiently strong to induce risk-neutral behavior, the effects of risk-aversion must be considered when we interpret the hypotheses with respect to the presumed quadratic relationship between changes in performance and shocks.

We analyze how remuneration and changes in performance depend on competitive and macroeconomic shocks. We test the following hypothesis based on expression (1) with respect to the impact of effort to manage shocks.

Hypothesis 2: Remuneration (the change in firm-related wealth) and the change in performance are both quadratic in shock variables and concave upwards.

As noted, risk management may reduce or negate the positive effort effects on remuneration and performance. If we find support for Hypothesis 2, we have an indication that managers' behavior is characterized by risk-neutrality. In case of no support, the explanation may be that managers devote effort to reduce the variability of performance and, thereby, remuneration.

The third and main hypothesis to be discussed in Section 6 refers to our theoretical result stating that optimal effort allocation between the two kinds of shocks from a shareholder point of view depends on the relative volatility of the shocks, the duration of the shocks and the cash flow effects of effort (as in expression (7)). These are the factors that determine the extent to which the volatility of the change in shareholder value depends on the volatility of competitive and macroeconomic shocks, respectively. For incentives to be consistent with the effort allocation in expression (7), the relative contribution of macroeconomic shocks to the volatility of remuneration should be equal to the relative

contribution of macroeconomic shocks to the volatility of changes in shareholder value (ΔQ_i). Because the main purpose of this paper is to investigate whether remuneration schemes providing short-term incentives will result in management devoting excessive efforts to manage short-term macroeconomic shocks, we state the following hypothesis to be tested on the aggregate as well as the industry level.

Hypothesis 3: Remunerations schemes generate excessive incentives to manage macroeconomic volatility.

The above hypothesis implies that the relative contribution of macroeconomic shocks to the volatility of remuneration (change in managers' firm-related wealth) exceeds the relative contribution of the same shocks to changes in shareholder wealth.

4. Competitive shocks in remuneration

Our measure of remuneration is the change in CEOs' firm-related wealth (FRW). This variable has been calculated by Coles, Daniel and Naveen (2013) with the objective to provide a better measure of the incentives of CEOs than traditional compensation measures that do not consider the effects of performance on CEOs' existing stakes in their firms. Updated data covering the period 1993-2014 have been obtained from those authors. The data set includes 2,795 CEOs from 1,171 publicly traded US firms during that period.¹⁴

Firm-Related Wealth (FRW) is defined in accordance with Coles, Daniel and Naveen (2013) as the sum of the values of the stock and option portfolios held by the executive at the end of each year. The value of the option portfolio at the end of a fiscal year is computed by

¹⁴ We thank Lalitha Naveen for providing us with the updated dataset.

using the Black-Scholes formula. For the period through 2006, the values of the three option portfolios (current year grants, previously granted unvested options, and vested options) are summed up. For the period post-2006, the values of all the tranches of options outstanding are summed up. For the stock portfolio, the value is computed by multiplying the number of shares by the fiscal year end price. The sum of the two provides the value of the CEO's stake in the firm at the end of the year. FRW at the end of period t can be thought of as the CEO's firm related wealth at the beginning of the year plus compensation in the form of awarded shares and options minus sales of the firm's shares and options during the year. Thus, the change in a CEO's FRW can be considered the total income from the firm's activities during a year.

In our empirical analysis we use the percentage change in FRW as the dependent remuneration variable.¹⁵ The statistical properties of the percent change in FRW for 2,795 CEOs during the period 1993-2014 are described in Table I. The table displays annual means and standard deviations for the changes in FRW. Note that an observation refers to a CEO in a particular year rather than a firm. The dependent variable in the regressions below refer, therefore, to a CEO's remuneration in a particular year rather than to compensation paid out by a firm in a particular year.

(Insert Table I)

Early U.S. studies of executive compensation across firms focused on the relation between CEO compensation and measures of firm performance (Coughlan and Schmidt, 1985; Murphy, 1985, 1986; Jensen and Murphy, 1990; Abowd, 1990; Leonard, 1990), while several recent

¹⁵ Incentive effects of FRW, in particular, may be affected by vesting requirements that restrict the CEO's ability to sell shares and options in order to diversify risk.

studies analyze whether CEOs are rewarded for performance relative to the market or industry benchmark (Gibbons and Murphy, 1990; Bertrand and Mullainathan, 2001; Bebchuk and Grinstein, 2005; Garvey and Milbourn, 2006; Coles et al 2013). Based on the literature, we analyze how changes in Sales and changes in Tobin's Q affect remuneration as measured by the change in CEOs' FRW. Since we specify the regression in terms of percent changes of FRW and performance, the change in sales is interpreted as a performance variable rather than as a proxy for firm size. Table II shows the changes in sales (average 8.9%) and the changes in Tobin's Q (average -26.4%).¹⁶

(Insert Table II)

Our next concern is if there exists an asymmetry or non-linearity in the impact on remuneration of positive and negative changes in performance, respectively, or a non-linear relationship captured by quadratic terms for performance measures. The following model in expression (9) is estimated for the period 1993-2014 using a random effects model with clustered (on the CEO level) robust standard errors.¹⁷ 17 industry dummies and 21-year dummies are introduced.

$$\Delta FRW_{i,t} = \alpha_0 + \alpha_1 \Delta Sales_{i,t} + \alpha_2 \Delta Q_{i,t} + \alpha_3 (Sales_{up_{i,t}} \times \Delta Sales_{i,t}) + \alpha_4 (Q_{up_{i,t}} \times \Delta Q_{i,t}) + \alpha_5 Sales_{up_{i,t}} + \alpha_6 Q_{up_{i,t}} + \sum_{i=1}^5 \beta_i \text{Control variables} + \sum_{i=1}^{17} \gamma_i \text{Industry dummies} + \varepsilon_{i,t} \quad (9)$$

ΔFRW is the percent change in FRW. $\Delta Sales$ is the percent change in sales. This variable represents one aspect of performance in both time and cross-section. ΔQ stands for the percent

¹⁶ Q is defined as (market value of equity + book value of debt) / (book value of equity + book value of debt).

¹⁷ The specification of this and other regressions below with dummy variables is the motivation for using random effects models.

change in Tobin's Q. The latter variable is adopted as the performance measure representing shareholder wealth in all our specifications.¹⁸

We choose CEO-year rather than firm-year because the firm-related wealth variable, FRW, is CEO-specific. In order to avoid outliers in changes of FRW, sales and Tobin's Q are winsorized at their 1st and 99th percentiles. Industry differences are considered through industry dummies. The regression coefficients for the performance variables are interpreted as "pay-for-performance elasticities".

