Managerial Incentives, CEO Characteristics and Corporate Innovation in China's Private Sector

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Abstract

We use a unique World Bank survey of 1,088 private manufacturing firms from 18 Chinese cities over the period 2000 to 2002 to empirically examine the roles of managerial incentives and CEO characteristics in a firm's innovation activities. We look at both innovation effort (R&D intensity) and innovation performance measures such as new product sales. We obtain the following main results: (1) the presence of CEO incentive schemes increases both corporate innovation effort and innovation performance; (2) sales-based performance measures in the incentive scheme, as compared with profit-based performance measure, are more conducive to firm innovation; and (3) CEO education level, professional background and political connection are positively associated with firm's innovation efforts. The main results are robust to endogeneity tests with instrumental variables. We also discuss some important policy implications.

Keywords: Corporate Innovation, Managerial Incentives, CEO Characteristics.
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1. Introduction

Since the opening up and reform in China in the late 1970s, the Chinese economy has been undergoing rapid changes and playing an increasingly important role in the world's economy. As of today, in terms of size it is already the third largest economy in the world after the United States and Japan. The biggest spark for China's economic growth has been the emergence of privately owned firms (e.g., Firth et al. 2009). According to Huang (2008), private entrepreneurship, facilitated by financial liberalization and microeconomic flexibility plays a central role in China's economic miracle. According to the National Bureau of Statistics, the private sector accounted for roughly 50% of GNP in 2005 and this is expected to rise to at least 75% by 2010[1].

However, there are concerns about the sustainability of China's rapid growth and especially the growth of the private sector. Some Chinese economists favor changing the mode of economic growth from the current strategy, which is mainly based on cheap labor, high savings and investment, to a more efficient utilization of resources and greater technological progress (e.g., Wu, 2006). To this end, it is important to encourage innovation within Chinese firms. Unfortunately, the research and development (R&D) expenditures of Chinese firms have been very low. In the mid-1990s, the total R&D expenditure to GDP ratio was around 0.6%. Recently, that has been increasing at 1.34% in 2005. However, compared with developed economies such as the U.S. (2.57% in 2006) and Japan (3.18% in 2004), China is lagging behind in innovation[2]. As China becomes a dominant manufacturing power and exerts an increasing impact on the global economy, sustainable growth in China is crucial for world economic development. The focus of our study, therefore, is to shed some light on this issue and, in particular, to gain an understanding of those factors that drive or hinder corporate R&D in

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[1] http://www.chinadaily.com.cn/china/2006-09/22/content_694432.htm
http://www.nsf.gov/statistics/seind08/c0/tt00-04.htm

China's private sector, which is widely regarded as the major engine of China's rapid growth (Allen, Qian and Qian, 2005)[3]. Furthermore, a recent article in *The Economist (2009)* magazine points out that smaller companies, which are mostly privately owned, are responsible for 66% of China's patent applications and more than 80% of its new products.

In this paper, we explore the determinants of innovation activities among a sample of firms in China's private sector. In particular, we examine the roles of managerial incentive scheme and the chief executive officer (CEO) characteristics in affecting firm R&D activity. As is well-known, R&D spending is one of the most fundamental investment decisions made by top managers of firms (Barker and Mueller, 2002). Therefore, financial incentives and characteristics of a CEO matter greatly in determining a firm's effort to conduct innovation activity. Given that R&D projects are typically risky and costly, providing managers with the right incentive so as to align their interests with the firm's long-term goals should help encourage manageres to make greater effort in innovations. Furthermore, a CEO's characteristics such as education, tenure, professional background, political connection, should also affect her R&D incentive.

We use a unique 2003 World Bank survey of 1,088 private manufacturing firms in 18 Chinese cities. The data are unique in that they provide detailed survey information about firm financial performance, managerial incentives, CEO characteristics, corporate R&D decisions, R&D intensity and new product sales. We find that firms that provide CEOs with significant shareholding and performance-based compensations are more likely to invest in R&D and tend to invest more in R&D. Regarding the primary performance measure in incentive contracts, sales as the primary performance measure exert more positive effect on the likelihood and intensity of R&D than do profit. Third, we find that CEOs with college education, professional background and political connection are more likely to invest in R&D and tend to invest more. In addition to these major findings, we also document that large firms with some market power also tend to

[3] Economists and business researchers have long believed that innovations are essential for the growth of the economy. Corporate's research and development (R&D), by making contributions to innovations, help to enhance corporate productivity and attractiveness (Griliches 1998. Heeley et al. 2006).

have stronger incentive for R&D. Our results have important policy and managerial implications. They indicate that well-designed CEO incentive schemes are important in encouraging corporate R&D and enhancing a firm's long term competitiveness and performance. In addition, CEO characteristics play an important role in corporate R&D decisions.

Our paper is related to two sets of studies. First, there are a growing number of studies on R&D in Chinese manufacturing in recent years. For example, Hu (2001) examines the relationship between R&D expenditure and productivity in Chinese firms using survey data of high-tech firms in Haidian District of Beijing and finds a strong link between private R&D and firm productivity. Using a large panel data set of large-and medium-sized enterprises (LMEs), Jefferson et al. (2003) report that R&D activity is becoming more intensive both in inputs and outputs during the period of 1994-1999, although a broad-based take-off of R&D activity is yet to take place. Hu and Jefferson (2003) estimate the returns to R&D in Chinese industry using a firm-level data set on innovation activity of LMEs in Beijing area. They found that robust relationship between past R&D investments and profit and productivity in the cross-section dimension.[4] More recently, Hu, Jefferson, and Qian (2005) find evidence of positive returns to firm in-house R&D in Chinese LMEs and that technology transfer (both domestic and foreign) benefits firm productivity largely through its interaction with in-house R&D activity. Zhang, Zhang, and Zhao (2003) investigate the R&D efficiency of Chinese firms and find that the state-sector has significantly lower R&D and productive efficiency than the non-state sector. Our paper complements previous studies in examining two important determinants of R&D (namely managerial incentives and CEO characteristics) in Chinese private sector. In addition, our data set contains both LMEs and small firms.

