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Pay-for-Performance for Top Managers and Innovation Activities in Firms

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Abstract

Based on crowding out theory, we expect that short and long term incentive pay of CEO and top executives have negative effect on innovation activities within firm. Using a sample of 1240 US firms from manufacturing industries, we find that variable payments for top executives and CEOs create disincentives to allocate firms? resources to patent activities respectively radical innovations. However incentive scheme can encourage executives to engage in incremental innovation activities like expenses in research and development.

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Abstract

Based on crowding-out theory, we expect that short- and long-term incentive pay for top managers have negative effects on innovation activities within a firm. Using a sample of 1,240 US firms from manufacturing industries, we find that variable pay for CEOs and top executives indeed creates disincentives to allocate firms' resources to patent activities and radical innovations. However, pay-for-performance simultaneously encourages executives to engage in incremental innovation activities such as increasing expenses in research and development.

Keywords: Pay-for-performance; Executives; Crowding out; Innovation; Patents; Radical innovation

1. Introduction

In the last few decades, executive payment has been extensively discussed in the public and scientific community (Benson and Davidson, 2010; Junarsin, 2011). The main reason for this is that the salaries of top managers have increased substantially over the years (Jensen et al., 2004; Minnick et al., 2011; Rost and Osterloh, 2007). By observing this trend, one realizes that the fixed income of top managers is more and more supplemented with variable performance components such bonus, option, and share programs (Jensen et al., 2004). According to shareholder value-maximization theory, "managers should make all decisions so as to increase the total long-run market value of the firm" (Jensen, 2002). Therefore, executive pay gets linked to firm performance in order to encourage managers to operate in alignment with shareholder interests (Jensen and Meckling, 1976). However, a still-open question is whether variable payment indeed leads to enhanced firm performance. Many studies explore the pros and cons of pay-for-performance for executives (for an overview Osterloh and Rost, 2011). Advocates state that aligning compensation to performance raises personal effort and performance (Kaplan, 2008; Kaplan and Rauh, 2010; Lazear, 2000; Lehman and Scott, 2004), while opponents believe that using incentive schemes decreases performance, and detrimentally causes considerable enhancement of executive pay, contributing to financial crises (Bebchuk and Grinstein, 2005; Bebchuk and Fried, 2003, 2004; Bebchuk and Fried, 2005; Turner, 2009). Despite the potential negative effects of pay-for-performance, many organizations still use these incentive schemes to motivate their executives.

Especially with regard to innovation, it is not clear whether incentive programs encourage innovation or not. Innovation is inevitably linked to risk-taking and to the long-term commitment to a firm's resources. One of the critical factors to foster innovation in firms is a high amount of intrinsic motivation, autonomy and freedom (Amabile and Gryskiewicz, 1987; Andrew and Farris, 1967; Paolillo and Brown, 1978; Siegel and Kaemmerer, 1978; Smeltz and Cross, 1984). Experimental research shows that tangible rewards, such as pay-for-performance, are likely to be perceived as controlling and thus likely to undermine such intrinsic motivation, autonomy and freedom (Deci and Ryan, 2000; Rummel and Feinberg, 1988; Tang and Hall, 1995; Weibel et al., 2010; Wiersma, 1992). Furthermore, variable-pay programs mostly focus on short-term measurements of performance such as stock performance or turnover (Jensen et al., 2004); this leads to the fact that individuals usually do not have incentives to focus on long-term measurements of performance such as innovation. The problem has become aggravated since the tenure of executives has dramatically declined in most companies (Kaplan, 2008; Murphy and Zábojník, 2004). Thus, executives have even less incentive to invest in the long-term oriented future of their companies.

Our main goal in this study is to explore the effect of incentive programs on innovation activities. There has been some prior research that addresses this issue but the results are mixed. Most of the previous studies believe that long-term payment such as stock options can foster innovation activity because it creates long-term commitment in executives (Barros and Lazzarini, 2012; Bereskin and Hsu, 2014; Francis et al., 2010; Lerner and Wulf, 2007). Ederer and Manso's (2013) experimental research considered this topic. By investigating the behaviors of three subjects under a pay-for-performance contract, a fixed-wage contract and a contract that tailors early failure to motivate exploration toward novel business strategy, they found that the combination of tolerance for early failure in addition with rewards for long-term success can be effective in encouraging innovation. Subjects under such an incentive are more likely to discover a novel business strategy than subjects under fixed-wage and short-term oriented pay-for-performance incentive plans. Following this direction, Baranchuk et al.'s (2014) recent study suggests that option compensation with longer vesting periods and protection from early termination can be helpful to motivate managers to pursue innovation. Francis et al. (2010) investigate the association between CEO compensation in S&P 400, 500, and 600 firms and innovation. They hypothesize a negative link between pay-for-performance sensitivity and innovation, and a positive link between long-term payment and innovation. They find no relationship between CEOs' share in value creation and innovation, and find a positive link of long-term payment on innovation. Lerner and Wulf (2007) focus on pay-for-performance for R&D executives. They find that long-term incentives for R&D heads positively affect the numbers of patent and patent citations.

In contrast to this former research, we base our paper on the crowding-out theory and expect negative effects of short- and long-term incentive pay for CEOs and top executives on the innovation activities within firms. Therefore, we include lagged compensation to see how previous executive payments motivate innovation activity, as it takes a couple of years for innovation activity to become visible within firms. Furthermore, we differentiate between radical and incremental innovation. Unlike Francis et al. (2010) who consider only the compensation of CEOs, we analyze both the compensation of CEOs and other top executives. We use Compustat and the NBER database to measure executive compensation and innovation activities. Our final sample consists of 1,240 US manufacturing firms during the period 1992-2006. In contrast to former research and in line with crowding-out theory, the findings show that long-term incentives such as stock options, decrease the incentives of top managers to invest in patent activities. Moreover the negative effects of pay-for-performance increase for the engagement in radical innovation activities.

2. Hypothesis Development

2.1. Performance-related pay and performance

The main idea of pay-for-performance is to align the interests between agents (i.e., managers) and principles (i.e., shareholders) to solve agency problem (Jensen and Murphy, 1990; McConnell and Servaes, 1990; Morck et al., 1998). Shareholders encourage managers through the incentive contracts to exert more effort, i.e., if shareholders achieve their goals by having higher prices in shares or stock options, managers will get rewarded because of their good performance. However, there are two opposing views about the effects of pay-for-performance on efficiency and productivity.