Asymmetry in compensation is captured in equation (9) by two firm-specific dummies, *Sales_up* and *Q_up*. They take the value one for all firms with increasing sales and Q, respectively, relative to the previous year. The value of the dummy is otherwise zero. The *Sales_up* interacting with $\Delta Sales$ and *Q_up* interacting with ΔQ test the hypothesis that the compensation elasticity is greater when sales or Q is increasing compared to when sales or Q is declining.

An alternative way to capture asymmetry in the compensation elasticities is to introduce the squares of $\Delta Sales$ and ΔQ . In this case we are considering whether the relationship between the change in performance and the change in FRW is non-linear. A positive coefficient for the quadratic terms implies that the compensation elasticities are increasing in the changes in sales and Q, respectively. In the regression with the squared terms the control variables are the same as in equation (9).

Table III shows the results for three regressions testing the relationship between ΔFRW as dependent and $\Delta Sales$ and ΔQ as independent variables. Column (1) does not allow for

¹⁸ To be interpreted with e caution since the variation may be influenced by risk management activities of risk-averse CEOs.

asymmetry or non-linearity. Column (2) includes the dummy variables separately and interactively as in equation (9). Quadratic terms for the performance variables in Column (3) substitute for the *Sales_up* and *Q_up* dummies.

(Insert Table III)

We find that the coefficients for changes in sales and changes in Q are positive and strongly significant in all formulations. Thus, the performance variable, $\Delta Sales$, has a significant impact on compensation and, as we posit, on effort incentives.

In column (2) we observe some evidence of asymmetry of compensation schemes. The *Sales_up* and the *Q_up* dummies are significant and positive, indicating that there is a fixed benefit from increasing performance in terms of both Sales and Q. The interactive terms show that there is no significant asymmetry in the elasticity with respect to sales but a significant asymmetry in the elasticity with respect to Q. The elasticity with respect to Q is greater for positive changes in Q than for negative changes. This result stands in contrast to the results in Daniel, Li and Naveen (2020), who do not find significant evidence of asymmetry in the elasticity with respect to changes in CEO's firm-related wealth.

The evidence of asymmetry in column (2) may be an indication of a non-linear relationship between the compensation and the performance variables. Column (3) addresses this issue by inclusion of the squared changes in Sales and Q. The squared $\Delta Sales$ is insignificant but the squared ΔQ is positive and significant. The positive sign for the quadratic term indicates upward concavity. This is consistent with the positive asymmetry detected with interactive variables in column (2). Hypothesis 1 stating that remuneration is linear in the performance variables is supported with respect to $\Delta Sales$ but finds no support with respect to

ΔQ . We take this result as an indication that compensation schemes have considered managers risk aversion thus reducing CEO's incentives to conduct risk-management.

With respect to control variables, we find that both CEO age and tenure are significant. The quadratic terms are also significant. It appears that the change in FRW increases with CEO age up to a point before declining with age. The signs for the tenure variable indicate that the change in FRW declines with tenure but at a decreasing rate as tenure increases. The gender dummy is insignificant in all regressions. Although we do not report coefficients for industry dummies, it is noted that industry dummy coefficients show substantial variation across industries.¹⁹

5. Competitive and macroeconomic shocks in remuneration and shareholder value

In order to analyze the contribution of macroeconomic volatility to the volatilities of remuneration and changes in shareholder value, we must first analyze how these two variables depend on competitive and macroeconomic factors, respectively. Expression (1) showed in general terms how the change in shareholder value depends on the two kinds of factors including quadratic terms. This expression forms the basis for formulating regressions for both remuneration and the change in shareholder value with explicit specifications for the two kinds of shocks. Below, the regressions are formulated with explicit variables representing macroeconomic factors described in detail. Here we test Hypothesis 2.

¹⁹ The sectors in Table II are the following with the number of firms in parenthesis: 1=Oil and Gas (22); 2=Food Tobacco Products (28); 3=Paper and Paper Products (48); 4=Chemical Products (64); 5=Manufacturing (35); 6=Computer Hardware & Software (66); 7=Electronic equipment (35); 8=Transportation (51); 9=Scientific Instruments (38); 10=Communications (10); 11=Electric and Gas Services (58); 12=Durable Goods (8); 13=Retail (32); 14=Eating and Drinking Establishments (20); 15=Financial Services (38); 16=Entertainment Services (4); 17=Health (5); 18=All Others (72).

5.1 Regression specifications

Both competitive and macroeconomic factors can affect remuneration through the performance variables of *Sales* and ΔQ . While macroeconomic factors are specified explicitly, proxies for competitive factors for each individual firm are lacking. For this reason, we create two variables to capture the performance effects of these shocks in the regressions. These variables are $\Delta AdjSales$ and $\Delta AdjQ$ in equation (10) below. $\Delta AdjSales$ is defined as the percent change in a firm's sales minus the average change in sales across all firms. $\Delta AdjQ$ is defined similarly as the change in a firm's Q minus the average (equally weighted) change in Q.

Expression (10) shows the regression for remuneration defined as the change in firm-related wealth (ΔFRW). The regression includes changes in macro-variables as well as the change in adjusted sales ($\Delta AdjSales$) and the change in adjusted Q ($\Delta AdjQ$) to control for the performance effects of CEO-specific shocks.

$$\begin{aligned} \Delta FRW = & \alpha_0 + \alpha_1 \Delta AdjSales_{i,t} + \alpha_2 \Delta AdjQ_{i,t} + \alpha_3 (\Delta AdjSales)_{i,t}^2 + \\ & \alpha_4 (\Delta AdjQ)_{i,t}^2 + \alpha_5 \Delta Interest\ rate_t + \alpha_6 \Delta Interest\ rate\ spread_t + \\ & \alpha_7 \Delta CPI_t + \alpha_8 \Delta Exchange\ rate_t + \alpha_9 \Delta Oil\ price_t + \alpha_{10} (\Delta Interest\ rate)_t^2 + \alpha_{11} (\Delta CPI)_t^2 + \\ & \alpha_{12} (\Delta Exchange\ rate)_t^2 + \alpha_{13} (\Delta Oil\ price)_t^2 + \sum_{i=1}^5 \beta_i \text{Control variables} + \\ & \sum_{i=1}^{17} \gamma_i \text{Industry dummies} + \varepsilon_{i,t} \end{aligned} \quad (10)$$