Second, our paper adds to the general literature on CEO incentives and corporate R&D. the unique survey data allow us to distinguish different CEO incentives and characteristics and examine their impact on corporate innovation activity. Despite its importance, little empirical

[4] In a theoretical model, Qian and Xu (1998) study the incentives of bureaucrats and the mechanisms used in a centralized economy in screening and selecting innovation projects.

evidence is available about the relationship between CEO incentives and corporate innovation. Using the data of more than 300 publicly traded U.S. firms, Lerner and Wulf (2007) tests the relationship between performance pay given to central corporate research executives and corporate innovation in the U.S. context. Barker and Mueller (2002) examine the impacts of CEO characteristics on firm R&D spending using the data of 172 U.S. firms. To the best of our knowledge, no study has examined the impact of managerial incentives and CEO characteristics on corporate R&D in developing and transitional countries[5]. Our study therefore fills the gap in the literature.

The rest of the paper is organized as follows. Section 2 develops relevant hypotheses. Section 3 presents the data and defines the variables used in our statistical analysis. Section 4 presents and discusses the empirical results, while Section 5 concludes.

2. Related Studies and Hypotheses

2.1. CEO incentives

Two fundamental features of R&D activities are: They are uncertain and often require huge amount of investment. R&D investments may not yield the desired outcome (i.e., new products or new processes) or may not yield the desired outcome by a given date of time, due to both technical and economic reasons. Whether or not to engage in risky R&D projects is one of the most fundamental investment decisions made by the top managers of a firm (Baker and Mueller, 2002). Therefore, managerial incentives also play an important role in influencing corporate R&D. Generally, there are two reasons that managers are more risk averse than firm owners. First, while the firm owners can diversify their risk by owning shares in other businesses, managers' wealth and employment security are directly and uniquely linked to the success or

[5] Using the data of China's listed firms, Bai et al. (2004) explores the impacts of corporate governance on firm value. Using a panel data set of CEO contracts from more than 300 Chinese state-owned enterprises, Bai et al. (2005) studies the CEO incentives in China's SOEs.

failure of a firm's specific projects and cannot be diversified. Therefore, their incentives to take risk are curtailed (e.g., Beatty, R. P. and Zajac, E.J., 1994; Gray and Cannella, 1997; Wiseman and Gomez-Mejia, 1998; Balkin, Markman, and Gomez-Mejia, 2000). Second, managers tend to have more short-term focuses than owners since they generally do not have equity ownership with the firm and are rewarded by short-term incentives such as base pay and bonus (e.g., Tosi et al., 2000).

It is argued that, theoretically, managerial incentive payoffs can mitigate the effects of agency problems and CEO risk aversion so that CEOs are more willing to take on risky projects (Coles, Daniel, and Naveen, 2006). As R&D and innovations are possibly one of the most risky long-term investments and are more prone to asymmetric information, it is essential to reward managers to induce them to work for the benefit of the firm's owners. However, the empirical studies on this issue are very limited and mostly in the US context. For example, Balkin, Markman, and Gomez-Mejia (2000) examine the relationship between innovation and CEO pay in 90 high-technology firms. With firm size, performance, and other factors controlled, they find that CEO short-term compensation was related to innovation as measured by number of patents and R&D spending. Coles, Daniel, and Naveen (2006) provide evidence of a strong causal relationship between managerial compensation, and investment policy as well as firm risk. In particular, they find that a higher sensitivity of CEO wealth to stock volatility (vega) leads to the implementation of riskier choices, including relatively more investment in R&D. Another recent study by Lerner and Wulf (2007) finds that in U.S. centralized R&D organizations, more long-term incentives (e.g., stock options and restricted stock) to R&D department head are associated with more heavily cited patents.

It is recognized that China's enterprises are plagued by agency problems due to weak manager incentive schemes and restricted decision-making power (Chang and Wong, 2004). Hence, it would be interesting to explore the impact of these factors on corporate innovation activities in China. We therefore pose the following hypothesis:

Hypothesis 1. CEOs with more financial incentives linking their compensations with firm performance make more efforts in R&D.

2.2. CEO characteristics

A CEO's background and other characteristics should also be important in her receptivity to innovative ideas and activities. Barker and Muller (2002) argue that CEOs' career experience in various functions is important in corporate R&D decisions, as their perceptions of new technology will be biased by their prior functional experience. For example, a CEO with significant career experience in output functions (i.e., R&D/engineering and marketing/sales) will favor innovative strategies because these business functions emphasize growth through discovering new products and markets. In contrast, a CEO with career experience in throughput functions (i.e., accounting/finance, production, administration and legal) will work at improving the efficiency of the organization (e.g., Finkesltein and Hambrick, 1996). In the Chinese context, we believe that whether the CEO comes from a professional background will affect her view of innovation. A CEO with a professional background will be more skillful in business decision making and arguably more inclined to take risks. Therefore, we pose the following hypothesis:

Hypothesis 2A. CEO's professional background is positively associated with a firm's innovation activities.

It has been found in the recent finance and economics literature that political connections help firms to secure favorable regulatory conditions (Agrawal and Knoeber, 2001), better access to finance such as bank loans (Khwaja and Mian, 2005; Claessens, Feijend, Laeven, 2008), and potential bailouts (Faccio, McConnell, and Masulis, 2006), which ultimately increases the value of firms (Fisman, 2001; Calomiris, Fisman and Wang, 2009) or improves their performance (Li, Meng, Wang and Zhou, 2008). In this regards, the CEO political connection might help the firm to get access to financial and other resources and helping hands from the government in conducting R&D activities. On the other hand, a former government official/bureaucrat may be less innovative, as her career experience is more closely related to bureaucracy and her skills are less business oriented. Therefore, we pose the following competing hypotheses:

Hypothesis 2B. CEO's political connection is positively associated with a firm's innovation activities.

Hypothesis 2C. CEO's political connection is negatively associated with a firm's innovation activities.

Another CEO background variable is CEO education. Obviously, as R&D and innovation activities are typically associated with new technology or new products, better educated executives tend to have greater cognitive complexity to absorb new ideas, which therefore increases the probability of accepting innovations (Barker and Mueller, 2002). This argument leads to the following hypothesis:

Hypothesis 2D. CEO's education level is positively associated with a firm's innovation activities.

