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Pay for accounting performance and R&D investment: Evidence from China☆

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ABSTRACT

Previous studies argue that due to the complexity and long-term nature of research and development (R&D), there is no significant relationship between pay for short-term accounting performance and R&D investment. Meanwhile, we might also expect a negative relationship between pay for accounting performance and R&D investment in firms under temporary earnings pressure. However, we show that in an emerging market such as China, where the agency cost of innovation is high, firms may use incentive plans based on accounting performance to mitigate the opportunistic behavior of management. We find a positive relationship between pay for accounting performance and R&D investment. In addition, we find that the above relationship becomes weaker if there are alternative governance mechanisms to mitigate the agency cost of innovation.

1. Introduction

Recent studies on the relationship between R&D investment and pay for short-term accounting performance have reached different conclusions. Considering the complexity of R&D, some paper (Lerner & Wulf, 2007; Manso, 2011; Ederer & Manso, 2013) suggest that incentive schemes designed to motivate innovation should reward long-term success rather than short-term profitability. Hence compensation should not be tied to short-term performance and we should not expect to find any significant relationship between R&D investment and pay for short-term accounting performance. Meanwhile, Stein (1989) suggests that managers are likely to engage in myopic behavior and cut investment projects to boost short-term earnings. The literature also provides evidence that managers lower R&D investment to manage earnings (Jocobs, 1991; Baber, Fairfield, & Haggard, 1991; Roychowdhury, 2006). Recently, Bennett, Bettis, Gopalan, and Milbourn (2014) find that firms that just exceed profit goals have lower levels of R&D investment. This is consistent with the conjecture that firms cut R&D investment to meet certain performance goals. Under these circumstances, we should expect a negative relationship between R&D investment and pay for short-term accounting performance.

However, in emerging markets with severe agency costs, we argue that firms investing more in R&D may have a higher pay for accounting performance sensitivity. Managers sometimes mask their self-serving agendas behind excessive investment in R&D activities (Beyer, Czarnitzki, & Kraft, 2011; Dhaoui & Jouini, 2011). Due to weak corporate governance in emerging markets, shareholders might not have the mechanisms to effectively monitor or discipline managers for engaging in such opportunistic R&D investment. We hypothesize that shareholders may use short-term accounting goals to minimize the agency cost of R&D. Such an effect should be more apparent in firms with stronger managerial power or weaker corporate governance.

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Jensen and Murphy (1990) suggest that performance-based incentive plans are helpful tools for aligning the interests of managers and shareholders that can lead to more efficient managerial investment. Using a sample of Chinese firms from the 2007 and 2011 period, we find that the pay for accounting performance sensitivity is higher for firms with higher levels of R&D investment. We interpret this as evidence that accounting performance sensitivity is used as a governance mechanism to minimize management's opportunistic behavior. To provide additional support for this claim, we examine whether the presence of alternative governance mechanisms weakens the pay for accounting performance sensitivity in these firms. We find that firms that are not owned by the state government, those that are under-investing, those with a more competitive labor market for managers, and those with higher quality auditors are less likely to use pay for accounting performance as a governance mechanism to curb management overspending.

Our study contributes to the literature in the following ways. We study the relationship between compensation and innovation in emerging markets where information asymmetry is greater and agency conflicts are more severe than in developed markets. We then explore how the link between compensation and short-term accounting goals affects innovation. We find that using pay for accounting performance to mitigate agency conflicts is a dominant mechanism in China. This is very different from previous findings (Manso, 2011; Ederer & Manso, 2013; Baber et al., 1991) that suggest either no relationship or a negative relationship between R&D investment and pay for accounting performance sensitivity. Overall, our study shows that in emerging markets where governance quality is weak, agency cost plays a significant role in the relationship between pay for accounting performance and innovation. Our findings might also be extended to firms in developed markets that suffer a significant agency cost of innovation.

The remainder of this paper is organized as follows. Section 2 discusses the related literature and our hypotheses. Section 3 describes the variables and empirical methodology. Section 4 reports the data and our empirical analyses and Section 5 provides the conclusion.

2. Literature review and hypotheses development

Inderst and Klein (2007) provide a theoretical model showing that managers are biased toward overspending, especially when they have to compete for resources. The issue of over-investment is particularly severe in China. Ding, Guariglia, and Knight (2014) find evidence of over-investment in all types of Chinese firms, including private sector firms. Furthermore, they show that excessive free cash flow is the main reason for such over-investment. The main agency concern in some emerging markets is the conflict between the controlling shareholder and minority shareholders (La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 2002) and Chen, Xu, and Yu (2009) show that tunneling by a controlling shareholder also results in over-investment.

Managers may seek greater remuneration by over-investing in R&D to grow the company (Beyer et al., 2011). Previous studies (Baker, Jensen, & Murphy, 1988; Jensen & Murphy, 1990; Gabaix & Landier, 2008; Frydman & Saks, 2010) show that company size rather than profitability is the main driver of management compensation. Therefore, managers have strong incentives to grow the company by over-investing in R&D. R&D investment also increases the level of information asymmetry between insider and outsider, and if the investment is asset- or team-specific, it makes replacing the incumbent management costly for shareholders. Dhaoui and Jouini (2011) show that managers have a tendency to be wasteful in investing the company's free cash flow in R&D, and that such investment allows managers to enhance their authority within the firm. Finally, managers might also use the uncertain nature of innovation to eschew personal responsibility. Dhaoui and Jouini (2011) argue that managers are more likely to extract personal benefits through investment in innovation because a higher level of R&D investment often results in a higher level of information asymmetry.

Compensating managers based on company performance can alleviate agency conflicts between managers and shareholders and incentivize managers to improve company performance (Holmström, 1979; Lambert & Larcker, 1987). The optimal incentive contract based on the agency framework suggests that pay for performance plays a significant role in aligning the interests of managers and shareholders (Jensen & Murphy, 1990). We therefore expect that firms trying to minimize potential R&D over-investment and the self-serving behavior of managers will curb managers' incentives to over-invest by implementing a higher level of pay for performance sensitivity.