The macroeconomic price variables we use to capture macroeconomic shocks are changes in the 1-year US interest rate ($\Delta Interest\ rate$), the inflation rate (ΔCPI), the effective exchange rate change ($\Delta Exchange\ rate$ in foreign currency per dollar) and the oil price change ($\Delta Oil\ price$).²⁰ The lagged level of the effective exchange rate index is included as a control variable

²⁰ The change in the interest rate can be interpreted as the effect of a change in the real interest rate since a change in the interest rate at a constant inflation rate represents a change in the real rate.

to capture effects of long-lasting misalignments. Time dummies are excluded when macro-variables are included but industry dummies are retained. Equation (9) is estimated on a panel incorporating random effects.²¹

The state of the macro economy can in principle be assessed using a combination of quantity variables like GDP, investments, and employment, and macroeconomic price variables like interest rates, inflation, exchange rates, oil prices and the stock market index. The advantage of price variables is that they can be observed without substantial delay by a firm's board at the time it makes decisions with respect to remuneration. The price variables represent observable signals of underlying macroeconomic shocks and developments as noted in Oxelheim and Wihlborg (2008). A shock would have a certain effect on a group of price variables as well as on GDP, employment, etc. but only the former would be observable at the time a shock occurs. Hence, filtering out macroeconomic effects on compensation using, for example, GDP measures would require a longer time lag than if macroeconomic effects can be captured by price variables.

In the literature on the role of luck in measuring performance and compensation, as well as in the literature on corporate exposure to macroeconomic risk factors, it is common to use the stock market index as a proxy for general macroeconomic developments. We find that introducing the stock market return as an additional macroeconomic variable do not add explanatory power when the interest rate is included.²²

²¹ The random effects model is used since it can estimate coefficients of time-invariant variables, such as gender and tenure.

²² Daniel et al (2020) regresses the firm's annual stock returns on the equal-weighted and value-weighted industry returns, and time dummies as in Garvey and Milbourn (2006) and Gopalan et al (2010). Luck is the predicted value from the regression multiplied by the firm's market capitalization at the beginning of the year. Skill is the residual stock returns multiplied by the firm's market capitalization at the beginning of the year. Both luck and skill can be positive or negative.

In order to test for the robustness of our specifications of macroeconomic shocks in terms of price variables we run regressions with GDP growth as an additional macroeconomic factor. This variable does not add explanatory value although it affects coefficients for the macroeconomic price variables. Therefore, we are satisfied that the mentioned price variables are sufficient to capture macroeconomic factors. The impact of GDP growth is captured by its correlation with the other variables. For this reason, we do not present regressions including GDP growth.

We add one more control variable, the change in the interest rate spread between the 10-year and the 1-year interest rate, to those already mentioned to capture changes in the expected duration of macroeconomic shocks.

The squared terms in equation (10) capture non-linearity and asymmetry in remuneration elasticities as mentioned in the previous section where we found that the squared change in Q had a significant positive effect on compensation.

The regression for the change in shareholder value (ΔQ) is specified with the same set of variables as those included in expression (10) to capture effects of competitive and macroeconomic factors, respectively. These squared terms are included in the regression for ΔQ as well since expression (1) implies that there is a non-linear relationship between shocks and the change in shareholder value.²³

5.2 *The macroeconomic variables*

We do not state specific hypotheses for the coefficients on macroeconomic variables. It is likely that each firm's performance is sensitive to its specific set of macro-variables but here we

²³ The quadratic terms for firm-specific variables are dropped since they were insignificant in the remuneration regression in Column 1, Table V and because they represent performance effects rather than shocks.

employ only one set of macroeconomic variables assumed valid for all firms in the study. In our industry regressions (see Appendix), the impact of our chosen macro variables is - as expected - seen to differ across industries.

The macroeconomic variables in our empirical analysis include percentage point/100 changes in interest rates, percent inflation rates/100, percent exchange rate changes/100, percent oil price changes/100 and percent real GDP growth/100 to begin with. The interest rate for a particular year is the average 1-year Treasury bill rate. Annual values for inflation rates are averages of monthly percent changes in the level of consumer prices relative to the previous year (ΔCPI). The exchange rate is the average effective (trade weighted) dollar rate (FC/\$). Annual percent changes are calculated relative to the previous year. Data for all the macroeconomic factors are obtained from DataStream. Table IV describes the means and standard deviations for changes in the macroeconomic variables for the period 1993-2014.

The average change in the 1-year T-bill rate is -0.1% and the average annual inflation rate is 2.3%. The average annual exchange rate change is 0.5% with a standard deviation of 17.1%. A positive change implies an appreciation of the effective value of the dollar. Table V shows correlations among changes in macroeconomic price variables that are used in our studies. Any concern for multicollinearity is not warranted.

(Insert Table IV & V here)

5.3 *Regressions results for remuneration and the change in shareholder value*

Results of regressions with ΔFRW and ΔQ as dependent variables are presented in Table VI. All the variables in the models refer to fiscal years, which often differ from calendar years. Age, tenure and industry dummies are included in both regressions.

We focus first on the results for the remuneration variable ΔFRW . It can be observed that the coefficients with respect to changes in adjusted sales and adjusted Q in Table VI are very close to the coefficients with respect to changes in total sales and Q in Table III. The squared changes in $AdjSales$ and $AdjQ$ are not significant in Table VI. As noted, these variables represent performance effects of competitive shocks. As expected, there is no or negligible concavity in the remuneration effects of $\Delta AdjQ$ and $\Delta AdjSales$.

(Insert Table VI here)

The coefficient for the change in the interest rate is positive and significant. This sign can be explained by correlation between the change in the interest rate and GDP growth. The inflation rate has a very strong positive and significant effect on remuneration. This strong effect on remuneration may also be explained by correlation between inflation and general economic activity as well as asset prices.

The direct effect of an appreciation of the dollar (an increase in the effective exchange rate) is likely to reduce the competitiveness of US firms but the appreciation may be the result of a productivity increase in the economy with positive effects on firms' performance. The coefficient for the exchange rate change in the ΔFRW regression is small and insignificant.

A higher lagged level of the exchange rate captures greater overvaluation or reduced undervaluation of the dollar. This misalignment effect is additional to effects from changes in the exchange rate from period to period. The effect of a high valuation of the dollar on the change in FRW is negative. Finally, the change in oil price shows a positive and significant effect on remuneration.