CEO tenure might also exert impact on corporate R&D. Miller (1991) argues that longer-tenured CEOs may lose touch with their organizational environment and hence may not make the changes and risky investments to keep the firm evolving over time. On the other hand, Hirshleifer (1993) argues that shorter-tenured CEOs might have strong incentives to focus on short-term outcomes in order to build their reputation and therefore might be less willing to invest in highly risky R&D projects. We therefore view the relationship between CEO tenure and corporate R&D as an empirical question and will examine the relationship in our empirical analysis.

2.3. Other control variables

We also control other cofactors that might affect a firm's innovative activity. The first are firm-based control variables. The so-called Schumpeterian hypothesis claims that innovation is fostered by a climate where firms are large or in industries where there is less competition. Therefore, in our following empirical analysis, we control for company size as well as industry competitiveness. We also control the firm age variable, as it is believed that as firms get older, they may tend to look more inward and have less incentive to innovate (e.g., Tassey 1991). Second, we control variables for business environment such as local market size, GDP growth, and the number of higher education institutions, as these may also be important determinants of business decisions in firm's innovations in a given city. Finally, we also control for industry effect in our regression analysis to take into account the fact that some industries are relatively more technology-oriented while others are more traditional.

3. Sample and Variables

3.1 Sample

Our primary database is the Business Environment and Enterprise Performance Survey (BEEPS), conducted jointly by the World Bank and the Enterprise Survey Organization of China in the early 2003. The main purpose of the survey is to identify the driving factors behind and obstacles to enterprise performance and growth in China. The survey asks firm managers to answer questions about market structure, institutional environment, corporate governance, ownership structure of the firm, and standard information on financial statements. In particular, the survey asks questions on corporate R&D expenditures and innovations such as patents, new products and new production process. Specifically, the firm R&D expenditures are reported for each year from 2000 to 2002. The innovation output measure is based on firm's sales revenues of new products reported in the survey for each year from 2000 to 2002. While many of the quantitative variables (e.g. R&D expenditure, new product sales, firm size and firm age) contain observations from 2000 to 2002, some of the qualitative questions (e.g. managerial incentives, CEO characteristics) only pertain to the year 2002. Hence, in the full-sample regression analysis of this paper, some qualitative variables are time invariant, while some quantitative variables vary over the time period. In addition to the firm-level data set, we collect the macro control variables from the City Statistical Yearbook of China.

Our original sample has 1,572 non-listed manufacturing firms and 4,716 firm-year observations. Of these, 168 firm-year observations are dropped due to missing values of R&D expenditures[6]. We further drop another 267 observations due to missing values of other variables such as market competition and drop another 206 firm-year observations for which the CEO has more than 50% of the share outstanding[7]. Lastly, we focus our analysis on the firms with no state ownership[8]. The final three-year pooled sample consists of 3,192 observations, with a sample of 1,088 firms for the year of 2002.

Table 1 provides brief descriptions of the sample distributions and innovative activities across the cities and sectors. The cities are sorted in a descending order based on the percentage of firms engaged in R&D. The second column lists the number of samples from each city/sector. The third column lists the percentage of firms with R&D investment in each city/sector. The fourth column lists each city/sector's average R&D intensity, measured as the ratio of R&D expenditure to total sales revenue. The fifth column presents each city/sector's average new product sales, measured as the percentage of sales from new product in total sales. Overall, 38% of firms in our sample have invested in R&D, with a mean R&D intensity of 1.3% and average new product sales 12.9%.

[Table 1 here]

From Table 1, we observe at least two patterns: (1) Innovative activities vary significantly across cities and sectors. For instance, over 68% of the enterprises in Hangzhou city report making positive R&D investment; while only about 13.5% of the enterprises in Kunming invested in R&D. About 54.9% of the enterprises in electronic equipment sector report making

[6] We replace those missing R&D expenditures with zero in our regression analysis in a robust check. The results are highly consistent with our main findings.

[7] For a private firm whose CEO is the owner, an incentive plan in compensation may not be necessary since the CEO is the residual claimer. Since the main task of this study is to examine the impact of CEO incentive schemes on corporate R&D, we focus on the subsample where CEOs have relatively small portion of shares. The empirical results, however, are highly robust if the full sample is used in the analysis.

[8] In our sample, about 80% of the firms are private firms with no state ownership.

positive R&D investment; while only about 10.9% of the enterprises in transportation equipment sector invested in R&D. (2) Higher percentage of R&D participation generally induces more new product sales.

3.2 Variables and Measures

Table 2 lists the definition of all the variables used in this analysis. We discuss those variables in more detail in the following sections.

[Table 2 here]

3.2.1. Dependent variables

The innovation measure is the dependent variable in our analysis. Nevertheless, it is difficult to find a perfect measure due to the nature of broad scope of innovative activities. As early as in 1930, Joseph Schumpter defined five types of firm innovations (see OECD, 1997, page 28). Those include the introduction of new product or service, new process of production, opening of new markets, new sources of raw materials and change of industrial organization. In order to set a benchmark for innovation survey and research, the OECD definition (OECD, 1997) of innovation focuses on the first two Schumpter measures: the introduction of both new product and new production process. Here the emphasis is on the commercialization of innovative activities. That is, those new products or processes need to be commercialized to generate profit. This definition also excludes organizational innovation partly due to "its measurement appears to be very difficult both conceptually and in practice".

We believe the best way to assess innovation is to make distinction between innovation input and innovation output. In terms of input, R&D investment decision dummy and R&D intensity have been the most widely used R&D measures (e.g. Cohen, and Klepper, 1996; Balkin, et al., 2000; Lee and O'Neill, 2003; Coles, Daniel, and Naveen, 2006). These measures are easy to understand and easy to obtain from firm's financial statements. The potential shortcoming of these measures is that they do not capture the outcome of innovation. That is, there is an implicit assumption which states that the R&D efficiency is similar across firms. Firms spending more on R&D are assumed to be also more innovative (Acs and Audretsch, 1987).