We argue that in emerging markets where information asymmetry is large and agency conflicts are rather severe, concern about over-investment will be the dominant factor in the design of compensation contracts. Previous studies have demonstrated the existence of over-investment in China at the national (Bai, Hsieh, & Qian, 2006), provincial (Qin & Song, 2009), and firm level (Ding, Guariglia, and Knight, 2014). Thus, we make the following hypothesis.

Hypothesis. In emerging markets, firms with greater investment in R&D exhibit a higher level of pay for accounting performance sensitivity.

3. Variable definitions and methodology

3.1. Variable definitions

3.1.1. Executive compensation

Since December 2001, the China Securities Regulatory Commission has required all publicly traded companies to disclose the total compensation paid to their top three managers. A feature of executive compensation in China is the large proportion of monetary compensation within incentive packages (Conyon & He, 2011; Wang & Xiao, 2011), primarily in the form of salary. We thus focus on cash compensation, as stocks and stock options as compensation is rare in Chinese listed firms during our sample period. Thus, similar to Cadman, Carter, and Hillegeist (2010), we measure management compensation (*Salary*) by taking the natural logarithm of the total salary earned by the top three managers in a firm.

3.1.2. Pay for accounting performance sensitivity

Following previous studies (Jensen & Murphy, 1990; Gu, Wang, & Xiao, 2010), we ran change regressions between the change in executive compensation (Δ*Salary*) and the change in company accounting performance (Δ*Perf*) to measure pay for accounting performance sensitivity. Similar to Firth, Fung, and Rui (2006) and Zhang, Cahan, and Allen (2005), we use return on assets (*ROA*) and the return on equity (*ROE*) as alternative measures of accounting performance.

3.1.3. R&D intensity

Following Godfrey and Hamilton (2005), we measure the level of R&D as the percentage R&D investment over revenue. We then follow Oswald (2008); Huang and Zhang (2011), and Banker, Byzalov, and Xian (2013) and measure a firm's R&D intensity (*RDI*) as the percentile ranking of the firm's R&D intensity within each firm's industry-year. The use of these transformed R&D measures mitigates the issue of skewed distributions inherited from the R&D variable. We also create a dummy variable *RDD* that equals 1 if the firm invests in R&D during the year, and 0 otherwise.

3.1.4. Control variables

We follow the literature (Chang, Choy, & Wan, 2008; Xin & Tan, 2009; Huang & Wang, 2015; Dong & Gou, 2010) and control for the following variables in our models: 1) size, measured as the natural logarithm of total assets; 2) growth, measured as the percentage change in sales; 3) leverage (*Lev*), measured as total debt over total assets; 4) risk, measured as the standard deviation of the company monthly stock return; 5) capital investment (*CAPDEP*), measured as capital investment over depreciation; 6) an ST dummy that equals 1 if the firm was under special treatment, and 0 otherwise[1]; 7) board size (*BSize*), measured as the logarithm of the number of board members; 8) independent director (*DSize*), measured as the number of independent directors over the number of board members; and 9) CEO duality (*Duality*), a dummy that equals 1 if the CEO is also the chairman of the board, and 0 otherwise.

The definitions of all of the variables are given in Table 1.

3.2. Empirical models

To test our hypothesis, we assess pay for accounting performance sensitivity by regressing changes in performance on changes in management compensation. We also include an interaction term between R&D and accounting performance to examine the effect of R&D on the pay for accounting performance sensitivity. Following previous studies (e.g., Jensen & Murphy, 1990; Gu et al., 2010), we use the following model:

$$\begin{aligned}\Delta \text{Salary} = {} & \beta_0 + \beta_1 \Delta \text{Perf} + \beta_2 RDD(or\Delta RDI) + \beta_3 RDD(or\Delta RDI) \times \Delta \text{Perf} + \beta_4 \Delta \text{Size} + \beta_5 \Delta \text{Growth} + \beta_6 \Delta \text{Lev} + \beta_7 \Delta \text{Risk} \\ & + \beta_8 \Delta \text{CAPDEP} + \beta_9 \Delta \text{BSize} + \beta_{10} \Delta \text{Indep} + \varepsilon.\end{aligned} \tag{1}$$

In the above model, we also control for year and industry fixed effects by including year and industry dummies.

4. Descriptive statistics and empirical results

4.1. Descriptive statistics

Our sample period begins in 2007,[2] when China implemented a new accounting reporting standard that required a more accurate and consistent disclosure of corporate R&D investment. We exclude financial and insurance firms from our sample and collect R&D data from the remaining publicly traded companies in China. Among the firms with complete financial data available, we identify 1051 firm year observations of firms with R&D investments in the 2007 and 2011 period. Panel A of Table 2 shows that the average R&D intensity, which is defined as R&D investment over sales, is 1.59%. The number of firms investing in R&D increases continually over the sample period, and the mean and median investment intensity also grows over the period. We winsorize our sample at the 5% level to minimize the influence of extreme outliers.

We then construct a size-matched sample that includes firms with no R&D investment during the same year in the same industry.[3] In Panel B of Table 2, we report the descriptive statistics for both the R&D sample and the matched sample. A quick look at the table suggests that there are no significant differences between the two samples in terms of size, leverage, risk, or growth. However, firms with R&D investment appear to report higher salaries and lower short-term accounting performance

[1] Firms with abnormal financial conditions are placed under special treatment. They typically perform poorly and are in danger of being delisted.
[2] Prior to 2007, Chinese firms were not required to disclose R&D expenditure.
[3] We also do a propensity score matching in the robustness tests.

Table 1
Variable definitions.