Standard economic and behavioral management theories argue that by linking executive payment to personal performance, behavior can be directed (Lehman and Scott, 2004; Stajkovic and Luthans, 2003). Underlying this is the assumption of rational, selfish and extrinsically motivated actors, the so-called *homo oeconomicus*, who react to external incentives in a predictable manner. This assumption is implicitly based on the stimulus-response theory, which involves only the observable factors in a black-box treatment. Changes in behavior are traced back to changes in restrictions, and not to changes in preferences (see Stigler and Becker, 1977). As a consequence, human behavior can be directed through the selective deployment of rewards or sanctions. Individuals will perform best when the incentive system links rewards as closely as possible to performance. For example, Lazear (2000) explores the productivity improvement of Safelite Glass corporation employees by changing their compensation from hourly wages to piece-rate pay (with a guaranteed minimum wage). As a result, productivity improved by 44% (Lazear, 2000). In an overview of the literature, Rynes et al. (2005) conclude that "PE (performance evaluation) and PFP (pay-for-performance) are two of the most powerful tools in an organization's motivational arsenal… so powerful that one of the main challenges for managers is to make sure that their compensation systems are not motivating the wrong kinds of behavior" (Rynes et al., 2005, 595).

In contrast, other authors argue that remuneration cannot always solve agency problems (Bebchuk and Grinstein, 2005; Bebchuk and Fried, 2003, 2004; Bebchuk et al., 2006). In corporations, boards of directors and compensation committees set remuneration packages for CEOs. Lack of information, of expertise and of negotiating skills may lead to poorly designed remuneration packages. Insufficient incentive designs can restrict their effectiveness and create incentives for executives to take actions that destroys firm value instead of creating it. For example, under some bonus plans, executives will not get any bonus until they achieve a threshold performance, and when they achieve the target performance they are paid target bonuses (Jensen et al., 2004). This type of design might cause shirking in managers: if they find out that they cannot achieve the threshold performance this year they decline their performance, or once they achieve the maximized bonuses they stop performing.

This observation is in line with self-determination theory and psychological economics, suggesting that motivation is not a unitary phenomenon (Deci and Ryan, 1985, 2000; Frey and Jegen, 2001; Frey and Osterloh, 2002). Individuals may not only have different levels of motivation, but may also experience different kinds of motivation depending on the specificities of the organizational context and of the task characteristics (Ryan and Deci, 2000). Extrinsic motivation satisfies personal needs indirectly, that is, extrinsic motivation refers to doing something because it leads to separable outcomes such as monetary compensation (Ryan and Deci, 2000). Money cannot produce direct utility but it enables an individual to acquire desired products. Intrinsic motivation, in contrast, satisfies personal needs directly (Frey and Jegen, 2001) by creating an intrinsic reward for those who perform the tasks (George, 1992). Tasks are thought to be intrinsically rewarding if they are perceived to be interesting, i.e., to be challenging, enjoyable or purposeful. In short, psychological economics and self-determination theory assume that individuals may also derive utility from the activity itself (Deci, 1973; Lindenberg, 2001). Pay-for-performance is proposed to have, under certain conditions, a negative, crowding-out effect on intrinsic motivation. For this reason especially, the performance of interesting tasks is likely to suffer upon the introduction of performance-related pay (Frey and Jegen, 2001; Ryan and Deci, 2000). This argument is supported by numerous experiments and field studies in psychology (e.g. Amabile, 1998; Deci, 1971; Lepper and Greene, 1978) and psychological economics (e.g. Falk and Kosfeld, 2006; Fehr and Falk, 2002; Fehr and Gächter, 2001; Frey and Oberholzer-Gee, 1997; Irlenbusch and Sliwka, 2003). For example McGraw and McCullers (1979) show that contingently-rewarded students perform considerably worse than their unpaid colleagues at interesting "out-of-the-box" thinking tasks.

As a consequence, psychological economics and self-determination theory propose that pay-for-performance hurts performance in the case of interesting tasks. In contrast, standard economics and behavioral management theory propose that pay-for-performance increases performance, independent of the type of task involved. A meta-analysis of former field experiments supports that indeed, performance-contingent pay has negative effects on performance in the case of interesting tasks (Weibel et al., 2010). Crowding-out effects can occur as three sub-effects: the overjustification effect, the spillover effect and the multitasking effect.

Lepper, Greene & Nisbett (1973) define the term *'overjustification effect'* as "the proposition that a person's intrinsic motivation in an activity may be decreased by inducing him to engage in that activity as an explicit means to some extrinsic goal" (Lepper et al., 1973: 130). Individuals show less interest when they are tangiblely rewarded for doing interesting activities (Deci, 1973; Frey and Oberholzer-Gee, 1997; Lepper and Greene, 1978); their intrinsic motivation decreases so that their internal locus of causality is substituted by an external locus of causality, which means that the self-initiating activity is now replaced by the activity which is forced by others (De Charms, 1968). In order to compensate the reduced intrinsic motivation, an employer should assign considerable external incentives such as money to employees; otherwise, the performance of employees will substantially decline. According to the *spillover effect* when individuals with intrinsic motivation are rewarded extrinsically for a certain task, the decline of intrinsic motivation is not limited to that task in question but is also transferred to other areas to which the incentive mechanism was not targeted. For example, a child who receives a monetary reward for cleaning his room finds out that he/she can ask for money to carrying out other tasks (Frey and Jegen, 2001; Rost and Osterloh, 2009).

Furthermore, according to the *multitasking effec*t when persons are paid based on their performance, they just focus on the tasks for which they are paid, and neglect those tasks that are less observable and quantifiable. For instance, applying piece-rate payment systems may distort workers' motivations away from maintaining the quality of firm's machinery or products. Therefore, this kind of incentive scheme may reinforce strategic behavior in individuals (Holmström and Milgrom, 1991; Jensen et al., 2004; Rost and Osterloh, 2009). Other factors also reinforce the detrimental effect of pay-for-performance on performance, for example, self-selection. Extrinsically motivated persons prefer to be under external control, and so they enter organizations with a performance-based incentive system; on the contrary, intrinsically motivated people do not like to work under this control because the control may limit their freedom and autonomy. Therefore, they quit such a job and attempt to find an appropriate one (Rost and Osterloh, 2009).