To avoid the shortcoming of R&D input measure, some authors have been relying on the innovation output measures. Those output measures include the number of patents granted (Griliches, 1990; Balkin, et al, 2000; Argyres and Silverman, 2004; Lerner and Wulf, 2007) and patent forward citations (Lerner and Wulf, 2007; Hall, Jaffe and Trajtenberg, 2001). A possible drawback of patent data is that patent does not necessarily represent a commercially exploited innovation. Consistent with the OECD definition of innovation, Bhattacharya and Harry (2004) use a dummy variable of new product development as a measure of innovation. In another study, Kochhar and David (1996) use the number of new products as a measure of firm innovation. However, these measures cannot measure the commercial value of the new products.

Given the merits and limitations of each innovation measure, we evaluate firm innovative activities by comprehensive measures of both innovative input and output. For innovation input/effort measures, we use R&D intensity and an R&D decision dummy. The first measure is a dummy variable that equals 1 if the firm made positive investment in R&D in a specific year (*R&D Decision*), while the second measure is the amount of R&D spending as a percentage of total sales (*R&D Intensity*). For innovation output measures, we use the new product sales to capture the innovative outputs. Specifically, the dataset contains a question about the sales revenue of the new product (*New Product Sales*) as percentage of the total sales. This variable is also a very standard measure of firm innovations because it both takes the commercial value of the new products into account and also overcomes the shortcoming of using a discrete R&D output measure[9]. Following the seminal work by Crepon, Duguet and Mairesse (1998), many studies have used this variable to measure corporate innovation performance (e.g. Czarnitzki and Kraft, 2004; Czarnitzki, 2005; Cassiman and Veugelers, 2006).

[9] This variable becomes a standard measure in the European Community Innovation Surveys since 1993.

3.2.2. Independent variables

CEO incentives are captured by a set of variables. The first one is a continuous measure of CEO's ownership (*CEO Ownership*) of the firm, which equals to natural logarithm of one plus the percentage of stock held by the CEO. The second one is a dummy variable (*CEO Incentive*) which equals to one if there is an incentive plan linking the CEO's compensations with the firm's performance and zero otherwise. Drilling further down to explore how the managerial incentives influence the corporate R&D activities, we look in details at the primary performance measures in the incentive contracts. Two dummy variables are constructed based on the survey[10]. *Profit incentive contract* is a dummy variable which takes on the value of one if the primary CEO performance measure in the incentive contract is firm's profitability. *Sales incentive contract* is a dummy variable which takes on the value of one if the primary CEO performance measure in the incentive contract is the firm's sales revenue. The benchmark group is the group of firms that use other primary performance measures (e.g. safety) in their CEO incentive contracts. Furthermore, we use another variable (*Delta*) to measure the CEO pay performance sensitivity. This variable is constructed base on a unique question in the survey which asks about the percentage of CEO income increase for each one percent increase of the firm's primary performance measure. The variable, which directly measures CEO incentives, has been used widely in executive compensation literature (e.g. Coles, Daniel and Naveen, 2006).

Regarding the professional background, CEOs with business management experience are classified as *professionals*. One entry of the survey asks about the position of the CEO before he or she is nominated as CEO for the current firm. If the CEO was a manager before his or her current position, we code variable *professional* as one, and zero otherwise. Following the recent literature (e.g. Firth, Lin, Liu, Wong, 2009), we classify politically connected CEOs based on their previous employment in the government agencies. *Official* is a dummy variable that is equal to one if the general manager (this is the CEO in U.S. parlance) was a government official

[10] Since the sample contains non-listed private manufacturing firms, stock market performance is not used as a primary performance measure in most incentive contracts.

before taking a position in the enterprise, and zero otherwise. Furthermore, *college* represents the CEO's education level. It equals to one if the CEO has college or above education, and zero otherwise. *Tenure* measures the years of CEO tenure.

3.2.3. Other Control variables

We control for several factors known to affect firm R&D investment. Firm performance is measured by return on asset (*ROA*), the ratio of operating income before tax to total asset. *Firm size* is measured by the nature logarithm of the end-of-year total number of employees. *Firm Age* is the number of years since the enterprise was established. We also include city *GDP growth* rate, city *population*, and the number of universities in the city (*university*) as the macro-control variables. Furthermore, we control for the market structure by including a series of competition dummy variables (Comp_1:1-3 competitors in the firm's main market; Comp_2: 4-6 competitors in the firm's main market; Comp_3: 7-15 competitors in the firm's main market; Comp_4: 16-100 competitors in the firm's main market). Lastly, since innovations may cluster in certain region or in certain industry, we include the city average R&D investment and industry average R&D investment to account for the innovation variations across regions and sectors.

4. Empirical Analysis and Results

4.1 Summary Statistics

Table 3 reports summary statistics and makes some basic comparisons of firm innovation. Panel A presents the basic summary statistics of the key variables discussed in the previous section.

[Table 3 here]

Panel B of table 3 compares the differences in R&D activities across various incentive schemes. In column 1 and column 2, we split the sample according to whether there exists any CEO incentive plan. In column 3 and 4, we divide the sample according to the CEO's ownership in the firm. In the last two columns, we compares innovations according to the CEOs' education background, that is, whether the CEO has a university or above degree. Consistent with hypothesis 2A, firms with CEO incentive scheme (or CEO ownership) are more likely to invest and generally invest more in R&D. Although not reported, we find that firms with neither incentive scheme nor CEO ownership are associated with even lower R&D investment and innovations. We find that firms with college educated CEOs are more likely to invest and tend to invest more in R&D.

In general, table 3 documents some preliminary relationships between CEO incentives, CEO characteristics, and corporate R&D, which are mostly consistent with the hypotheses in Section 2. In the following analysis, we perform more rigorous study of those relations with multivariate Probit and Tobit models.

The correlations among the key variables are presented in Table 4. As can be seen from the table, multicollinearity is not a serious problem for the variables. Most of the correlation coefficients between independent variables are below 0.3, which makes us comfortable to include these variables in the models simultaneously.

[Table 4 here]

4.2 R&D investment

4.2.1. Probit model on R&D Investment Decision

To examine the relationship between CEO incentives, characteristics, and firm innovations, we use Probit and Tobit regressions separately. Both approaches are widely used in the literature on R&D investment.