Variable	Definition
Salary	The natural logarithm of the total salary earned by a firm's top three managers.
RDI	The percentile rank of the ratio of the company's R&D expenditure to sales. It is positively related to R&D ratios and ranges from [0, 1].
RDD	A dummy variable that equals 1 if the firm invested in R&D during the year, and 0 otherwise.
ROA	Return on total assets, defined as net income divided by total assets.
ROE	Return on total equity, defined as net income divided by total equity.
Size	The natural logarithm of total assets in RMB.
Growth	Sales revenues in year t minus sales revenues in year t-1 divided by sales revenue in year t-1.
Lev	Financial leverage, calculated as total debt divided by total assets.
Risk	The standard deviation of a firm's monthly stock market rates of return.
CAPDEP	Capital investment, measured as capital investment over depreciation.
ST	A dummy variable that equals 1 if the firm is under special treatment, and 0 otherwise.
BSize	The natural logarithm of the number of board members.
Indep	The percentage of independent directors on the board.
Duality	A dummy variable that equals 1 if the CEO is also the Chairman, and 0 otherwise.
△Salary	Change in salary from the previous year.
△ROA	Change in ROA from the previous year.
△ROE	Change in ROE from the previous year.
△Size	Change in Size from the previous year.
△Growth	Change in Growth from the previous year.
△Lev	Change in Financial Leverage from the previous year.
△Risk	Change in Risk from the previous year.
△CAPDEP	Change in CAPDEP from the previous year.
△BSize	Change in BSize from the previous year.
△Indep	Change in Indep from the previous year.

than firms with no R&D investments. Additionally, firms with R&D investment are less likely to be ST firms, and are more likely to have a greater percentage of independent directors than firms with no R&D investment.

Finally, Panel C of Table 2 reports the correlation matrix. We can see that salary is positively related to ROA, ROE, and R&D intensity, and negatively related to firm leverage and risk.

4.2. Regression analyses

Studies of executive compensation and innovation (Balkin, Markman, & Gomez-Mejia, 2000; Lerner & Wulf, 2007; Fong, 2010) generally find a positive relationship between management pay and the level of R&D investment. Understanding the relationship between R&D investment and compensation helps us to explore the relationship between R&D and pay for performance sensitivity. To explore this relationship, we run the following model using both the R&D investment dummy and R&D investment intensity measured as the percentile rank of R&D investment in the sample.

$$\begin{aligned} Salary = {} & \beta_0 + \beta_1 RDD(orRDI) + \beta_2 Perf + \beta_3 Size + \beta_4 Growth + \beta_5 Lev + \beta_6 Risk + \beta_7 CAPDEP + \beta_8 ST + \beta_9 BSize + \beta_{10} Indep \\ & + \beta_{11} Duality + \varepsilon. \end{aligned} \tag{2}$$

We follow Petersen (2009) and compute the clustered standard errors. In Table 3, both the R&D dummy and R&D intensity are significant and positive. It seems that firms with greater investment in R&D pay managers higher salaries. We also observe a positive relationship between performance and salary, whereas firm risk, leverage, and ST listing all decrease management salaries.

To address potential endogeneity in our model, we construct an instrumental variable and run a two-stage regression model. In line with recent studies (Hoechle, Schmid, Walter, & Yermack, 2012; Wintoki, Linck, & Netter, 2012), our instrumental variables for the two-stage least-squares regression are the industry's mean and the previous year's value of the R&D investment. The industry-level R&D is correlated with the firm-level R&D, but is less likely to be correlated with the outcome variable, that is, management compensation. Similarly, a company's lag R&D is generally correlated with R&D investment in the current year (Borisova & Brown, 2013), but there is no evidence that it affects contemporaneous management compensation. These instruments are correlated with the firm's R&D investment, but are unlikely to correlate with the error term.

We also follow Larcker and Rusticus (2010) and test the effectiveness of our instrumental variables. We show in Table 4 that both the industry mean R&D and the prior year R&D investments are significant in our models. In addition, we compute the J statistics and report the test of endogeneity (i.e., the test of weak instruments). The results suggest that these two instrumental variables are robust. Consistent with our hypothesis, the coefficients for R&D intensity are positively and significantly related to management salary, as shown in Table 4, columns 2 and 4.

Next, we examine the difference in the pay for accounting performance sensitivity in firms with and without R&D investment. Table 5 reports the difference in the correlation between the change in accounting performance ($\Delta Perf$) and change in compensation ($\Delta Salary$). When using *ROA* as a measure of accounting performance, the correlation is 0.080 for firms with no R&D and

Table 2
Descriptive statistics. Please see Table 1 for the variable definitions. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Summary statistics for R&D investment

Year	N	Mean	Std	Min	Q1	Median	Q3	Max
2007	109	1.18%	1.42%	0.00%	0.18%	0.59%	1.36%	4.72%
2008	141	1.46%	1.51%	0.00%	0.30%	0.91%	2.31%	4.72%
2009	215	1.33%	1.42%	0.00%	0.22%	0.76%	1.89%	4.72%
2010	233	1.53%	1.55%	0.00%	0.27%	0.91%	2.44%	4.72%
2011	353	1.97%	1.72%	0.00%	0.38%	1.36%	3.60%	4.72%
2007–2011	1051	1.59%	1.59%	0.00%	0.26%	0.97%	2.63%	4.72%

Panel B: Summary statistics for the main variables for the test and size-matched samples