The squared macroeconomic price variables representing macroeconomic shocks have significant effects on ΔFRW . Positive signs are consistent with our expectations while negative signs contradict it. Thus, our expectations are supported for exchange rate changes as well as for oil price changes. The coefficients for the squared interest rate and the squared inflation are negative in the ΔFRW regression. We return to this result when the ΔQ regression is discussed next.

Next, we turn to the ΔQ regression. The results are shown in the right-hand column of Table VI, which reveals that all the variables representing competitive and macroeconomic factors are significant in the ΔQ regression.²⁴ The impact of each of the macroeconomic factors is similar to the impact in the ΔFRW regression. The one exception is the interest rate spread capturing the impact of expected changes in macroeconomic conditions.

The quadratic terms for the macroeconomic are significant and similar in the two regressions. Thus, the non-linearity with respect to the impacts of the macroeconomic factors on remuneration is explained by their impacts on the performance variable ΔQ . Hypothesis 2 is supported for exchange rate changes and oil price changes, but not for interest rate changes and inflation. As noted in Section 2.3 the negative sign for the quadratic terms for the latter two macroeconomic factors may indicate that risk-averse managers sacrifice performance with their effort to reduce the impact of these variables on ΔQ although it implies that they also sacrifice remuneration.

Another possible explanation for the results is that the coefficients represent averages for all firms in all industries. To rule out the explanation that there is a more fine-grained

²⁴ One difference relative to the ΔFRW regression is that $\Delta Sales$ variables are not included since the purpose is to separate the impact of the different kinds of shocks on ΔQ . Also, the squared term for the ΔQ has been excluded on the grounds that it proved to be insignificant as in the ΔFRW regression.

reaction pattern to different shocks, we run regressions for ΔFRW and ΔQ on the industry level as well. Our results – as shown in Appendix 1 for each of 18 industries - reveals the same pattern for the quadratic terms as the regressions presented in Table VI. Thus, our Hypothesis 2 - that effort effects generate upward concavity in performance - is only partially supported.

6. Variance decomposition and effort allocation

In this section, we test our third hypothesis that the responsiveness of remuneration to macroeconomic variables can generate excessive incentives to manage short-term macroeconomic uncertainties. We decompose the variances from the regressions in Table VI for ΔFRW and ΔQ . As first step we decompose the variances of these variables into time variation and cross-section variation though the panel data in the previous section. Macroeconomic volatility has only a time dimension, while – as in the panel analysis – competitive shocks have both a time and a cross-section dimension.

Table VII shows in columns (1) and (2) the shares of the total variation in ΔFRW and ΔQ , which represent time variation (ESS_{Time}/TSS in ΔFRW and ESS_{Time}/TSS in ΔQ). In the second variance decomposition we decompose the total variation (TSS) in the two variables into the variation explained by macro factors (ESS_{Macro}) and other factors that include both time and cross-section variation.²⁵ Columns (3) and (4) in Table VII shows ESS_{Macro}/TSS in ΔFRW and ESS_{Macro}/TSS in ΔQ , respectively. Thereafter, we use columns (1) and (3) to calculate ESS_{Macro}/ESS_{Time} in ΔFRW , and columns (2) and (4) to calculate ESS_{Macro}/ESS_{Time} in ΔQ . Finally, in column (5) we calculate ESS_{Macro}/ESS_{Time} in ΔFRW relative to in ΔQ . A

²⁵ The contributions of the variances of macroeconomic and competitive factors to the total variances are estimated by using “Partial Sum of Squares Method” or ANOVA as suggested by Gibbons, Overman and Pelkonen (2012).

ratio above 1 in this column implies that remuneration provides excessive incentives to devote effort to macroeconomic factors.

(Insert Table VII)

Column (5) in Table VII shows that macro shocks in the full sample of firms explain approximately the same share of the time variation in ΔFRW and ΔQ , respectively. Thus, on the aggregate level there is no evidence of excessive incentives to devote effort to manage macroeconomic shocks. Hence, Hypothesis 3 is not supported.²⁶

In Table VIII we turn our analysis on the industry level based on regressions for ΔFRW and ΔQ in 18 industries. The regressions are presented in Appendix 1. Columns (2) and (3) show that there are substantial differences across industries in ESS_{Macro} / ESS_{Time} in ΔFRW as well as in ESS_{Macro} / ESS_{Time} in ΔQ . Column (4) shows the ratio between the two ESS_{Macro} / ESS_{Time} in different industries. A ratio above 1 in this column implies that remuneration provides excessive incentives to devote effort to macroeconomic factors. The figures in this column show that the ratio is clearly above 1 in 9 out of 18 industries.

(Insert Table VIII)

The table also shows that the correlation between ESS_{Macro} / ESS_{Time} in ΔQ (Column (3)) and the relative ESS_{Macro} / ESS_{Time} in Column (4) is strongly negative (-0.70). The

²⁶ Instead of FRW , which measures the long-term remuneration, we also test short term remunerations, i.e. bonus, or salary plus bonus in Table VII. The results show that the share of the time variation in $\Delta Bonus$ and ΔQ is 0.59, while the share of the time variation in $\Delta Salary + \Delta Bonus$ and ΔQ is 0.45. Thus, the short-term compensation schemes give even less efforts to devote incentives to manage macroeconomic shocks.

interpretation of this correlation is that in industries where the variation in ΔQ is explained by macro factors to a high extent, the incentives to devote effort to manage these factors are insufficient. By the same token, the incentive to devote effort to macroeconomic factors is excessive in industries where competitive factors explain a relatively large share of the variation in ΔQ .

7. Conclusions and implications

Managers can respond to competitive (firm-specific/relative) and macroeconomic shocks by adjusting operations with the objective of enhancing the value effects of positive shocks and dampening the impact of negative shocks. We develop a model showing that optimal allocation of effort to respond to these two kinds of shocks depends on their relative volatility of the shocks, their relative serial correlations, and managers' relative ability to adjust cash flows by adjusting operations to the shocks.

Based on our theoretical model we formulate and test three hypotheses. Our first hypothesis stating that remuneration is linear in the performance variables is supported with respect to one of the performance variables, changes in sales, but is not supported with respect to the other performance variable, changes in shareholder wealth. We take this result as an indication that compensation schemes have the objective of reducing CEO's incentives to conduct risk management, i.e. to increase the risk appetite.

When it comes to our second hypothesis, the analysis of factors affecting remuneration defined as changes in CEOs firm related wealth shows that macroeconomic factors have a significant effect on remuneration through their effects on changes in shareholder wealth, and changes in sales. The macroeconomic factors are specified as the interest rate change, inflation, the effective exchange rate change, and the oil price change. The quadratic terms for these

factors are evidence of effort effects on performance. The second hypothesis that effort is the cause of upward concavity in the relation between macroeconomic shocks and performance measures is supported for exchange rate and oil price changes. Downward concavity for interest rate changes and inflation can be explained by managers' active risk management at the expense of performance.