` We first use the Probit model to explore the potential determinants of a firm's R&D investment decisions. The probability function of investment in R&D is expressed as following:

$$Pr\ (R\&D\ Decision = 1) = f(X\beta) = f(CEO\ Incentive, CEO\ Characteristics, Firm\ Characteristics, Competition, Macro\ Controls, Industry\ controls)$$

where $f(\cdot)$ is the standard normal cumulative distribution (cdf) in the Probit model, which can be expressed as $f(z) = \Phi(z) = \int_{-\infty}^{z} \phi(v)dv$, where $\phi(\cdot)$ is the standard normal density. Firm characteristics are captured by a vector of control variables, which include the firm performance (ROA), firm size, firm age. Macro controls include city population, GDP growth, and the number of colleges and research institutions within the city. Competition dummies and city and industry R&D investment decision are also controlled for. Furthermore, the heteroskedasticity-robust standard errors clustered at the firm level are used in computing t-values. The results of the Probit models are presented in Table 5[11].

[Table 5 here]

As can be seen in table 5, the coefficients of all *CEO share* and *Incentive Compensation* are positive and statistically significant at the 1% or 5% levels in all model specifications, suggesting that stronger managerial incentives results in a higher probability of investing in R&D. In a more detailed look at more specific incentive measures, we find that sales performance based incentive scheme exerts a larger positive effect on the likelihood of R&D investment than does the profit-based incentive scheme. The different effects might come from the difference in focuses of various incentive plans. Profit-based incentive contract focus more on firm profitability, which might be negatively affected by corporate R&D investment in the short term before innovation activity is completed and generates new sales and profits. This feature may discourage CEOs to engage in R&D activity. On the other hand, sales performance based incentive contract emphasize more on market shares, which may not be directly linked to on-going R&D investments of the firm. Therefore, CEOs with sales-based incentives might be more willing to invest in R&D projects than are the CEOs with profit-based incentives. Furthermore, we also find that the CEO pay-performance sensitivity (*Delta*) is positively associated with the likelihood

[11] As mentioned previously, in the full-sample regression analysis of this paper, some qualitative variables are time invariant (e.g. managerial incentives, CEO background), while some quantitative variables vary over the time period. The presented results are based on the full sample (2000 to 2002). The cross sectional sample in year 2002 yield very similar results. For brevity, the cross sectional results are not presented but available from the authors.

of corporate R&D investment. The effect is statistically significant at the 1% level. Overall, the empirical results strongly support the hypothesis 2A that CEOs with more financial incentives linking their compensation with firm performance are more likely to make R&D investment.

Regarding the CEO characteristics, the coefficients of *College* are positive and statistically significant in all model specification, suggesting that firms with college educated CEOs are more likely to invest in R&D projects. The empirical results bolster our hypothesis 2D that CEO education level is positively associated with the likelihood of R&D investment. The coefficients of *Professional background* and *Official* are positively and statistically at the 1% level, suggesting that CEOs with professional background and political connection are more likely to make R&D investments. The empirical results strongly support our hypotheses 2A and 2B, respectively. In addition, we find marginally significant and positive relationship between CEO tenure and the likelihood of R&D investment.

The control variables also yield some interesting results. As expected, the industry and city R&D investment tendency is strongly and positively associated with the likelihood of corporate R&D investment. We find that both firm performance and firm size are positively and significantly (at the 1% level) associated with the likelihood of a firm's R&D investment. Firm age has a somewhat negative impact on corporate R&D decision, suggesting that older firms tend to be less innovative. City population is positively related to a firm's R&D incentive, indicating the positive effect of a local market. Other macro controls do not enter the models significantly.

4.2.2. **Tobit model on R&D Intensity**

The analysis so far focuses on the probability of undertaking R&D investment. We next explore the relationship between various covariates and the amount of R&D spending as well as a measure of innovation output, namely sales of new product. Since the dependent variable is left censored at 0, the Tobit model is employed in the analysis.[12] The estimation is based on the three year sample with firm clustering effect. In addition, as a violation of the homoscedasticity assumption would lead to inconsistent coefficient estimates in Tobit models, we estimate the Tobit models with variance adjusted for heteroskedasticity by firm size. The empirical results are presented in Table 6.

[Table 6 here]

The Tobit estimation results confirm our previous findings in the Probit model. The coefficients of *CEO ownership* and *incentive* are positive and statistically significant for the first two models, suggesting that firms with stronger managerial incentives tend to invest more in R&D. Regarding the more specific incentive measures, we find that sales performance based incentive scheme exerts a more positive effect on R&D intensity than does the profit-based incentive scheme. In addition, the CEO pay-performance sensitivity (*Delta*) is positively associated with the corporate R&D intensity.

Similarly, the relation between CEO background and R&D investment is also consistent with previous findings. Firm managers with a professional background or higher education degrees tend to spend more in R&D projects, as indicated by the positive and statistically significant coefficients of *college* and *professional* in the Tobit regressions for R&D intensity. Consistent with the Probit model, we also find that CEOs with political connection have exerted positive and significant impacts on R&D intensity. As expected, the industry and city average R&D investment spending are positively associated with the corporate R&D intensity.

Overall, the Tobit results bolster our previous findings and confirm the hypotheses 1, 2A, 2B and 2D.

4.2.3. Instrumental Variable Analysis

In our study, the potential endogeneity problem may not be a serious problem because it seems not very likely that an individual firm's R&D decision and investment will influence the

[12] The estimation method is not presented because the model is well known and widely used in the literature.

managerial incentives and ownership. Nevertheless, it is still possible that R&D decision and the managerial incentive schemes are jointly determined by some unobserved characteristics of the firm. To deal with this potential endogeneity problem, we need to use the instrumental variable analysis. However, it is not easy to find the instrumental variables since we already control for many firm characteristics such as performance, size and age, competition, etc. We follow the approach in selection of instrumental variables in the recent literature of economic development (Reinikka and Svensson, 2006; Fisman and Svensson, 2007). Specifically, Fisman and Svensson (2007) use industry-location averages as instruments. They point out that if the endogeneity problem is specific for firms, but not for industries or locations, then netting out this firm-specific component yields a measure that only depends on the underlying characteristics of inherent to particular industries and/or locations (Reinikka and Svensson, 2006; Fisman and Svensson, 2007). In our case, firms in the same location and industry may compete for the talent manager in the local labor market. The provision of managerial incentive schemes by a firm may depend on whether or not local competitors offer similar incentive schemes. Moreover, incentive scheme decisions by local competitors should not have a direct impact on this firm's R&D investment. Therefore, we follow Fisman and Svensson (2007) to instrument for CEO incentive measures (i.e. CEO share, Incentive Compensation, Profit incentive contract, Sales incentive contract, delta) using their location-industry averages as instruments[13]. ROA is also subject to endogenity problem. We also instrument the firm ROA using the industry-region mean ROA as instrumental variables. With these instrumental variables, the standard IV Probit and Tobit (Newey, 1987) are used and the empirical results are presented in table 7.