	Full sample (n = 2102)			Test sample (n = 1051)			Size-matched sample (n = 1051)			T-statistic for the difference in means
	Mean	P50	SD	Mean	P50	SD	Mean	P50	SD	
Executive compensation										
Salary	13.886	13.898	0.631	13.924	13.916	0.613	13.849	13.886	0.646	2.708***
Performance										
ROA	0.052	0.044	0.051	0.050	0.042	0.051	0.054	0.046	0.051	−1.939*
ROE	0.091	0.087	0.089	0.088	0.080	0.090	0.095	0.092	0.088	−2.011**
Firm characteristics										
Size	21.666	21.575	0.813	21.670	21.572	0.985	21.661	21.576	0.595	0.251
Growth	0.462	0.468	0.196	0.455	0.468	0.201	0.469	0.469	0.191	−1.597
Lev	0.204	0.164	0.276	0.208	0.172	0.270	0.201	0.156	0.281	0.567
Risk	0.139	0.130	0.048	0.140	0.130	0.049	0.138	0.129	0.048	1.145
CAPDEP	2.835	1.976	2.585	3.029	2.174	2.683	2.641	1.792	2.469	3.451***
ST	0.076	0.000	0.264	0.056	0.000	0.230	0.095	0.000	0.294	−3.390***
BSize	2.186	2.197	0.173	2.181	2.197	0.184	2.191	2.197	0.161	−1.379
Indep	0.363	0.333	0.041	0.367	0.333	0.042	0.360	0.333	0.039	4.245***
Duality	0.209	0.000	0.407	0.197	0.000	0.398	0.221	0.000	0.415	−1.341

Panel C: Pearson correlation matrix of the main variables

	Salary	ROA	ROE	RDD	Size	Lev	Growth	Risk	CAPDEP	ST	BSize
ROA	0.34**										
ROE	0.36**	0.87**									
RDD	0.06**	−0.04	−0.04**								
Size	0.34**	0.00	0.17**	0.01							
Lev	−0.08**	−0.46**	−0.18**	−0.03	0.39**						
Growth	0.06	0.32**	0.37**	0.01	0.08**	0.02**					
Risk	−0.26**	−0.16**	−0.10**	0.03	−0.06**	0.19**	−0.00				
CAPDEP	0.10**	0.18**	0.15**	0.08**	0.02**	−0.17**	0.18**	−0.15**			
ST	−0.14**	−0.10**	−0.06**	−0.07**	−0.09**	0.20**	−0.02	0.04**	−0.09**		
BSize	0.11**	−0.01	0.02	−0.03	0.24**	0.15**	−0.01	0.02	−0.02	−0.05**	
Indep	0.03	−0.05**	−0.04	0.09**	0.03	0.01	0.00	0.00	0.00	0.01	−0.36**

0.190 for firms with R&D. The difference is significant at the 5% level. Similar results are found using *ROE* as a measure of performance. It appears that in our sample, the firms that invest more in R&D have a higher level of pay for accounting performance.

We run Model 1 and report the results in panel B of Table 5. We use the interaction term of the R&D dummy (or change in R&D intensity) and change in performance to examine the effect of R&D investment on the pay for accounting performance sensitivity. Column 1 of panel B in Table 5 shows that the interaction term between the R&D dummy and $\Delta Perf$ is positive and significant at the 5% (1%) level when *ROA* (*ROE*) is used to measure accounting performance. The interaction term between changes in R&D intensity and $\Delta Perf$ yields the same result. The coefficient for the interaction term is 2.157 (1.720) and is significant at the 5% (1%) level when *ROA* (*ROE*) is used.

The results in Table 5 are consistent with our main hypothesis, suggesting that firms with high levels of R&D investment may increase their pay for accounting performance sensitivity to mitigate the agency conflicts of managerial over-investment.

4.3. Robustness checks

Although the size-matched sample reduces the noise in the large sample, biases may have arisen in constructing the size-matched firms. We therefore run the tests using the whole sample to ensure that our results are not driven by a particular choice of matched sample. The results of these regressions are shown in Table 6. Column 1 (2) shows the results using the R&D dummy (rank) variable. The coefficients for the R&D variables are both significant at the 1% level, suggesting that large-scale investment in R&D is associated with high compensation.

Table 3
R&D investment and executive compensation. Please see Table 1 for the variable definitions. The regression model is $Salary = \beta_0 + \beta_1 RDD(orRDI) + \beta_2 Perf + \beta_3 Size + \beta_4 Growth + \beta_5 Lev + \beta_6 Risk + \beta_7 CAPDEP + \beta_8 ST + \beta_9 BSize + \beta_{10} Indep + \beta_{11} Duality + \varepsilon$. ***, ** and, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable = salary	(1)		(2)	
	Pref = ROA	Pref = ROE	Pref = ROA	Pref = ROE
Perf	4.166***	2.096***	4.145***	2.082***
	(9.80)	(9.70)	(9.83)	(9.71)
RDD	**0.091****	**0.086****		
	(2.56)	**(2.42)**		
RDI			**0.159*****	**0.149*****
			(2.79)	**(2.63)**
Size	0.237***	0.227***	0.243***	0.233***
	(9.45)	(8.87)	(9.68)	(9.10)
Lev	−0.004	−0.316***	−0.196***	−0.194***
	(−0.03)	(−2.95)	(−4.00)	(−3.86)
Growth	−0.202***	−0.200***	0.011	−0.301***
	(−4.14)	(−3.98)	(0.10)	(−2.80)
Risk	−1.356***	−1.414***	−1.341***	−1.400***
	(−3.52)	(−3.67)	(−3.48)	(−3.63)
CAPDEP	−0.004	−0.004	−0.005	−0.005
	(−0.63)	(−0.64)	(−0.88)	(−0.86)
ST	−0.155**	−0.147**	−0.159**	−0.150**
	(−2.24)	(−2.13)	(−2.31)	(−2.20)
BSize	0.291**	0.311**	0.296**	0.316**
	(2.25)	(2.39)	(2.28)	(2.42)
Indep	0.755	0.736	0.726	0.710
	(1.58)	(1.55)	(1.50)	(1.48)
Duality	0.135***	0.134***	0.133***	0.132***
	(3.06)	(3.05)	(3.02)	(3.01)
Intercept	7.859***	8.210***	7.717***	8.075***
	(13.70)	(14.03)	(13.41)	(13.78)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Observations	2102	2102	2102	2102
Adjusted R^2	0.315	0.309	0.315	0.309
F	44.152	44.464	44.754	44.757

We also compare the pay for accounting performance sensitivity in firms with and without R&D. Panel A of Table 7 shows that the pay for performance sensitivity is statistically higher (lower) for the firms with (without) R&D. Panel B of Table 7 presents the results of regressions examining the interaction between R&D and the pay for performance sensitivity. The interaction term between the R&D variables ($RDD \times \Delta Perf$ in column 1 and $\Delta RDI \times \Delta Perf$ in column 2) and $\Delta Perf$ are both positive and significant. Consistent with the results given in Panel B of Table 5, these results suggest that firms with greater investment in R&D also display a higher level of pay for performance sensitivity.