2.2. Performance-related pay and innovation

The main issue that we address in this research is the effect of pay-for-performance on innovation. Given the increasingly competitive business environment, firms must develop and commercialize innovative products and services in order to survive in a competitive business environment (Makri et al., 2006). According to a CEO survey, the greatest concern for companies is “stimulating innovation, creativity and enabling entrepreneurship” (Rudis, 2004). In this respect, having the appropriate compensation packages for top executives in corporations can have an impact on encouraging innovation in organizations. In the following, we discuss whether performance-contingent rewards have positive or negative effects on innovation tasks in organizations.

Intrinsic motivation can be considered as a moderating and mediating element for the evaluation of employees’ performance in the innovation process. According to componential theory, task motivation determines the extent to which a person fully engages his/her expertise and creative thinking skills in creative tasks (Amabile, 1997; 1998). Scholars such as Angle (1989) also highlight the power of intrinsic motivation in producing creative behavior, in the sense that intrinsically motivated individuals feel free of extraneous concerns about contextual conditions and can focus only on tasks (Shalley, 1995; Shalley and Oldham, 1985). Intrinsic motivation encourages exploration (Zhou, 1998), persistance (Oldham and Cummings, 1996; Zhou, 1998), flexibility, spontaneity, and finally, creativity (Deci and Ryan, 1985; Ryan and Deci, 2000).

In the former sections, we pointed out that external incentives such as monetary rewards could crowd out intrinsic motivation. This effect may be of high relevance in the context of innovation activities. When managers of technology-intensive firms are paid based on their performance (e.g., stock options or bonus) their intrinsic motivation to invest in innovations and new ideas might get reduced, i.e., they may become more interested in their payment than in successful innovation. Further, according to the theory of multitasking effects, managers may focus on tasks which have the higher return in short run (Jensen et al., 2004). It becomes unlikely that managers perform innovation activities because, for innovation activities, firms should endure high expenses today in order to have future benefits, which leads to lower short-term profits (Gibbs, 2012). Furthermore, there may also be a self-selection in favor of extrinsically motivated managers. According to these arguments, we assume that pay-for-performance for managers has negative effects on their incentives to invest in innovations, i.e. pay-for-performance reduces the innovation performance of firms in the next periods.

Hypothesis 1. *Firms that pay their top managers with a higher amount of pay-for-performance have a lower next-period innovation performance.*

The second issue that we address here is the effect of pay-for-performance on incremental and radical innovation. Radical innovation activities are surrounded by technical, market, organizational and resource uncertainties (Leifer et al., 2001). For instance, managers have to consider whether an innovation meets a customer's needs. Furthermore, in comparison to incremental innovations, radical innovations have a longer life cycle, i.e., it often takes a decade or longer to develop and implement (Green et al., 1995; McDermott and O'Connor, 2002; Rice et al., 2001). Given these characteristics of radical innovation, managers are only likely to pursue this kind of innovation when they are intrinsically motivated by their work (Gilson and Madjar, 2011). Therefore managers might not engage in radical innovations unless they are really motivated and excited about their work. Thus, the negative effects of pay-for-performance on innovation – especially the overjustification effect – should be higher in the case of radical innovations than in the case of incremental innovation. Moreover, the multitasking effect is likely to be higher for radical innovation compared to incremental innovation. In the face of performance-related pay, managers may neglect radical innovation activities since the results of these activities are less observable and quantifiable in the short run.

Hypothesis 2. *The negative effects of pay-for-performance on innovation performance are especially high in the case of radical innovations as compared to incremental innovations.*

3. Method

3.1. Data

The data for addressing our research question are collected from Compustat and the National Bureau of Economic Research (NBER) database. Compustat includes the data set Execucomp that is comprised of compensation data for US senior executives during the period 1992 to 2012. We collect information on base salary, bonus payment, restricted stock grants, option grants and long-term incentive plans (LTIP). The NBER patent database has been created by Hall et al. (2001) and includes almost 3 million US patents granted during the period 1963 to 2006, and the citations made to these patents between 1975 and 2006. The database provides the number of patents and the number of citations received by each patent. We consider the application year of patents instead of their grant year because application year is closer to the real time of innovation (Griliches et al., 1987). Information about research and development expenses and financial characteristics of firms can be also found in Compustat. NBER and Compustat databases were matched on the level of each firm. We considered all firms in the manufacturing industry (based on SIC codes). Firms of the financial industry were excluded since innovations are difficult to measure in this industry. The final dataset includes 20 sub-industries with four-digit SIC codes and consists of 1,240 firms in the period of 1992-2006, with and without patents.

3.2. Measurement of variables

3.2.1. Executive Compensation

Executive compensation, more precisely pay-for-performance composed of short-term and long-term incentives, is the main explanatory variable in our study. A bonus is considered as a short-term incentive compensation and restricted stock grants, and option grants, and long-term incentive plans (LTIP) are used as measures for long-term incentive compensation. In line with the former literature, we analyze the ratio of long-term and short-term payment to total compensation, and we take the logarithm of all compensation ratios because the distributions of all variables are highly skewed (Tosi, 2005; Tosi et al., 2000). Executive compensation is either measured as the compensation for all top managers working for the firm or as the compensation for the CEO.