[Table 7 here]

As can be seen in Table 7, our empirical results are very robust to the instrumental variable analysis. Firms with managerial incentive schemes are more likely to conduct R&D and

[13] We are not claiming that these variables are the best instrumental variables. Instead, we hold that the instruments are reasonably exogenous and have decent explanatory power of firm's managerial incentive schemes. Similar to the claim in Lerner and Wulf (2007), our study at least shows some very strong relationship between managerial incentives and corporate innovations.

tend to invest more in R&D, as indicated by the positive and statistically significant coefficients of *CEO Ownership* and *Incentives* in all model specifications. Consistent with previous findings, we find that sales performance based incentive scheme exerts a more positive effect on R&D likelihood and intensity than does the profit-based incentive scheme. The coefficient for ROA remains positive and significant[14].

Regarding the control variables, firm size is positively associated with both the likelihood and the amount of R&D investment. Firm age is negatively associated with both the likelihood and the amount of R&D investment. Market competition dummies are included in the model specifications. For brevity, the coefficients are not reported.

Using the IV Tobit models, we also check the robustness to various firm size controls. The sample includes firms across all size categories. Therefore, a very natural conjecture is that firm size might exert a non-linear effect on corporate R&D. We therefore include a square term into the model specification to test the robustness of the results. Alternatively, we categorize the sample into large (more than 329 employees in the firm), medium size (more than 109 but less than 329 employees in the firm) and small firms (less than 109 employees in the firm) based on the sample distribution. We construct three size dummies accordingly and test the robustness of the results to the inclusion of these size dummies. The empirical results are presented in Table 8. As can be seen from the table, all the main effects remain significant and the empirical results are highly consistent with our previous findings.

[Table 8 here]

4.3. Innovation Performance

[14] We notice that the t-statistics are generally higher in the IV estimation. This might indicate the existence of potential measurement error, which would tend to "attenuate" the coefficient estimate toward insignificant (Rajan and Subramania, 2005). This pattern has been documented in some recent papers (e.g. Beck, Demirguc-Kunt and Levine, 2006). In addition, we use the standard Newey IV Probit and Tobit, which does not allow for clustering and variance adjustment for heteroskedasticity by firm size. The MLE estimation is not used because the convergence cannot be reached. Therefore, the t-statistics might not be readily comparable across models. It is also worth noting that our main results do not depend on instrumentation, although the latter increases the statistical significance.

The aforementioned analyses focus on the input side of the innovation (i.e. R&D investment decision and R&D intensity). We now consider the effects of managerial incentives and CEO characteristics on R&D output, measured by the new product sales. As discussed earlier, new product sales are a standard measure of innovation performance in the literature. We repeat our previous analysis using *New Product Sales* as the dependent variable. The estimation is based on IV tobit models discussed in the previous section. The empirical results are presented in table 9.

[Table 9 here]

As can be seen from the table, stronger managerial incentives improve innovation performance, as indicated by the positive and statistically significant coefficients of incentive measures. As discussed earlier, this might be due to fact that stronger managerial incentives mitigate agency problem to make decisions that increase private benefits of the management at the expense of shareholders, such as funding of "pet projects", and consequently improve innovation performance. We do not find statistically significant impacts of CEO characteristics on innovation performance.

5. Conclusions

Using a unique World Bank survey of 1,088 private manufacturing firms from 18 Chinese cities over the period 2000 to 2002, we find the following main results: (1) the presence of CEO incentive schemes increases both corporate innovation effort and innovation performance; (2) sales based performance measure in the incentive scheme, as compared with profit based performance measure, is more conducive to firm innovation; and (3) CEO education level, professional background and political connection are positively associated with firm's innovation efforts. Beyond these main findings, we also find that younger and larger firms in less competitive industries tend to conduct more R&D. A larger local market (as proxied by population) also seems to be associated with greater corporate innovation activities. Finally, some evidence suggests that local technological and innovation infrastructure (as proxied by the number of local education institutions) is positively related to corporate innovation activities. Our findings have important policy implications because innovations have long been understood to be a key driver of economic growth and because China's private sector is widely regarded as the major engine of China's rapid growth.

Finally, we would like to point out that we do not intend to provide a comprehensive study of determinants of corporate R&D in China in this paper. Rather, our focus is on internal mechanisms/factors that can affect corporate R&D effort. To the best of our knowledge, our paper is among the first to study the effects of CEO incentive schemes and characteristics on firm R&D activity. External factors such as country's property right protection system, government tax and subsidy policies, etc., are obviously also important factors influencing firm incentive for R&D. These important issues, however, are left for future research.