Additionally, we use propensity score matching to construct a matched control sample and rerun our tests; we find very similar results to those reported in Tables 3 and 5.[4] Specifically, treated firms are matched using nearest-neighbor logit propensity score matching. The matching variables are performance (*ROA* or *ROE*), size, leverage, growth, risk, capital expenditure, special listing dummy, board size, and the percentage of independent directors. We continue to find a strong and positive relationship between pay for accounting performance and R&D investment.

It is possible that managers might resort to earnings manipulation techniques or even accounting fraud for higher pay. This might bias the pay for performance sensitivity found in our analysis. To test the effect of firm earnings management on executive pay for performance sensitivity, we first decompose firm earnings into cash flow from operating activities (*OCF*), non-discretionary accruals (*NDA*), and discretionary accruals (*DA*) (Balsam, 1998). We use *DA* as a measure of firms' earnings management. To be specific, *OCF* is cash flow from operating activities, scaled by total assets at the beginning of the year. Following the performance-matched modified Jones model (Kothari, Leone, & Wasley, 2005), we estimate *NDA* based on the following regression model conducted by industry and year: $TA_{i,t} = a_0 + a_1(1/ASSETS_{i,t-1}) + a_2\Delta SALES_{it} + a_3PPE_{it} + \varepsilon_{it}$. $TA_{i,t}$ is total accruals for firm i in year t, defined as earnings before extraordinary items minus operating cash flows. Using the estimated parameters of the above equation, non-discretionary accruals are calculated as $NDA_{it} = \hat{a}_0 + \hat{a}_1(1/ASSETS_{i,t-1}) + \hat{a}_2\Delta SALES_{it} + \hat{a}_3 (PPE_{it} - \Delta AR_{i,t})$. Discretionary accruals are estimated as $DA_{it} = TA_{i,t} - NDA_{it}$. We then divide the sample into the above average DA group and below average DA group and run Model 1 separately. We find no significant difference in coefficient estimates between the two samples,[5] suggesting that our results are not driven by the likelihood of earnings management.

[4] As the results are qualitatively similar to our results in earlier tables, we do not tabulate these results here to save space. They are available upon request.
[5] As the results are qualitatively similar to the results reported in earlier tables, we do not tabulate these results here to save space. They are available upon request.

Table 4
Two-stage least squares regression for R&D investment and executive compensation. Please see Table 1 for the variable definitions. We use both the industry mean R&D investment and the company R&D investment in the previous year as instrumental variables. We follow Larcker and Rusticus (2010) to test the effectiveness of the instrumental variables. We also compute the J statistics and report the test of endogeneity. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Pref = ROA		Pref = ROE	
	(1) Dependent variable = RDI	(2) Dependent variable = salary	(3) Dependent variable = RDI	(4) Dependent variable = salary
RDI_t_IM	0.345*** (8.72)		0.345*** (8.72)	
RDI_{t-1}	0.613*** (17.68)		0.613*** (17.68)	
RDI $_t$		**0.171**** **(2.44)**		**0.161**** **(2.33)**
Size $_t$	−0.010* (−1.96)	0.242*** (8.84)	−0.010* (−1.96)	0.228*** (8.09)
Growth $_t$	−0.039*** (−2.87)	−0.250*** (−4.25)	−0.039*** (−2.87)	−0.237*** (−4.00)
Lev $_t$	−0.070*** (−4.01)	0.021 (0.17)	−0.070*** (−4.01)	−0.303*** (−2.62)
Perf $_t$		4.323*** (8.84)		2.271*** (9.08)
Risk $_t$		−1.491*** (−2.95)		−1.588*** (−3.13)
CAPDEP $_t$		−0.003 (−0.49)		−0.004 (−0.56)
ST $_t$		−0.134* (−1.76)		−0.121 (−1.60)
DSize $_t$		0.247* (1.76)		0.269* (1.91)
BSize $_t$		0.340 (0.61)		0.357 (0.65)
Duality $_t$		0.138*** (2.88)		0.140*** (2.92)
Intercept	0.299** (2.51)	8.108*** (12.91)	0.299** (2.51)	8.538*** (13.28)
Year fixed effects	Control	Control	Control	Control
Industry fixed effects	Control	Control	Control	Control
Observations	1466	1466	1466	1466
Adjusted R^2	0.833	0.293	0.833	0.290
F	721.830	30.640	721.830	31.270
Test of weak instruments	**2856.64**		**2856.64**	
J test of over-identifying and P value		**J = 1.853** **P = 0.173**		**J = 2.042** **P = 0.153**

In the Chinese market, the conflict of interests between controlling shareholders and minority shareholders could hamper the adoption of incentive payment schemes (Wang & Xiao, 2011). Controlling shareholders can receive private benefits from their controlling positions through various forms of self-dealing transactions. The agency cost of a controlling shareholder might negatively affect the effectiveness of performance-based incentives. To ensure that our results are robust, we control for the potential agency cost of a controlling shareholder. We compute the separation of control (voting rights) and ownership (cash flow rights) of the ultimate owners as an alternative proxy for the agency cost of a controlling shareholder.[6] Following La Porta, Lopez-de-Silanes, and Shleifer (1999) and Claessens, Djankov, and Lang (2000), we calculate the separation as the difference between the voting rights and the cash flow rights of the ultimate owner. The voting right is the weakest link in the chain of control rights. The cash flow right is the product of the ownership stakes along the chain. The incentives for and abilities of ultimate owners to derive private benefits from outside investors increase with their level of voting rights over the associated cash flow rights. We divide the sample into a high agency cost group (high separation between control and cash flow) and a low agency cost group (low separation between control and cash flow) and run Model 1 separately for the two groups. We find no significant differences between the coefficient estimates of the two samples,[7] suggesting that our results are not driven by the difference in the agency costs of controlling shareholders.