Our third and main hypothesis for the empirical analysis is that compensation schemes skew effort allocation towards macroeconomic shocks relative to the allocation that maximizes shareholder wealth. Although the all-firm variance decomposition suggests no aggregate evidence of excessive incentives to manage macroeconomic shocks — macro shocks explain a similar share of the time variation in CEO firm-related wealth and shareholder wealth — this average pattern is misleading. The aggregate results mask substantial cross-industry heterogeneity. In nine of the eighteen industries, we find clear evidence of excessive effort directed toward managing macroeconomic shocks. Thus, while the overall sample appears consistent with our first hypothesis that compensation schemes dampen incentives for risk-management and with existing findings showing limited short-termism on average, a very different picture emerges at the industry level. The presence of excessive macro-oriented effort in half of the industries underscores the importance of accounting for industry-specific exposure when designing CEO compensation schemes. What appears benign in the aggregate may obscure significant distortions in managerial incentives within particular sectors.

Future study could explore further into the issues of excessive incentives in remuneration and identify industries which demonstrate more sensitivity to short-term macroeconomic shocks. Further investigation on the reason that remuneration in some industries is more sensitive compared to others can help firms set compensation structure that is effective to the goal of the management team.

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Table I Changes in Firm-Related Wealth (Δ FRW) Year by Year

This table displays annual means and standard deviations for changes in CEO's Firm-Related Wealth (FRW). The dataset includes 2,795 CEOs in 1,778 US firms during the period 1993-2014.

Year	# of CEOs	Mean	Std.
1993	109	0.14	0.40
1994	326	0.02	0.41
1995	486	0.22	0.54
1996	525	0.16	0.48
1997	514	0.24	0.47
1998	539	0.00	0.64
1999	529	0.10	0.71
2000	540	0.10	0.83
2001	565	0.01	0.61
2002	611	-0.21	0.67
2003	613	0.40	0.53
2004	640	0.14	0.58
2005	619	0.06	0.49
2006	607	0.06	0.56
2007	657	-0.11	0.66
2008	738	-0.67	0.81
2009	746	0.46	0.86
2010	761	0.29	0.51
2011	732	-0.06	0.55
2012	704	0.12	0.54
2013	708	0.33	0.62
2014	608	0.07	0.57
93-14	2,771	0.08	0.67

Table II Year by Year Descriptive Statistics for Δ Sales and Δ Q

This table displays annual means and standard deviations for changes in sales and changes in Q. The dataset includes 2,795 CEOs in 1,778 US firms during the period 1993-2014.

Year	Sales changes		Tobin's Q changes	
	Mean	Std.	Mean	Std.
1993	0.085	0.231	0.024	0.228
1994	0.142	0.215	-0.095	0.246
1995	0.146	0.295	0.061	0.303
1996	0.135	0.228	-0.022	0.297
1997	0.133	0.241	0.062	0.291
1998	0.113	0.289	-0.104	0.365
1999	0.135	0.257	-0.042	0.480
2000	0.188	0.301	-0.129	0.611
2001	0.026	0.307	-0.096	0.475
2002	-0.024	0.287	-0.245	0.415
2003	0.090	0.206	0.216	0.356
2004	0.143	0.227	-0.006	0.293
2005	0.124	0.169	-0.007	0.294
2006	0.115	0.205	-0.034	0.278
2007	0.091	0.184	-0.095	0.313
2008	0.084	0.246	-0.383	0.426
2009	-0.099	0.233	0.172	0.369
2010	0.128	0.284	0.078	0.259
2011	0.119	0.206	-0.107	0.286
2012	0.062	0.216	0.015	0.267
2013	0.039	0.259	0.150	0.259
2014	0.078	0.197	0.010	0.289
93-14	0.089	0.251	-0.264	0.377

Table III Changes in Firm-Related Wealth (ΔFRW) with Asymmetry/Non-linearity in performance variables

This table reports the parameter estimations from three random effects models. The dependent variable is changes in CEO's Firm-Related Wealth (ΔFRW) in each regression. The industries are identified in footnote 18 in the text.

	Changes in FRW (1)	Changes in FRW (2)	Changes in FRW (3)
Age	0.017** (2.44)	0.017** (2.47)	0.019*** (2.68)
Age ²	-0.020*** (-3.25)	-0.020*** (-3.24)	-0.021*** (-3.45)
Tenure	-0.006*** (-3.89)	-0.006*** (-3.90)	-0.006*** (-3.82)
Tenure ²	0.014*** (3.69)	0.013*** (3.70)	0.013*** (3.63)
Gender	0.050 (1.64)	0.046 (1.51)	0.051 (1.64)
Changes in sales	0.263*** (6.88)	0.109* (1.69)	0.256*** (7.54)
Changes in Q	1.134*** (43.42)	1.006*** (26.00)	1.153*** (41.38)
Sales_up $\times$ Changes in sales		-0.014 (-0.26)	
Q_up $\times$ Changes in Q		0.190*** (2.91)	
Sales_up		0.043** (2.48)	
Q_up		0.150*** (8.53)	
Changes in sales squared			0.028 (1.45)
Changes in Q squared			0.052** (2.13)
Constant	-0.226 (-1.15)	-0.361* (-1.81)	-0.299 (-1.49)
Industry dummies	Yes	Yes	Yes
Observations	12,358	12,358	12,358
Overall R-squared	0.430	0.438	0.431
Number of CEOs	2,795	2,795	2,795
Period	93-14	93-14	93-14

1. *t*-values are in parentheses.

2. *, **, *** denotes significance at the 0.10, 0.05 and 0.01 level or better.

3. All changes are percent changes.

Table IV Year by Year Descriptive Statistics for the Macroeconomic Factors

This table displays annual means and standard deviations for the Macroeconomic Factors.