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Table 1A: R&D comparison across sample cities

	Sample	R&D Decision	R&D intensity	New Product Sales
Hangzhou	142	0.683	0.013	0.210
Chongqing	215	0.660	0.022	0.214
Wuhan	217	0.525	0.015	0.135
Changchun	228	0.513	0.017	0.160
Jiangmen	163	0.491	0.012	0.070
Xian	202	0.490	0.016	0.146
Shenzhen	159	0.421	0.014	0.162
Wenzhou	138	0.399	0.005	0.170
Guiyang	153	0.392	0.022	0.101
Nanchang	161	0.354	0.011	0.125
Dalian	140	0.336	0.009	0.106
Changsha	189	0.302	0.010	0.178
Haerbin	207	0.261	0.018	0.120
Zhengzhou	245	0.249	0.009	0.125
Nanning	160	0.244	0.017	0.060
Benxi	153	0.176	0.014	0.108
Lanzhou	150	0.167	0.004	0.053
Kunming	170	0.135	0.002	0.034
Total	3192	0.383	0.013	0.129

Table 1B: R&D comparison across sample sectors

sector	Sample	R&D Decision	R&D intensity	New Product Sales
Electronic equipment	563	0.549	0.025	0.184
Auto & auto parts	719	0.473	0.009	0.160
Chemical products & medicine	170	0.429	0.029	0.094
Electronic parts making	557	0.397	0.014	0.121
Food processing	129	0.333	0.015	0.098
Metallurgical products	275	0.233	0.015	0.091
Garment & leather products	724	0.228	0.003	0.096
Transportation equipment	55	0.109	0.005	0.033
Total	3192	0.383	0.013	0.129

Table 2: Variable Definition

Variable	Definition
R&D decision	Dummy variable, equals to one if the firm has reported a positive expense on R&D in a corresponding year.
R&D Intensity	R&D intensity, defined as R&D expenditure divided by total sales.
New Product Sales	Sales of new product, measured as a percentage of total sales.
CEO share	Ln(1+CEO share ratio)
Incentive	Dummy variable, equals to one if the CEO's income is linked with firm performance.
Sales Incentive Contract	Sales as primary performance measure in the incentive contract.
Profit Incentive Contract	Profit as primary performance measure in the incentive contract.
Delta	Sensitivity of CEO income to firm performance. Measured as the percentage of CEO income increase for each one percent increase of the firm's primary performance measure.
College	Dummy variable, equals to one if the CEO has a college or above education background.
Official	Dummy variable, equals to one if the CEO was a government official before the current position.
Professional	Dummy variable, equals to one if the CEO was a manager before her current position.
CEO Tenure	Tenure of CEO
Firm Size	Measured as the nature logarithm of total number of employment.
Large Firm	Dummy variable for firm size, equals to one if there are more than 329 employees in the firm, zero otherwise
Median Firm	Dummy variable for firm size, equals to one if there are more than 109 but less than 329 employees in the firm, zero otherwise
Firm age	Years since the firm was established.
Comp_1	Dummy Variable, Equals to 1 if there is 1-3 competitors in the firm's main market, 0 otherwise
Comp_2	Dummy Variable, Equals to 1 if there is 4-6 competitors in the firm's main market, 0 otherwise
Comp_3	Dummy Variable, Equals to 1 if there is 7-15 competitors in the firm's main market, 0 otherwise
Comp_4	Dummy Variable, Equals to 1 if there is 16-100 competitors in the firm's main market, 0 otherwise
Population	city population.
GDP growth	city GDP growth rate.
University	the number of universities in the city.

Table 3: Summary statistics of key variables and comparison across groups

Panel A: Summary Statistics (Sample size: 3192)

	mean	sd	min	max
R&D decision	0.383	0.486	0.000	1.000
R&D Intensity	0.013	0.053	0.000	0.919
New Product Sales	0.129	0.236	0.000	1.000
CEO share	0.047	0.105	0.000	0.405
Incentive	0.254	0.435	0.000	1.000
Profit incentive contract	0.037	0.189	0.000	1.000
Sales incentive contract	0.198	0.399	0.000	1.000
Delta	0.008	0.038	0.000	0.500
College	0.786	0.410	0.000	1.000
Official	0.028	0.165	0.000	1.000
Professional	0.496	0.500	0.000	1.000
CEO Tenure	1.767	0.516	0.693	3.932
ROA	0.020	0.082	-0.161	0.223
Firm Size	4.982	1.330	2.303	9.649
Large	0.258	0.438	0.000	1.000
Median	0.300	0.458	0.000	1.000
Firm age	12.320	12.460	0.000	52.000
Population	6.299	0.692	4.828	8.044
GDP growth	9.564	0.627	8.545	11.994
University	19.780	11.541	1.000	48.000

Panel B: R&D between different incentive schemes

	No Incentive	Incentive	CEO w/o Share	CEO w/ Share	Below college	college
Sample Size	2381	811	2411	781	683	2509
R&D decision	0.011	0.020***	0.010	0.023***	0.004	0.016***
R&D Intensity	0.324	0.554***	0.356	0.464***	0.171	0.440***
New Product Sales	0.113	0.175***	0.119	0.159***	0.095	0.138***

Note: Asterisks in the third column indicate that innovation activities are significantly higher for CEOs whose income is linked with firm performance. In the fifth column they indicate whether innovation activities are significantly higher for firms whose CEOs hold shares of that firm. In the last column they indicate that innovation activities are significantly higher for CEOs with college or higher education. One-tail T-test significant levels are reported. Three asterisks indicate a significance level of 1%.

Table 4: Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12
1:R&D/Sales												
2:CEO share	0.092*											
3:Incentive	0.079*	0.033										
4: Profit incentive contract	0.056*	0.035*	0.851*									
5:Sales incentive contract	0.047*	-0.004	0.337*	-0.098*								
6:Delta	0.012	0.013	0.379	0.346	0.119							
7: College	0.095*	-0.057*	0.161	0.129*	0.066*	0.048						
8:Official	0.052*	0.0003	0.050	0.050	-0.033	-0.016	0.061					
9:Professional	0.053*	-0.066*	0.107*	0.059	0.099*	0.037*	0.163*	-0.168*				
10:CEO Tenure	-0.038*	0.022	-0.145*	-0.096	-0.099	-0.038	-0.233*	-0.025	-0.124*			
11:ROA	-0.015	0.029	0.104	0.110	0.004	0.073*	0.068	0.0301	-0.052*	-0.029		
12:Firm Size	-0.011	-0.082	0.143	0.135*	0.053*	0.042*	0.290*	-0.022	0.228*	-0.129	0.058	
13:Firm Age	-0.053*	-0.093	-0.084	-0.081*	0.006	-0.027	-0.061*	-0.006	0.120*	0.081	-0.158*	0.213