4.4. Additional tests

The key finding of our study is that Chinese firms with greater investment in R&D are more likely to use a higher pay for performance sensitivity to mitigate the problem of managerial over-investment. To find further support for our hypothesis, we

[6] We compute cash flow rights and control rights using the standard methodology developed by La Porta et al. (1999) and used by Claessens et al. (2000)

[7] As the results are qualitatively similar to the results given in earlier tables, we do not tabulate these results here to save space. They are available upon request.

Table 5
R&D investment and pay performance sensitivity in the size-matched sample. Please see Table 1 for the variable definitions. The regression model is

$$\Delta Salary = \beta_0 + \beta_1 \Delta Perf + \beta_2 RDD(or\Delta RDI) + \beta_3 RDD(or\Delta RDI) \times \Delta Perf + \beta_4 \Delta Size + \beta_5 \Delta Growth + \beta_6 \Delta Lev + \beta_7 \Delta Risk + \beta_8 \Delta CAPDEP + \beta_9 \Delta BSize + \beta_{10} \Delta Indep + \varepsilon.$$

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Z-statistics on the differences between correlation coefficients

		(1) △Perf = △ROA		(2) △Perf = △ROE	
		RDD			
		0	1	0	1
△Salary	Observations	1051	1051	1051	1051
	Correlation coefficient	0.080	0.190	0.053	0.185
		Z = −2.549**, P = 0.011		Z = −3.063***, P = 0.002	

Panel B: Regression results for R&D investment and pay performance sensitivity

Dependent variable = △Salary

	(1)		(2)	
	△Pref = △ROA	△Pref = △ROE	△Pref = △ROA	△Pref = △ROE
△Perf	0.376	0.056	0.446	0.019
	(1.47)	(0.48)	(1.45)	(0.13)
RDD	0.001	0.003		
	(0.07)	(0.25)		
RDD*△Perf	**0.980****	**0.635*****		
	(2.27)	**(3.09)**		
△RDI			0.010	0.018
			(0.48)	(0.86)
△RDI*△Perf			**2.157****	**1.720*****
			(2.15)	**(3.47)**
△Size	0.199***	0.199***	0.173***	0.177***
	(5.26)	(5.27)	(3.79)	(3.87)
△Lev	−0.023	−0.083	0.079	−0.006
	(−0.23)	(−0.87)	(0.68)	(−0.05)
△Growth	0.008	0.014	−0.002	0.008
	(0.39)	(0.70)	(−0.06)	(0.34)
△Risk	−0.193	−0.207	−0.113	−0.126
	(−1.51)	(−1.61)	(−0.72)	(−0.80)
△CAPDEP	−0.001	−0.001	−0.005	−0.004
	(−0.37)	(−0.35)	(−1.46)	(−1.38)
△Bsize	0.254**	0.254***	0.214	0.223
	(2.56)	(2.59)	(1.53)	(1.61)
△Indep	0.774***	0.779***	0.859**	0.907**
	(2.78)	(2.82)	(2.34)	(2.50)
Intercept	0.096***	0.096***	0.087***	0.085***
	(7.77)	(7.70)	(6.18)	(6.09)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Observations	2102	2102	1466	1466
Adjusted R^2	0.050	0.050	0.041	0.043
F	6.656	6.637	3.982	4.320

also study different firm characteristics and internal or external mechanisms that might also reduce the agency problem of over-investment. Specifically, we expect that pay for performance sensitivity will be lower or less significant if alternative mechanisms are in place.

We identify four non-overlapping categories to separate our sample into high and low pay for performance sensitivity groups: state versus private ownership, differences in company investment scale, labor market competitiveness for managers, and auditor quality.

1) *State versus private ownership*

Companies in China are either privately owned or state owned. State-owned firms are more likely to over-invest, as managers do not directly hold a significant stake in the firms, unlike their peers in privately owned companies. The agency problem of over-investment is therefore greater for state-owned firms. Using a dummy variable, SOE, that equals 1 if the firm is owned by the government and 0 otherwise, we expect state-owned firms to curb incentives for managerial over-investment by adopting a higher level of pay for performance sensitivity.

Table 6
R&D investment and executive compensation in the full sample. Please see Table 1 for the variable definitions. The regression model is

$$Salary = \beta_0 + \beta_1 RDD(orRDI) + \beta_2 Perf + \beta_3 Size + \beta_4 Growth + \beta_5 Lev + \beta_6 Risk + \beta_7 CAPDEP + \beta_8 ST + \beta_9 BSize + \beta_{10} Indep + \beta_{11} Duality + \varepsilon.$$