3.2.2. Innovation

We include four measurements for the innovation performance of firms. First, we include research and development (R&D) expenditures. Second, R&D intensity, calculated as R&D expenditures divided by sales, is considered. Both variables indicate the firms' resources allocation to produce innovation activity (Yanadori and Marler, 2006). The third proxy for innovation activity is the number of patents. Patents capture the technological innovation of firms and can be applied to measure innovation (Griliches, 1990). Nevertheless, using patents as a proxy for innovation activities has some limitations. Firms do not patent all of their innovation and invention, e.g., sometimes they prefer to use secrecy or copyright since patenting is expensive and time consuming (Archibugi, 1992; Arundel and Kabla, 1998). Despite this problem, patent data are a proper and objective indicator for measuring the innovation activities of firms. In particular, this study is not interested in measuring firms' innovation capability; in fact we focus on resource allocation of executives to innovation activity. Based on Hall et al. (2001), there is an average gap of three years between granted and applied year of patent. To avoid truncation bias we consider this gap in our analysis and only include patent data up to 2004. The number of forward citations is used as a fourth proxy for innovation activities and indicates the "importance" of cited patents (Hall et al., 2001). Forward citations can be used to measure the radicalness of innovation (Trajtenberg, 1990). When patents receive more citations it is more likely that they include significant and important technologies (Dutta and Weiss, 1997). Patent citation data suffer from truncation because younger patents are probably less cited. In order to correct truncation of post-2006, Hall et al. (2001) provide a measure in their paper which is also available in the NBER database. We apply these weights to the number of citations in order to avoid truncation bias.

3.2.3. Control Variables

Control variables are considered at three levels, namely the firm, executive and corporate governance level.

3.2.3.1. Firm level

At the firm level, we control for *firm size* measured by the number of employees. Studies show that firm size increases the amount of executive pay (Ehrenberg and Smith, 2003; Tosi et al., 2000) and has effects on the composition of executive pay (Zenger and Marshall, 2000). Moreover, firm size affects R&D spending and the number of patents (Balkin et al., 2000). *Firm performance* is another common control variable in executive compensation and innovation studies. Firms with high profits are more likely to pay executives more (Yanadori and Marler, 2006) and perform more intense innovation activities (Geroski et al., 1993). Firm performance is measured by return on assets (ROA) and leverage ratio that is calculated by dividing the long term debt by total assets (Mehran, 1995; Yanadori and Marler, 2006). Another variable which relates to executive compensation is *firm volatility*. According to former research, variable compensation increases in the case of high volatility because of greater managerial discretion (Demsetz and Lehn, 1985). We use the Black-Scholes volatility measure, which is the standard deviation volatility calculated over 60 months. Furthermore, *multi segment firms* generate a smaller number of patents with less citation, compared with single- segment firms (Seru, 2014). To address this issue, we consider a dummy variable that is equal to 1 when firms have more than one business segment, and 0 otherwise.

3.2.3.2. Executive level

Executive age, CEO tenure, the number of executives and their total compensation are the control variables at the executive level. Gibbons and Murphy (1992) find that with increasing

CEO age, the pay-for-performance sensitivity increases and it is more likely that younger CEOs perform innovation activity in firms (Barros and Lazzarini, 2012). Furthermore, with increasing *CEO tenure*, executives may gain control over the board of directors and therefore may have the power to change their compensation based on their preferences instead of stockholders preferences (Hill and Phan, 1991). We also control for *number of executives* in a top management team as team size varies among firms and implies – among other things – different levels of control (Dalton et al., 1999).

3.2.3.3. Corporate governance level

We control for the case in which executives are listed in boards (Ex_director) and sit in compensation committees (Ex_Comp_Committee). Both, board of directors and compensation committee have the responsibility to set the remuneration of CEOs and of other top executives. Therefore, including top executives and CEOs in boards and compensation committees might have an effect on their remuneration (Jensen et al., 2004). *Ex_director* and *Ex_Comp_Committee* are binary variables; they amount to 1 if executives are listed in the board of directors and in compensation committees, and 0 otherwise.

3.3. Model

Our dependent variables, R&D expenses and R&D intensity, are continuous variables. In contrast, the dependent variables, patent and patent citation, are count variables. Since patent data are over-dispersed and their variance is much greater than their mean, the assumption of the Poisson estimator is not supported. Therefore, we will use a negative binomial regression model when patent and patent citation are dependent variables, and Ordinary Least Square (OLS) when R&D expenses and R&D intensity are dependent variables. Based on the results of a Hausman test, we apply fixed-effect models. Fixed-effect models seem also more appropriate to answer our research question, as they compute how changes of the independent variables within a firm become reflected in changes of the dependent variable within this firm. However, we also run random-effect models for robustness checks and find comparable results.

4. Results

Table 1 presents the descriptive statistics for the variables of interest. It shows that the average of total compensation of all executives and CEOs is 1.9 and 4.3 million dollars, respectively. Executives, on average, received 12.6% and 40.9% of their total compensation in short- and long-term variable payments, respectively. CEOs received 13.4% of their total compensation as a bonus pay and 42.5% as long term incentives. CEOs are, on average, 62.5 years old and stay in companies around 6.7 years. The maximum number of patents that a firm (Hewlett-Packard Company) in the sample has is 2,371. In the sample, Pfizer Company has the maximum expense for research and development, with a total of 12,183 US dollars.

Insert Table 1 about here

Table 2 illustrates the bivariate correlations of the variables. There is no serious correlation between variables, therefore the concerns about multicollinearity can be eased. We additionally checked the variance inflation factors in the regression models. In the following we will first discuss pay-for-performance sensitivities that indicate the alignment of executive and shareholder interests with respect to innovation and second, pay-for-performance links that indicate optimal incentive contracts that make the agent's compensation contingent on the outcomes desired by the principal. In the literature, both models are used to evaluate the efficiency of incentive pay (Jensen and Murphy, 1990). However, we prefer the results with respect to the pay-for-performance link because the model considers time-lag effects and thus, model human reactions to incentive pay more correctly.

Insert Table 2 about here

Table 3 first shows the regression results of pay-for-performance sensitivities for both top executives and CEOs. It tests the assumption of agency theory, that shareholders tie the performance to the pay of managers. Scholars refer to this relationship as the sensitivity of pay to performance, i.e., changes in shareholder wealth will be correlated with changes in executive compensation (Jensen and Murphy, 1990). Greater pay-for-performance sensitivities indicate greater alignment of executive and shareholder interests. We find only two significant positive effects, namely between the short-term incentives for CEOs and R&D expenses, and between the long-term incentives for an average executive and the number of patent citations. However, such positive effects cannot be obtained systematically. According to the remaining results, innovation outputs (R&D intensity, patent, patent citation) are, in most cases, significantly negatively correlated with short-term incentives. Long-term incentives are significantly negatively correlated with R&D expenses or show no systematic relationship with innovation outputs. Overall, these results can be interpreted as a signal for executives and CEOs that innovation mostly does not count for the company or shareholder wealth.