Year	1-year interest rate changes		10-year interest rate changes		CPI changes		Effective exchange rate changes		Oil price changes	
	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.
1993	0.000	0.001	-0.001	0.002	0.027	0.019	0.009	0.115	-0.294	0.613
1994	0.003	0.002	0.002	0.002	0.026	0.016	-0.011	0.133	0.188	0.680
1995	-0.002	0.001	-0.002	0.002	0.025	0.020	0.015	0.243	0.106	0.585
1996	0.000	0.002	0.000	0.002	0.033	0.020	0.021	0.066	0.271	0.690
1997	0.000	0.001	0.000	0.002	0.017	0.018	0.092	0.153	-0.310	0.800
1998	-0.001	0.003	-0.001	0.002	0.016	0.010	-0.010	0.196	-0.504	0.899
1999	0.001	0.001	0.001	0.002	0.026	0.026	-0.008	0.098	0.877	0.918
2000	0.000	0.002	-0.001	0.003	0.033	0.033	0.071	0.132	0.011	1.325
2001	-0.003	0.003	0.000	0.002	0.015	0.042	0.036	0.106	-0.311	0.917
2002	-0.001	0.002	-0.001	0.002	0.023	0.028	-0.043	0.150	0.409	0.868
2003	0.000	0.001	0.000	0.003	0.019	0.041	-0.104	0.202	0.071	0.985
2004	0.001	0.002	0.000	0.002	0.032	0.038	-0.054	0.192	0.266	0.907
2005	0.001	0.001	0.000	0.002	0.034	0.066	0.059	0.126	0.368	0.827
2006	0.000	0.001	0.000	0.001	0.025	0.053	-0.042	0.132	0.077	0.856
2007	-0.001	0.002	0.000	0.002	0.040	0.040	-0.055	0.155	0.383	0.840
2008	-0.002	0.004	-0.001	0.004	0.001	0.111	0.096	0.309	-0.767	1.910
2009	0.000	0.001	0.001	0.002	0.027	0.034	-0.075	0.232	0.589	0.978
2010	0.000	0.000	0.000	0.003	0.015	0.017	-0.012	0.235	0.185	0.610
2011	0.000	0.000	-0.001	0.003	0.029	0.045	0.019	0.160	0.146	0.647
2012	0.000	0.000	0.000	0.001	0.017	0.047	-0.020	0.154	-0.030	0.776
2013	0.000	0.000	0.001	0.002	0.015	0.034	0.031	0.103	0.042	0.392
2014	0.000	0.000	-0.001	0.001	0.008	0.046	0.089	0.115	-0.555	0.913
93-14	-0.001	0.002	-0.002	0.002	0.023	0.040	0.005	0.171	0.055	0.952

Table V Correlations for the Macroeconomic Factors

	1-year interest rate changes	10-year interest rate changes	CPI changes	Effective exchange rate changes	Oil prices changes	GDP growth	Returns of S&P 500
1-year interest rate changes	1						
10-year interest rate changes	0.687***	1					
CPI changes	0.504***	0.340***	1				
Effective exchange rate changes	-0.013	0.029***	-0.403***	1			
Oil prices changes	0.330***	0.396***	0.737***	-0.595***	1		
GDP growth	0.613***	0.425***	0.373***	-0.188***	0.304***	1	
Returns of S&P 500	0.473***	0.249***	0.241***	-0.312***	0.320***	0.670***	1

1. *, **, *** denotes significance at the 0.10, 0.05 and 0.01 level or better.

Table VI Changes in remuneration (ΔFRW) and shareholder value (ΔQ) with competitive and macroeconomic factors

This table reports the parameter estimations for a random effects model with competitive and macroeconomic factors, including squared terms.

	Changes in FRW (1)	Changes in Q (2)
Age	0.019*** (2.69)	0.01 (0.83)
Age squared /100	-0.021*** (-3.45)	-0.001 (-0.88)
Tenure	-0.007*** (-4.05)	0.000*** (2.04)
Tenure squared /100	0.013*** (3.49)	-0.000 (-.06)
Gender	0.038 (1.25)	-0.000 (-0.04)
Changes in adjusted sales	0.228*** (7.45)	-
Changes in adjusted Q	1.039*** (40.38)	0.986*** (291.98)
Changes in adjusted sales squared	0.007 (0.34)	-
Changes in adjusted Q squared	0.037 (1.49)	-
Interest rate changes	3.090*** (3.24)	1.223*** (7.68)
Interest rate spread (10y -1y) changes	2.357* (1.92)	-0.661 (-3.86)
CPI changes	62.471*** (13.53)	30.392*** (52.50)
Effective exchange rate changes	-0.033 (-0.30)	-0.363*** (-24.95)
Effective exchange rate $_{t-1}$	-0.004*** (-4.93)	-0.006*** (-39.68)
Oil price changes	0.190*** (6.34)	0.101*** (28.10)
Interest rate changes squared*100	-4.489*** (-17.53)	-3.082*** (-76.09)
CPI changes squared*100	-14.720*** (-16.96)	-7.685*** (-70.85)
Effective exchange rate changes squared*100	0.271*** (16.27)	0.174*** (101.78)
Oil price changes squared*100	0.001*** (3.02)	0.002*** (47.16)

Constant	-0.380*	0.349***
	(-1.85)	(13.03)
Industry dummies	Yes	Yes
Observations	12,358	12,258
Overall R-squared	0.421	0.86
Number of CEOs	2,795	2,795
Period	93-14	93-14

1. t-values are in parentheses.

2. *, **, *** denote significance levels 0.10, 0.05 and 0.01, respectively.

Table VII Variance decomposition for all firms

This table shows the macro variation relative to the time variation for all firms. In the table, ESS = Explained sum of squares, TSS = Total sum of squares.

ESS_{Time}/TSS in ΔFRW	ESS_{Time}/TSS in ΔQ	ESS_{Macro}/TSS in ΔFRW	ESS_{Macro}/TSS in ΔQ	$ESS_{\text{Macro}}/ESS_{\text{Time}}$ in ΔFRW relative to in ΔQ [(3)/(1)]/[(4)/(2)]
(1)	(2)	(3)	(4)	(5)
0.139	0.137	0.127	0.132	0.948

Table VIII Variance decomposition by industry

This table shows the macro variation relative to the time variation for individual industries. In the table, ESS: Explained sum of squares, TSS: Total sum of squares.