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable = salary				
	(1)		(2)	
	Pref = ROA	Pref = ROE	Pref = ROA	Pref = ROE
Perf	3.728***	1.582***	3.723***	1.579***
	(15.38)	(15.07)	(15.39)	(15.07)
RDD	**0.167*** **	**0.169*** **		
	(5.88)	**(5.95)**		
RDI			**0.358*** **	**0.362*** **
			(5.95)	**(6.01)**
Size	0.236***	0.233***	0.238***	0.235***
	(18.17)	(17.86)	(18.28)	(17.98)
Lev	−0.026	−0.314***	−0.100***	−0.074***
	(−0.34)	(−4.46)	(−3.97)	(−2.95)
Growth	−0.102***	−0.076***	−0.019	−0.306***
	(−4.06)	(−3.04)	(−0.25)	(−4.34)
Risk	−0.656***	−0.799***	−0.650***	−0.793***
	(−3.10)	(−3.74)	(−3.07)	(−3.71)
CAPDEP	0.001	0.003	0.001	0.003
	(0.36)	(0.87)	(0.19)	(0.70)
ST	−0.213***	−0.213***	−0.215***	−0.215***
	(−5.35)	(−5.38)	(−5.39)	(−5.43)
BSize	0.248***	0.274***	0.252***	0.278***
	(3.28)	(3.59)	(3.32)	(3.63)
Indep	0.137	0.152	0.123	0.138
	(0.45)	(0.50)	(0.40)	(0.45)
Duality	0.107***	0.106***	0.107***	0.106***
	(3.57)	(3.50)	(3.56)	(3.49)
Intercept	8.046***	8.229***	8.006***	8.187***
	(25.71)	(26.18)	(25.48)	(25.94)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
N	7544	7544	7544	7544
R-sq	0.370	0.363	0.369	0.363
F	168.549	169.516	168.326	169.214

2) *Differences in company investment scale*

Differences in company investment scale directly affect a firm's pay for accounting performance sensitivity. When a company is under-investing, its shareholders are less likely to impose a high level of pay for accounting performance to discourage managers from taking on risky R&D investments. However, if a firm is already over-investing, its shareholders are more likely to limit additional R&D investment and demand a closer association between managers' pay and accounting performance. Using the percentage rank of a company's debt ratio over cash ratio to measure the likelihood of over-investment (Biddle, Hilary, & Verdi, 2009; Chen & Lin, 2013; Chen, Young, & Zhuang, 2013), we consider firms with a greater than the median percentage rank to be over-investing firms, and firms with a lower than the median percentage rank to be under-investing firms. Our hypothesis suggests that the pay for accounting performance sensitivity will be much higher for the over-investment sample than for the under-investment sample.

3) *Competitiveness of management labor market*

We use management labor market competitiveness as a way to separate our sample into firms subject to high and low levels of competition. Gabaix and Landier (2008) suggest that competition in the labor market can serve as an effective discipline for managers. Following previous studies (Parrino, 1997; Park, Seo, & Chin, 2012), we use the number of senior managers available in the same industry as a measure of labor market competeviness. We then separately examine the effect of R&D investment on the pay for accounting performance sensitivity in firms faced with high and low levels of competition. We expect the pay for accounting performance sensitivity to be significantly higher for firms faced with a weakly competitive external labor market (i.e., with a higher level of agency conflicts).

4) *Auditor quality*

Auditor quality measures the severity of information quality and agency problems. Tutticci, Krishnan, and Percy (2007) show that a higher auditor quality alleviates the problem of information asymmetry. We separate our sample into two groups based on

Table 7
R&D investment and pay performance sensitivity in the full sample. Please see Table 1 for the variable definitions. The regression model is $\Delta Salary = \beta_0 + \beta_1 \Delta Perf + \beta_2 RDD(or \Delta RDI) + \beta_3 RDD(or \Delta RDI) \times \Delta Perf + \beta_4 \Delta Size + \beta_5 \Delta Growth + \beta_6 \Delta Lev + \beta_7 \Delta Risk + \beta_8 \Delta CAPDEP + \beta_9 \Delta BSize + \beta_{10} \Delta Indep + \varepsilon$.
***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Z-statistics for the difference between correlation coefficients

		(1) △Perf = △ROA		(2) △Perf = △ROE	
		RDD			
		0	1	0	1
△Salary	Observations	6493	1051	6493	1051
	Correlation coefficient	0.100	0.187	0.093	0.177
		Z = −2.652***, P = 0.008		Z = −2.556**, P = 0.011	

Panel B: Regression results for R&D investment and pay performance sensitivity

Dependent variable = △Salary

	(1)		(2)	
	△Pref = △ROA	△Pref = △ROE	△Pref = △ROA	△Pref = △ROE
△Perf	0.411***	0.150***	0.437***	0.160***
	(4.01)	(3.59)	(3.96)	(3.51)
RDD	0.411***	0.411***		
	(4.01)	(4.01)		
RDDx△Perf	3.041**	1.536**		
	(2.40)	(2.56)		
△RDI			−0.002	0.005
			(−0.06)	(0.18)
△RDIx△Perf			19.587*	12.285**
			(1.77)	(2.11)
△Size	0.196***	0.195***	0.190***	0.190***
	(9.56)	(9.52)	(8.24)	(8.30)
△Lev	−0.121**	−0.162***	−0.093	−0.136**
	(−2.20)	(−3.05)	(−1.54)	(−2.38)
△Growth	0.004	0.007	0.000	0.003
	(0.39)	(0.66)	(0.02)	(0.30)
△Risk	−0.004	−0.008	−0.008	−0.014
	(−0.05)	(−0.12)	(−0.10)	(−0.18)
△CAPDEP	0.003**	0.004**	0.002	0.002
	(2.03)	(2.12)	(1.35)	(1.47)
△BSize	0.153***	0.157***	0.161**	0.166***
	(2.70)	(2.78)	(2.50)	(2.58)
△Indep	0.315**	0.319**	0.399**	0.410**
	(2.07)	(2.10)	(2.35)	(2.42)
Intercept	0.117***	0.117***	0.116***	0.116***
	(16.11)	(16.13)	(15.66)	(15.69)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
N	7544	7544	6273	6273
R-sq	0.040	0.039	0.031	0.031
F	16.426	16.183	11.631	11.464

whether they are audited by Big Four accounting firms. We expect that firms with Big Four auditors will be less likely to use pay for performance as a mechanism to curb managerial over-investment.