With respect to the control variables, firm size has a positive significant effect on innovations. Higher firm volatility is negatively correlated with R&D expenses, R&D intensity and patent citations. A higher leverage ratio and the ROA of a firm are negatively linked with R&D expense and intensity. Further, executives of younger age are more likely to spend in research and development, whereas older executives are more likely to increase the numbers of patents and patent citations. There is a negative correlation between listing executives in boards of directors and compensation committees and R&D expenses.

Insert Table 3 about here

Second, we test the assumptions of agency theory, that individuals are motivated by incentive payments. From this point of view, an optimal incentive contract makes the agent's compensation contingent on the outcomes desired by the principal (Fong and Tosi, 2007). To measure the pay-for-performance link, we use lagged compensation. We consider time lags of two and five years between compensation and innovation, as it takes, on average, two years for a patent to become issued and cited (Popp et al., 2004), and also the lag between research and development expenditure and return is nearly four to six years (Ravenscraft and Scherer, 1982). Table 4 illustrates the results for compensation with a time lag of two years and Table 5 shows the results for compensation with a time lag of five years.

As shown in Table 4, long-term incentive ratios are mostly positively correlated with R&D expenses and R&D intensity, suggesting that executives and CEOs who are paid a higher fraction of total compensation in the form of long-term incentives have a motivation to allocate firms' resources to R&D. While this finding is inconsistent with our Hypothesis 1, we also find negative links between long-term incentives and the number of patent and patent citations, particularly on the CEO level. The latter finding, in particular, states that long-term incentives seem to reduce the incentives of top managers to invest in radical innovations, which is in line with our Hypothesis 2. Both on the CEO and the executive levels, the coefficients for short-term incentives are insignificant in all models.

Table 5 reports the findings for compensation with a time lag of five years. The findings show that with increasing time lags, the negative effects of long-term incentives on radical innovation are enhanced. Although long-term incentives decrease executives' motivations to foster patent activities, the results also show that they can encourage managers to increase spending on R&D. Therefore, Hypothesis 1 – suggesting that firms which pay their top managers with a higher amount of pay-for-performance have a lower next-period innovation performance - is only validated for the numbers of patent and patent citations. Hypothesis 2 states that the negative effects of pay-for-performance on innovation performance are especially high in the case of radical innovations as compared to incremental innovations, and is temporally supported by the results. In the long run, we find that variable payments discourage both top executives and CEOs from investing in radical innovations. Regarding short-term incentives, we find significant coefficients only in one model on the executive level, suggesting that more bonus payment can be associated with more heavily cited patents. However, this is only a single finding and not replicated by other results.

With respect to the control variables in Tables 4 and 5, firm size has positive effects on innovation activities, higher volatility and a higher ROA leading to a decrease of R&D spending and intensity, and younger executives and CEOs are more likely to spend on R&D while older executives and CEOs tend to bring out more patents. Furthermore enhancing the tenure of CEOs can be effective for a firm's resource allocation to R&D but negatively influences patent citations.

Insert Tables 4 and 5 about here

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5. Discussion

This paper examined the effects of pay-for-performance for top managers on innovation activities in firms. We find mixed evidence for Hypothesis 1 that states that firms which pay their top managers with a higher amount of pay-for-performance have a lower next- period innovation performance measured by R&D expenses and patent outputs. We find strong evidence for Hypothesis 2 that states that the negative effects of pay-for-performance on innovation performance are especially high in the case of radical innovation measured by patent citations. In most cases, there is a negative association between incentive schemes and patent citations, indicating that pay-for-performance is not a proper stimulation for radical innovation. From this finding, one can conclude that in the long run, pay-for-performance for top managers indeed seems to undermine their incentives to invest in radical innovation activities within firms.

However, if firms intend only to increase their incremental innovation activities - e.g., their expenses in research and development – our findings additionally show that incentive schemes may encourage executives to engage in such activities. At least in the pay-for-performance-link models, we find positive correlations between long-term incentives and R&D expenses that suggest that managers who are paid with a higher amount of stocks and stock options invest more money in R&D. While our main finding suggests that these investments are not reflected in new technologies (i.e., the number of patents or patent citations) they may become reflected in (more incremental) new-product developments.

The main result of our study, namely that pay-for-performance for top managers is counterproductive for radical innovation activities in firms, seems to contradict previous studies that find that long term incentives positively affect patent activities (Francis et al., 2010; Lerner and Wulf, 2007). However, in contrast to these studies, our study focuses on the compensation of both top executives and CEOs, differentiates between radical and incremental innovation and applies lagged compensation to address the incentive effect of executive compensation on innovation output of firms. Ederer and Manso (2013) argue that pay-for-performance schemes that punish early failures with low reward discourage individuals from focusing on risky tasks such as innovations. In support of this argument, our results demonstrate that variable payments for top executives and CEOs create disincentives to allocate firms’ resources to patent activities and radical innovations. Therefore, if firms intend to stimulate innovation and creativity, and intend to enable entrepreneurship, they should structure incentive schemes differently from standard pay-for-performance contracts. In such situations, some alternatives incentive schemes such as fixed pay or profit sharing can be better alternatives to motivate managers to invest in innovations. Unlike pay-for-performance, fixed pay and profit sharing are not linked to the attainment of predefined goals. Therefore, managers who are paid based on such incentive schemes have more autonomy and freedom, which are critical factors in fostering innovation. In sum, our results suggest that increasing the proportion of fixed pay and profit sharing in top managers’ compensation can be helpful in enhancing their incentives to innovate.

This study has some limitations. First, following related studies, we try to address incentive effects of compensation by using time-lag effects of compensation. However, the negative effects of pay-for-performance on innovation may be also be influenced by other factors than CEOs’ incentives. As in all non-experimental settings, causality is still a critical issue. Second, the sample of this study is selected from the ExecuComp database that contains large manufacturing firms. The results may be not transferable to small firms or firms from the financial industry (and thus the fostering of financial innovations). Third, we did not have access to recent patent data (post-2006) so our study is limited to the period 1992-2006. Moreover, we restrict our sample to US firms. Firms in different countries are likely to be different regarding the compensation approach and innovation strategy. For instance, Soskice (1997) states that the innovation pattern of German firms is different from firms in the US and UK. Germany mostly focuses on incremental innovation in high quality products. Further, Kaplan (1994, 1997) finds evidence that Japanese executives own less shares than US counterparts. Finally, the lack of information in corporate governance variables such as the composition of the board of director or the specific characteristics of the shareholders is a further limitation of this study.