Industry	ESS_{Macro}/ESS_{Time} in ΔFRW	ESS_{Macro}/ESS_{Time} in ΔQ	ESS_{Macro}/ESS_{Time} in ΔFRW relative to in ΔQ (2)/(3)
(1)	(2)	(3)	(4)
1. Oil and Gas	0.476	0.418	1.14
2. Food and Tobacco Products	0.871	1.485	0.59
3. Paper, Paper products	0.920	1.105	0.83
4. Chemical Products	0.797	0.798	1.00
5. Manufacturing	0.620	0.748	0.83
6. Computer Hard- and Software	0.714	0.458	1.56
7. Electronic Equipment	0.470	0.286	1.64
8. Transportation	1.113	1.012	1.10
9. Scientific Instruments	0.600	0.628	0.96
10. Communications	0.531	0.453	1.17
11. Electric and Gas Services	1.139	1.468	0.78
12. Durables	0.813	0.714	1.14
13. Retail	0.553	0.441	1.26
14. Eat and Drink Establishments	0.755	0.615	1.23
15. Financial Services	0.828	0.938	0.88
16. Entertainment Services	0.324	0.621	0.52
17. Health	0.643	0.449	1.43
18. Others	1.034	1.074	0.96
Average	0.733	0.762	1.06
Correlation between column (3) & (4) = -0.70			

Appendix Industry regressions for the impact of firm-specific performance and macroeconomic shocks on remuneration in industries 1-9

	Industry 1	Industry 2	Industry 3	Industry 4	Industry 5	Industry 6	Industry 7	Industry 8	Industry 9
Age	0.033*	0.009	-0.024	0.019	0.025	-0.006	0.018	-0.030	0.021
	(1.90)	(0.22)	(-0.76)	(0.52)	(0.90)	(-0.48)	(1.06)	(-0.90)	(1.13)
Age squared /100	-0.026*	-0.011	0.008	-0.023	-0.029	0.001	-0.021	0.019	-0.022
	(-1.76)	(-0.27)	(0.33)	(-0.68)	(-1.17)	(0.11)	(-1.43)	(0.67)	(-1.29)
Tenure	-0.009*	-0.027**	-0.016**	-0.013	-0.007	-0.003	-0.014***	0.001	-0.008
	(-1.81)	(-2.06)	(-2.02)	(-1.41)	(-0.78)	(-0.76)	(-3.01)	(0.10)	(-1.43)
Tenure squared /100	0.014	0.044*	0.043**	0.022	0.015	0.006	0.041***	-0.007	0.010
	(1.33)	(1.66)	(2.38)	(1.03)	(0.55)	(0.76)	(3.28)	(-0.42)	(0.85)
Gender	0.054	0.255*	-0.016	-0.084	0.080	0.014	0.017	-0.088	0.017
	(1.05)	(1.67)	(-0.17)	(-1.12)	(0.71)	(0.32)	(0.23)	(-0.99)	(0.66)
Changes in adjusted sales	0.174***	0.506	0.256**	0.054	0.127	0.372***	0.320***	0.160	0.306***
	(3.15)	(1.52)	(2.18)	(1.34)	(1.15)	(4.37)	(3.75)	(1.13)	(3.97)
Changes in adjusted Q	1.130***	0.895***	0.997***	0.850***	1.019***	0.908***	1.135***	1.113***	1.105***
	(11.32)	(5.11)	(7.23)	(7.87)	(12.84)	(18.46)	(25.27)	(14.60)	(21.29)
Changes in adjusted sales squared	0.037	-0.664	-0.204	-0.003	-0.273*	0.120	-0.171	-0.231	0.121
	(0.90)	(-1.13)	(-1.07)	(-0.24)	(-1.79)	(1.14)	(-1.57)	(-0.93)	(0.90)
Changes in adjusted Q squared	0.069	-0.143	-0.041	0.054	-0.049	-0.030	0.084*	0.304*	0.036
	(0.54)	(-0.47)	(-0.50)	(0.85)	(-0.95)	(-0.71)	(1.89)	(1.65)	(0.46)
Interest rate changes	3.902	0.355	-7.150	4.472	0.787	1.258	4.366	6.718**	6.809**
	(0.86)	(0.06)	(-1.55)	(1.53)	(0.22)	(0.47)	(1.59)	(2.07)	(2.14)
Interest rate spread (10y-1y) changes	3.421	14.486*	-1.719	6.411**	0.187	-2.005	2.219	7.724**	5.989
	(0.62)	(1.67)	(-0.27)	(2.02)	(0.04)	(-0.62)	(0.60)	(1.97)	(1.18)
CPI changes	41.183**	68.232**	96.872***	63.664***	27.465	64.480***	61.254***	70.594***	52.178***
	(2.53)	(2.23)	(3.91)	(4.26)	(1.27)	(6.12)	(4.21)	(4.67)	(3.51)
Effective exchange rate changes	0.221	1.227**	0.406	0.157	0.067	-0.360	0.192	-0.216	-0.364
	(0.40)	(2.06)	(0.77)	(0.44)	(0.16)	(-1.29)	(0.78)	(-0.72)	(-0.85)
Effective exchange rate $_{t-1}$	0.001	-0.004	-0.009**	0.001	-0.003	-0.006***	-0.004	-0.008***	0.002
	(0.41)	(-0.98)	(-2.22)	(0.19)	(-0.93)	(-2.68)	(-1.39)	(-3.21)	(0.54)
Oil price changes	0.265**	0.367**	0.246	0.078	0.283**	0.183**	0.230***	0.146*	0.074
	(1.96)	(2.52)	(1.64)	(0.70)	(1.97)	(2.46)	(2.87)	(1.72)	(0.61)
Interest rate changes squared*100	-6.007***	-3.401*	-7.232***	-4.330***	-4.856***	-3.783***	-5.280***	-3.735***	-4.753***

	(-4.62)	(-1.83)	(-4.96)	(-5.15)	(-5.43)	(-6.02)	(-6.91)	(-5.11)	(-5.26)
CPI changes squared*100	-9.293***	-16.327***	-22.109***	-14.286***	-7.519**	-15.180***	-14.864***	-16.158***	-12.451***
	(-2.91)	(-2.78)	(-4.79)	(-5.02)	(-2.00)	(-7.65)	(-5.54)	(-5.73)	(-4.69)
Effective ex. rate changes squared*100	0.276***	0.183*	0.218***	0.199***	0.245***	0.262***	0.231***	0.253***	0.098**
	(3.29)	(1.88)	(3.01)	(4.18)	(4.94)	(5.74)	(5.23)	(4.12)	(1.98)
Oil price changes squared*100	-0.002	-0.004	0.001	0.001	0.001	0.002**	0.002*	0.002	0.001
	(-1.29)	(-1.61)	(0.37)	(0.83)	(0.72)	(2.39)	(1.96)	(1.51)	(1.51)
Constant	-1.319**	-0.048	1.456	-0.642	-0.224	0.366	-0.305	1.456	-0.901*
	(-1.98)	(-0.05)	(1.43)	(-0.60)	(-0.29)	(0.91)	(-0.59)	(1.42)	(-1.65)
Observations	589	293	514	1,005	700	2,123	1,207	846	955
Overall R-squared	0.431	0.246	0.402	0.397	0.384	0.440	0.620	0.388	0.492
Number of CEOs	128	68	111	206	139	496	225	178	193

1. t-values are in parentheses.