In Table 8, we use a matched sample to run Models 1 and 2. To save space, we only report the results using an R&D dummy variable to measure the presence of the R&D investment, and ROA as a measure of performance. Consistent with previous results, the coefficients for the interaction term between R&D and performance are statistically higher for state-owned firms (column 1), over-investing firms (column 2), firms in less competitive labor markets (column 3), and firms with a lower audit quality (column 4).[8]

These tests show that the agency cost of over-investment can be affected by various company characteristics and governance mechanisms. For example, if there is no competitive external labor market or if the firm is not audited by high-quality accounting firms, pay for accounting performance sensitivity is used to mitigate managerial over-investment.

[8] The results are qualitatively similar when we use the whole sample and when we use R&D rank as a proxy for R&D investment, or use ROE as a measure of performance.

Table 8
Additional tests on the relationship between R&D investment and pay for performance sensitivity. Please see Table 1 for the variable definitions. The regression model is

$$\Delta Salary = \beta_0 + \beta_1 \Delta Perf + \beta_2 RDD + \beta_3 RDD \times \Delta Perf + \beta_4 \Delta Size + \beta_5 \Delta Growth + \beta_6 \Delta Lev + \beta_7 \Delta Risk + \beta_8 \Delta CAPDEP + \beta_9 \Delta BSize + \beta_{10} \Delta Indep + \varepsilon.$$

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable = △Salary								
	Column 1		Column 2		Column 3		Column 4	
	SOE = 1	SOE = 0	Over-invest	Under-invest	L_LMC	H_LMC	Big4 = 0	Big4 = 1
RDD	−0.001	0.003	−0.005	0.010	0.001	−0.002	0.002	0.002
	(−0.07)	(0.16)	(−0.36)	(0.65)	(0.09)	(−0.11)	(0.20)	(0.03)
△Perf	0.861**	−0.244	0.640*	0.049	0.251	0.556*	0.374	0.875
	(2.22)	(−0.78)	(1.79)	(0.15)	(0.66)	(1.69)	(1.43)	(0.62)
RDD*△Perf	**1.178***	**0.959**	**1.177****	**0.751**	**1.517****	**0.489**	**0.928****	**1.616**
	(1.91)	**(1.61)**	**(2.04)**	**(1.23)**	**(2.34)**	**(0.86)**	**(2.08)**	**(0.86)**
△Size	0.190***	0.201***	0.276***	0.140**	0.182***	0.224***	0.209***	0.080
	(3.56)	(3.88)	(5.43)	(2.29)	(3.12)	(4.51)	(5.37)	(0.53)
△Lev	−0.061	−0.035	0.263**	−0.349**	0.067	−0.113	0.001	−0.355
	(−0.43)	(−0.25)	(2.15)	(−2.04)	(0.44)	(−0.86)	(0.01)	(−0.65)
△Growth	−0.007	0.035	−0.042	0.047*	0.022	−0.003	0.005	−0.016
	(−0.24)	(1.17)	(−1.43)	(1.76)	(0.77)	(−0.11)	(0.26)	(−0.17)
△Risk	−0.030	0.103	−0.255	−0.115	−0.126	−0.015	−0.173	−0.545
	(−0.20)	(0.57)	(−1.53)	(−0.58)	(−0.67)	(−0.09)	(−1.31)	(−1.04)
△CAPDEP	0.000	−0.002	0.001	−0.004	−0.000	−0.003	−0.000	−0.011
	(0.07)	(−0.49)	(0.39)	(−0.92)	(−0.04)	(−0.74)	(−0.17)	(−1.11)
△Bsize	0.240*	0.296**	0.352***	0.143	0.165	0.354**	0.283***	−0.223
	(1.90)	(2.01)	(2.60)	(1.03)	(1.23)	(2.55)	(2.74)	(−0.53)
△Indep	0.505	1.120**	0.999**	0.549	0.939**	0.611	0.804***	1.200
	(1.51)	(2.55)	(2.47)	(1.46)	(2.51)	(1.54)	(2.77)	(1.16)
Intercept	0.124***	0.107***	0.084***	0.107***	0.104***	0.116***	0.092***	0.124**
	(9.30)	(7.80)	(7.63)	(9.34)	(5.62)	(7.40)	(7.27)	(2.06)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1139	963	963	1139	1055	1047	1998	104
Adjusted R^2	0.059	0.034	0.037	0.053	0.056	0.046	0.052	0.136
F	6.748	3.072	3.527	6.172	3.706	4.139	6.525	1.036

5. Conclusion

Short-term accounting goals can result in myopic R&D investment decisions, and thus are an ineffective incentive for fostering innovation. However, they can be used to mitigate the agency conflicts between managers and shareholders. In emerging markets where the use of equity-based compensation is limited and agency conflicts remain a major concern for shareholders, the need to discipline managers may outweigh the need to encourage innovation. Using a sample of Chinese firms from the 2007 and 2011 period, we show that firms pay higher salaries to encourage R&D investment. They also impose a higher pay for accounting performance sensitivity to mitigate the potential agency conflicts that might arise from R&D investment. Higher pay for accounting performance sensitivity is dominant in firms with more severe agency conflict issues such as state-owned firms, those with surplus investment, those in labor markets that are weakly competitive, and those with low-quality auditors.

Our findings are very different from those of Manso (2011) and Ederer and Mansor (2013). We suggest that the relationship between pay for performance and innovation should also be examined in the context of corporate governance. In developed markets, where corporate governance is relatively more effective than in developing markets, firms may abstain from the use of pay for performance to encourage long-term innovation. However, in emerging markets where agency conflicts remain a key concern and the use of equity-based compensation is scarce, firms continue to use pay for performance to lower the agency cost of innovation.

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