Further research might overcome some of these limitations by using alternative databases or methods. For instance, data form European countries and companies can be used. The findings of this study also pose a number of open questions that may be analyzed by further research. First, it is not clear which incentive contracts for top managers, for example fixed pay or profit sharing, foster radical innovations. Second, it could be investigated whether the results of this study can be replicated for the incentive contracts of middle management and of R&D employees who have a key role in implementing innovation (Gómez-Mejía and Balkin, 1992). Third, a systematic overview of incentive contracts that foster radical versus incremental innovations is mostly missing. Fourth, in this study we consider all firms in the manufacturing industry. The adoption of incentive schemes and the orientation of firms toward innovations may, however, vary across the different sub-manufacturing industries. One possibility for further research may be a comparison of the effect of incentive schemes between firms that tend to do more incremental innovations with firms that pursue more radical innovations. Fifth, there is, in particular, a need for research for the case of incremental innovations. In this study we used monetary variables such as R&D expenses to capture incremental innovations. However, much better measurements exist, such as the amount of new product developments or qualitative expert evaluations of the invented products and technologies. Sixth, in this study we excluded financial firms. It would be, however, interesting to investigate what effects pay-for-performance for managers have on the radicalness of financial innovations. In the last decades, the financial industry has been one of the most innovative industries, and pay-for-performance for managers is most common within this industry. (Radical) financial innovations and wrong incentive contracts are often accused of being the main drivers of recent financial failures and crises (Turner, 2009).

Seventh, payment of top executives is not the only factor that affects motivation to pursue innovation. It would be instructive to also study the effect of top executive characteristics, such as their professional background and educational level on their incentive to carry out radical innovations. Eighth, beyond firms' internal factors (such as incentive pay), external factors such as taxation and subsidy policies might also have influence on radical and incremental innovation. Future research is encouraged in order to examine the effects of these factors. Ninth, as Rynes et al. (2005) highlight with regard to the role of performance evaluation (PE) in improving performance, further research can test the relationship of PE with innovation.

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TABLES

Table 1
Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
All Executives					
Salary ($)	15827	370.9	178.36	0	1910.25
Short-term incentive ($)	15827	196.97	357.77	0	19671.09
Long-term incentive ($)	10622	1003.37	2193.77	0	91142.76
Total Compensation ($)	15498	1964.39	2606.69	0	91635.17
Short-term incentive ratio(%)	15491	12.6	13.57	0	90.53
Long-term incentive ratio(%)	10615	40.94	24.85	0	99.5
Executive age	15811	59.42	7.34	37.67	87.00
Executive numbers	15827	5.85	1.36	1	15
Chief Executives Officer (CEO)					
Salary ($)	14415	668.24	333.73	0	4000.00
Short-term incentive ($)	14415	442.28	875.01	0	43511.54
Long-term incentive ($)	9402	2437.60	8035.93	0	600347.4
Total-Compensation ($)	14318	4311.45	7589.65	0	600347.4
Short-term incentive ratio(%)	14288	13.40	16.20	0	93.74
Long-term incentive ratio(%)	9388	42.53	28.80	0	100
PresentAge	14369	62.50	9.51	10	98
CEO tenure	14283	6.76	7.28	0	61
Patent	9622	38.13	123.65	0	2371
Citation	9172	621.83	2438.80	0	46168.75
R&D	14373	187.54	677.60	-0.30	12183
R&D intensity	14349	0.44	8.02	-5.6	509.42
ROA	18651	0.82	102.58	-10300.00	2409.20
Leverage ratio	18632	0.18	0.41	0	50.72
Employee numbers	18224	12.49	29.40	0	750
volatility	12005	0.47	0.32	0.115	5.24
Ex_director	14415	0.98	0.14	0	1
Ex_Comp_Committe	14415	0.04	0.20	0	1
Segment	26145	0.68	0.46	0	1

Table 2
Bivariate correlation

ID	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Log R&D	1															
2	Log R&D intensity	0.2768*	1														
3	Patent	0.5155*	0.0600*	1													
4	Citation	0.3797*	0.0613*	0.8679*	1												
5	Log Short-term incentive ratio	-0.1010*	-0.2230*	-0.0530*	-0.0298*	1											
6	Log Long-term incentive ratio	0.3219*	0.2453*	0.1348*	0.0913*	-0.3592*	1										
7	Log Employee N	0.6517*	-0.4636*	0.3639*	0.2646*	0.1101*	0.0602*	1									
8	Log volatility	-0.1989*	0.4508*	-0.0784*	-0.0676*	-0.2536*	0.1559*	-0.5159*	1								
9	Leverage ratio	-0.0027	-0.0516*	-0.0410*	-0.0547*	0.0144	-0.0459*	- 0.1933*	-0.0606*	1							
10	Log ROA	0.0133	0.1106*	0.0082	0.0444*	0.0616*	0.0430*	-0.1208*	-0.0337*	-0.2736*	1						
11	Ex_age	-0.0880*	-0.1280*	0.0189	0.0614*	0.3084*	-0.2027*	0.1286*	-0.3534*	0.0215*	-0.0361*	1					
12	Ex_director	-0.0375*	-0.0536*	0.0222	0.0350*	0.1235*	-0.1167*	0.0161*	-0.1077*	-0.0348*	0.0467*	0.2667*	1				
13	Ex_Comp_Committe	-0.1246*	-0.0122	-0.0431*	-0.0203	0.0525*	-0.0643*	-0.0721*	-0.0358*	-0.0330*	0.0284*	0.1999*	0.2118*	1			
14	Segment	-0.0845*	0.1384*	0.0725*	0.0677*	0.0344*	-0.0321*	-0.1518*	-0.1109*	-0.0249*	-0.0099	0.1376*	0.0465*	0.0461*	1		
15	Log Total compensation	0.6841*	-0.0388*	0.3472*	0.2294*	-0.1652*	0.5359*	0.5742*	-0.1214*	0.0710*	0.0745*	-0.2288*	-0.0704*	-0.1357*	-0.1508*	1	
16	Executive N	0.1877*	-0.0598*	0.1283*	0.1139*	-0.0835*	0.0392*	0.2393*	-0.1015*	0.0726*	-0.0904*	0.1078*	-0.2230*	-0.0346*	-0.0015	0.1009*	1