2. *, **, *** denotes significance at the 0.10, 0.05 and 0.01 level or better.

3. Industry names are in Footnote 16.

Appendix cont'd Industry regressions for the impact of firm-specific performance and macroeconomic shocks on remuneration in industries 10-18

	Industry 10	Industry 11	Industry 12	Industry 13	Industry 14	Industry 15	Industry 16	Industry 17	Industry 18
Age	0.024 (0.64)	0.084** (2.22)	0.078*** (3.52)	0.034 (0.82)	0.174 (0.96)	-0.008 (-0.22)	0.097 (0.97)	-0.021 (-0.86)	0.042* (1.91)
Age squared /100	-0.029 (-0.89)	-0.077** (-2.35)	-0.070*** (-3.46)	-0.035 (-0.94)	-0.149 (-0.94)	0.004 (0.14)	-0.084 (-0.98)	0.017 (0.79)	-0.044** (-2.31)
Tenure	-0.025 (-0.86)	-0.009 (-0.98)	-0.013** (-2.39)	0.003 (0.45)	-0.002 (-0.15)	0.008 (0.96)	-0.031 (-1.43)	0.007 (0.59)	-0.012** (-2.53)
Tenure squared /100	0.059 (0.72)	0.016 (0.56)	0.027** (2.43)	-0.004 (-0.27)	0.016 (0.52)	-0.026 (-1.40)	0.109* (1.65)	-0.022 (-0.91)	0.024** (2.12)
Gender	0.121 (1.28)	-0.051 (-0.38)		0.012 (0.12)	-0.092 (-1.19)	0.466 (1.28)	-0.606 (-0.21)	-0.011 (-0.07)	0.068 (0.72)
Changes in adjusted sales	0.750*** (3.54)	0.278*** (4.52)	0.283** (2.17)	0.159 (0.70)	0.374 (1.64)	0.474*** (2.63)	-0.338 (-0.68)	0.565*** (3.28)	0.245*** (3.63)
Changes in adjusted Q	1.017*** (3.86)	1.114*** (6.88)	1.100*** (13.78)	1.116*** (18.53)	1.010*** (10.70)	1.158*** (7.45)	1.398*** (10.40)	1.202*** (18.40)	1.122*** (17.19)
Changes in adjusted sales squared	-0.668*** (-3.04)	-0.015 (-0.29)	0.054 (0.37)	0.018 (0.08)	0.136 (0.52)	0.008 (0.04)	0.548 (0.95)	-0.422* (-1.88)	0.034* (1.70)
Changes in adjusted Q squared	-0.719* (-1.76)	-0.079 (-0.31)	-0.142 (-1.31)	0.089 (1.58)	0.285 (1.62)	-0.386 (-1.12)	0.014 (0.21)	-0.223*** (-2.65)	0.062 (0.44)
Interest rate changes	-8.413 (-0.68)	3.111 (0.78)	4.330 (1.06)	1.503 (0.34)	10.015** (2.08)	2.735 (0.68)	-0.277 (-0.02)	8.726* (1.65)	2.928 (0.98)
Interest rate spread (10y-1y) changes	-17.107 (-0.92)	-6.117 (-1.43)	6.632 (1.09)	4.297 (0.74)	12.632* (1.96)	1.819 (0.37)	14.408 (0.82)	6.589 (0.88)	0.451 (0.13)
CPI changes	93.181 (1.14)	56.205** (2.50)	81.209*** (3.44)	121.381*** (5.29)	109.098** (2.36)	91.306*** (3.34)	122.026** (2.18)	73.514** (2.21)	48.397*** (3.69)
Effective exchange rate changes	0.140 (0.09)	0.465 (0.96)	-0.566 (-1.07)	-0.878** (-2.43)	-0.566 (-1.10)	1.449** (2.07)	0.193 (0.14)	0.505 (0.38)	0.079 (0.24)
Effective exchange rate $t-1$	0.006 (0.48)	0.002 (0.45)	-0.007** (-1.98)	-0.010** (-2.17)	-0.007 (-1.19)	-0.006 (-1.30)	-0.031** (-2.53)	-0.007 (-1.16)	-0.006** (-2.11)
Oil price changes	0.314 (0.87)	0.133 (0.96)	-0.098 (-0.71)	-0.023 (-0.17)	-0.107 (-0.63)	0.139 (1.00)	-0.455 (-1.02)	0.381 (1.60)	0.408*** (4.93)

Interest rate changes squared*100	-3.973 (-1.07)	-5.527*** (-4.64)	-5.644*** (-4.32)	-2.485** (-2.25)	-4.048*** (-2.71)	-5.320*** (-3.12)	-2.969 (-0.92)	-3.621** (-2.55)	-3.769*** (-4.80)
CPI changes squared*100	-23.331 (-1.42)	-12.873*** (-3.11)	-17.097*** (-3.83)	-25.444*** (-5.93)	-22.738*** (-2.67)	-21.335*** (-3.40)	-22.807** (-2.29)	-17.099*** (-2.79)	-13.396*** (-5.31)
Effective ex. rate changes squared*100	0.446* (1.78)	0.305*** (4.20)	0.276*** (3.48)	0.516*** (7.31)	0.316*** (2.85)	0.269*** (3.10)	0.008 (0.03)	0.515** (2.53)	0.375*** (8.09)
Oil price changes squared*100	0.008** (1.97)	0.001 (0.31)	0.000 (0.11)	0.004** (2.46)	0.004* (1.93)	0.002 (1.18)	0.001 (0.16)	0.001 (0.50)	0.000 (0.25)
Constant	-1.640 (-1.36)	-2.629** (-2.28)	-2.004*** (-2.97)	-1.109 (-0.87)	-5.314 (-0.96)	-0.271 (-0.24)	-0.605 (-0.21)	0.719 (0.84)	-0.614 (-0.94)
Observations	179	673	284	574	254	314	111	227	1,510
Overall R-squared	0.244	0.259	0.597	0.515	0.357	0.425	0.390	0.583	0.406
Number of CEOs	46	152	60	148	40	168	27	54	356

1. t-values are in parentheses.

2. *, **, *** denotes significance at the 0.10, 0.05 and 0.01 level or better.

3. Industry names are in Footnote 16.