Table 3
Pay-for-performance sensitivity

	All executives				CEO			
	Log R&D	**Log R&D intensity**	**N Patents**	**N Patent citations**	**Log R&D**	**Log R&D intensity**	**N Patents**	**N Patent citations**
Log short-term incentive ratio	0.0112	-0.03***	-0.061***	-0.07***	0.03**	-0.04***	-0.076***	-0.161***
	(1.57)	(-4.24)	(-4.26)	(-3.57)	(2.90)	(-4.43)	(-4.19)	(-6.21)
Log long-term incentive ratio	-0.03**	0.004	-0.016	0.08*	-0.04**	0.0005	0.011	0.054
	(-2.73)	(0.45)	(-0.69)	(2.35)	(-2.68)	(0.04)	(0.39)	(1.23)
Log Employee N	0.861***	-0.014	0.05*	0.052*	0.842***	-0.014	0.031	0.134***
	(58.58)	(-1.01)	(2.43)	(2.47)	(49.17)	(-0.86)	(1.35)	(5.54)
Log volatility	-0.11***	-0.08***	-0.06	-0.13*	-0.082***	-0.085***	-0.071	-0.26***
	(-5.06)	(-3.99)	(-1.32)	(-2.36)	(-3.48)	(-3.84)	(-1.36)	(-4.13)
Leverage ratio	-0.251***	-0.205***	0.265*	0.116	-0.191**	-0.192**	0.221	-0.312
	(-4.67)	(-4.13)	(2.29)	(0.80)	(-2.98)	(-3.20)	(1.65)	(-1.82)
Log ROA	-0.05***	-0.074***	-0.014	0.062**	-0.055***	-0.077***	0.001	0.07*
	(-6.81)	(-11.29)	(-0.91)	(2.80)	(-6.79)	(-10.12)	(0.10)	(2.57)
Executive age	-0.023***	-0.003**	0.016***	0.082***	-0.015***	-0.002*	0.012***	0.07***
	(-18.07)	(-2.96)	(6.51)	(29.20)	(-13.96)	(-2.44)	(5.58)	(25.41)
Ex_director	-0.001***	-0.0002	0.0008	0.003**	0.067	0.091	-0.275	0.064
	(-3.41)	(-0.47)	(0.93)	(2.84)	(0.82)	(1.19)	(-1.77)	(0.25)
Ex_Comp_Committe	-0.003**	-0.002*	-0.004*	0.005*	-0.146***	-0.1***	-0.121*	0.23**
	(-3.23)	(-2.24)	(-2.11)	(1.99)	(-4.73)	(-3.42)	(-1.96)	(2.94)
Segment	0.014	0.092***	0.213***	0.44***	-0.0216	0.09**	0.21**	0.5***
	(0.51)	(3.57)	(3.65)	(5.01)	(-0.72)	(3.09)	(3.25)	(5.04)
Log Total Compensation	0.153***	-0.017	0.052*	-0.162***	0.152***	-0.028*	-0.033	-0.3***
	(12.59)	(-1.52)	(2.20)	(-4.86)	(12.77)	(-2.50)	(-1.41)	(-8.44)
CEO tenure					0.007***	0.001	0.0045	-0.022***
					(5.02)	(0.81)	(1.53)	(-6.44)
Executive N	-0.0007	-0.002	0.014	0.117***				
	(-0.17)	(-0.53)	(1.67)	(10.02)				
_cons	2.676***	-3.006***	-0.427	-6.000***	2.05***	-3.05***	0.824**	-3.273***
	(20.25)	(-24.56)	(-1.61)	(-17.49)	(12.99)	(-20.61)	(2.66)	(-7.35)
R- squared	0.5	0.004			0.48	0.001		
Log likelihood			-12569.4	-21972.6			-9720.5	-16716.6
Wald χ^2			136.51	1791.62			121.47	1352.82
N	5419	5419	4281	4478	4118	4118	3269	3436

t statistics in parentheses
**p<0.05, **p<0.001, ***p<0.001*

Table 4
Pay-for-performance link (two-year lag)

	All executives				CEO			
	Log R&D	**Log R&D intensity**	**N Patents**	**N Patent citations**	**Log R&D**	**Log R&D intensity**	**N Patents**	**N Patent citations**
Log (short-term incentive ratio)$_{t-2}$	0.011	-0.002	-0.001	0.032	0.011	-0.004	0.001	-0.025
	(1.77)	(-0.28)	(-0.09)	(1.41)	(1.27)	(-0.52)	(0.08)	(-0.77)
Log (long-term incentive ratio)$_{t-2}$	0.035***	0.02*	-0.022	-0.07*	0.054***	0.009	-0.083**	-0.255***
	(3.88)	(2.29)	(-1.02)	(-2.43)	(3.96)	(0.67)	(-2.88)	(-5.91)
Log Employee N	0.861***	-0.01	-0.007	-0.009	0.88***	-0.006	-0.033	0.07*
	(50.86)	(-0.66)	(-0.31)	(-0.36)	(42.89)	(-0.29)	(-1.12)	(2.47)
Log volatility	-0.15***	-0.085***	0.05	0.076	-0.113***	-0.096***	0.074	0.018
	(-7.01)	(-4.15)	(0.89)	(1.26)	(-4.82)	(-4.17)	(1.20)	(0.24)
Leverage ratio	-0.2***	-0.094	0.32*	0.318	-0.11	-0.005	0.233	0.022
	(-3.47)	(-1.72)	(2.31)	(1.85)	(-1.64)	(-0.08)	(1.39)	(0.10)
Log ROA	-0.036***	-0.075***	-0.03	0.016	-0.025**	-0.072***	-0.024	-0.034
	(-5.19)	(-11.12)	(-1.88)	(0.69)	(-3.05)	(-8.82)	(-1.23)	(-1.11)
Executive age	-0.021***	0.0003	0.03***	0.108***	-0.015***	-0.0002	0.017***	0.081***
	(-16.20)	(0.29)	(9.19)	(29.82)	(-14.30)	(-0.19)	(6.34)	(25.40)
Ex_director	-0.002**	-0.0007	0.0009	0.003*	0.01	0.091	0.116	1.29***
	(-3.23)	(-1.44)	(0.78)	(2.32)	(0.17)	(1.49)	(0.56)	(3.41)
Ex_Comp_Committe	-0.003**	-0.001	-0.003	0.003	-0.093**	-0.074*	-0.005	0.356***
	(-2.95)	(-1.59)	(-1.41)	(1.22)	(-2.77)	(-2.25)	(-0.08)	(3.57)
Segment	-0.02	0.08**	0.176**	0.374***	-0.035	0.084**	0.197**	0.544***
	(-0.65)	(3.12)	(2.82)	(4.05)	(-1.25)	(3.04)	(2.84)	(5.22)
Log Total compensation	0.092***	-0.007	0.043	-0.035	0.067***	-0.015	-0.037	-0.08**
	(8.83)	(-0.74)	(1.84)	(-1.05)	(6.62)	(-1.57)	(-1.68)	(-2.84)
CEO tenure					0.01***	-0.0006	0.003	-0.03***
					(6.78)	(-0.43)	(0.86)	(-6.05)
Executive N	-0.015***	-0.003	0.013	0.15***				
	(-3.48)	(-0.68)	(1.35)	(10.83)				
_cons	2.856***	-3.454***	-0.854**	-8.063***	2.341***	-3.519***	0.767*	-5.911***
	(22.16)	(-27.89)	(-2.86)	(-20.46)	(15.58)	(-23.84)	(2.10)	(-11.10)
R- squared	0.45	0.01			0.45	0.05		
Log likelihood			-9361.65	-16156.62			-6935.67	-11822.412
Wald χ^2			144.85	1685.03			125.37	1057.92
N	4510	4510	3217	3446	3267	3267	2314	2499

t statistics in parentheses
**p<0.05, **p<0.001, ***p<0.001*

Table 5
Pay-for-performance link (five-year lag)

	All executives				CEO			
	Log R&D	**Log R&D intensity**	**N Patents**	**N Patent citations**	**Log R&D**	**Log R&D intensity**	**N Patents**	**N Patent citations**
Log (short-term incentive ratio)$_{t-5}$	0.005	0.003	-0.017	0.081*	-0.005	-0.017	0.008	0.05
	(0.68)	(0.38)	(-0.76)	(2.22)	(-0.46)	(-1.55)	(0.27)	(0.92)
Log (long-term incentive ratio)$_{t-5}$	0.03**	0.007	-0.12***	-0.202***	0.041*	-0.022	-0.26***	-0.406***
	(2.83)	(0.65)	(-4.15)	(-4.57)	(2.45)	(-1.32)	(-6.19)	(-6.44)
Log Employee N	0.85***	0.005	-0.05	-0.0004	0.873***	0.018	-0.012	0.183***
	(35.73)	(0.22)	(-1.44)	(-0.01)	(29.50)	(0.61)	(-0.28)	(4.72)
Log volatility	-0.166***	-0.073**	0.163*	0.456***	-0.2***	-0.093**	0.302**	0.701***
	(-6.66)	(-2.94)	(2.28)	(5.36)	(-6.30)	(-3.11)	(3.17)	(6.53)
Leverage ratio	-0.124	0.078	0.445*	0.363	-0.133	-0.023	0.302	0.922**
	(-1.74)	(1.11)	(2.32)	(1.38)	(-1.54)	(-0.27)	(1.20)	(2.80)
Log ROA	-0.03***	-0.077***	-0.009	0.05	-0.036***	-0.104***	0.0013	0.07
	(-3.38)	(-9.72)	(-0.40)	(1.35)	(-3.82)	(-11.17)	(0.05)	(1.58)
Executive age	-0.02***	0.002	0.044***	0.122***	-0.012***	0.002	0.022***	0.093***
	(-11.44)	(1.48)	(9.91)	(20.27)	(-9.00)	(1.83)	(6.03)	(17.17)
Ex_director	-0.0007	0.0001	-0.0002	0.003	0.041	0.118	0.544	2.408***
	(-1.26)	(0.30)	(-0.14)	(-1.17)	(0.57)	(1.65)	(1.44)	(3.36)
Ex_Comp_Committe	-0.002	-0.0009	0.0001	0.012**	-0.122**	-0.064	0.042	0.757***
	(-1.84)	(-0.86)	(0.06)	(3.17)	(-2.75)	(-1.44)	(0.39)	(4.89)
Segment	-0.02	0.066*	0.136	0.355***	-0.05	0.074*	0.231**	0.43***
	(-0.72)	(2.36)	(1.85)	(3.38)	(-1.55)	(2.30)	(2.70)	(3.60)
Log Total compensation	0.063***	-0.024*	-0.06	0.055	0.02*	-0.023*	-0.05**	-0.064
	(5.18)	(-2.00)	(-1.81)	(1.12)	(2.12)	(-2.45)	(-2.62)	(-1.43)
CEO tenure					0.009***	-0.002	-0.007	-0.043***
					(4.66)	(-1.29)	(-1.35)	(-6.55)
Executive N	-0.003	0.013**	0.033*	0.215***				
	(-0.69)	(2.58)	(2.55)	(10.59)				
_cons	2.916***	-3.6***	-0.4	-9.509***	2.585***	-3.48***	1.001	-7.48***
	(18.75)	(-23.31)	(-0.96)	(-16.67)	(14.74)	(-19.85)	(1.79)	(-8.02)
R-squared	0.43	0.08			0.44	0.06		
Log likelihood			-5200.54	-8626.06			-3815.8	-6243.72
Wald χ^2			209.19	883.82			152.84	597.26
N	2916	2916	1836	2033	2085	2085	1306	1474

t statistics in parentheses
$^{*}p<0.05$, $^{**}p<0.001$, $^{***}p<0.001$