* indicates a significance level of at least 5%

Table 5 Probit regressions on the determinants of R&D investment decision

	(1)	(2)	(3)	(4)
CEO Share	0.5957	0.6745	0.5996	0.6786
	(2.475)**	(2.779)***	(2.487)**	(2.787)***
Incentive Compensation	0.4199	0.3899		
	(7.415)***	(6.849)***		
Profit incentive contract			0.3085	0.2799
			(4.631)***	(4.198)***
Sales incentive contract			0.6257	0.6011
			(4.773)***	(4.568)***
Delta			2.6124	2.6358
			(3.348)***	(3.482)***
College		0.2440		0.2442
		(3.344)***		(3.330)***
Official		0.3694		0.4120
		(2.327)**		(2.613)***
Professional		0.1193		0.1149
		(2.273)**		(2.183)**
CEO tenure		0.0688		0.0771
		(1.355)		(1.515)
ROA	1.3794	1.3989	1.3303	1.3437
	(4.509)***	(4.532)***	(4.356)***	(4.355)***
Firm Size	0.3108	0.2909	0.3116	0.2925
	(14.745)***	(13.291)***	(14.777)***	(13.383)***
Firm Age	-0.0079	-0.0078	-0.0081	-0.0081
	(3.633)***	(3.584)***	(3.731)***	(3.686)***
Population	0.2559	0.2495	0.2718	0.2662
	(4.144)***	(4.036)***	(4.382)***	(4.287)***
GDP growth	0.0494	0.0323	0.0674	0.0521
	(0.855)	(0.555)	(1.165)	(0.892)
University	0.0056	0.0047	0.0057	0.0049
	(2.027)**	(1.697)*	(2.064)**	(1.761)*
Competition Dummies	yes	yes	yes	yes
Industry Dummies	yes	yes	yes	yes
Constant	-4.8196	-4.8449	-5.0970	-5.1657
	(5.762)***	(5.774)***	(6.069)***	(6.128)***
Observations	3192	3192	3192	3192

Note: The regressions are run with probit, which is based on standard maximum likelihood estimation with heteroskedasticity-robust standard errors clustering within firms. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively. T-statistics based on robust standard errors are in parentheses. The dependent variable is R&D Decision Dummy, which takes on value one if the firm has positive R&D investment in a specific year, and zero otherwise. The detailed definitions of other variables can be found in Table 2.

Table 6: Tobit regression on the determinants of R&D intensity

	(1)	(2)	(3)	(4)
CEO Share	0.0537	0.0659	0.0561	0.0678
	(1.843)*	(2.202)**	(1.927)*	(2.256)**
Incentive Compensation	0.0249	0.0220		
	(4.828)***	(4.464)***		
Profit incentive contract			0.0191	0.0170
			(3.482)***	(3.267)***
Sales incentive contract			0.0385	0.0334
			(3.795)***	(3.316)***
Delta			0.0702	0.0752
			(2.809)***	(2.840)***
College		0.0257		0.0258
		(2.678)***		(2.675)***
Official		0.0315		0.0344
		(2.049)**		(2.217)**
Professional		0.0131		0.0129
		(2.659)***		(2.605)***
CEO tenure		-0.0020		-0.0016
		(0.337)		(0.271)
ROA	0.0169	0.0318	0.0152	0.0293
	(0.696)	(1.284)	(0.622)	(1.179)
Firm Size	0.0177	0.0160	0.0178	0.0160
	(6.970)***	(7.040)***	(7.029)***	(7.125)***
Firm Age	-0.0002	-0.0002	-0.0002	-0.0002
	(1.196)	(1.005)	(1.357)	(1.151)
Population	0.0155	0.0143	0.0163	0.0153
	(3.080)***	(2.898)***	(3.288)***	(3.127)***
GDP growth	0.0012	-0.0002	0.0022	0.0009
	(0.265)	(0.048)	(0.481)	(0.189)
University	0.0002	0.0001	0.0002	0.0002
	(0.838)	(0.719)	(0.945)	(0.810)
Competition Dummies	yes	yes	yes	yes
Industry Dummies	yes	yes	yes	yes
Constant	-0.2951	-0.2860	-0.3108	-0.3049
	(3.995)***	(3.887)***	(4.217)***	(4.143)***
Observations	3192	3192	3192	3192

Note: The regressions are run with tobit, which is based on standard maximum likelihood estimation with heteroskedasticity-robust standard errors clustering within firms. The variance is adjusted for heteroskedasticity by firm size. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively. T-statistics based on robust standard errors are in parentheses. The dependent variable is R&D intensity, which is the amount of R&D spending as a percentage of total sales. The detailed definitions of other variables can be found in Table 2.

Table 7: IV Tobit & IV probit regressions for R&D decision and intensity

	(1) IVTOBIT	(2) IVTOBIT	(3) IVTOBIT	(4) IVTOBIT	(5) IVPROBIT	(6) IVPROBIT
CEO Share	0.1528	0.1617	0.0863	0.0995	1.3231	0.6486
	(5.084)***	(5.400)***	(3.554)***	(4.103)***	(3.493)***	(2.155)**
Incentive Compensation	0.0324	0.0287			0.4238	
	(5.325)***	(4.664)***			(5.417)***	
Profit incentive contract			0.0323	0.0286		0.3671
			(4.653)***	(4.101)***		(4.020)***
Sales incentive contract			0.0685	0.0660		0.8258
			(4.804)***	(4.597)***		(4.402)***
Delta			0.0151	0.0223		1.7080
			(0.276)	(0.411)		(1.984)**
College		0.0275		0.0268	0.2434	0.2356
		(4.318)***		(4.212)***	(3.282)***	(3.165)***
Official		0.0395		0.0420	0.3641	0.3960
		(3.435)***		(3.656)***	(2.437)**	(2.661)***
Professional		0.0170		0.0158	0.1262	0.1139
		(3.956)***		(3.653)***	(2.367)**	(2.130)**
CEO tenure		0.0049		0.0062	0.0705	0.0844
		(1.156)		(1.449)	(1.346)	(1.602)
ROA	0.0832	0.0936	0.0846	0.0922	2.1034	1.9935
	(2.140)**	(2.409)**	(2.166)**	(2.361)**	(4.388)***	(4.134)***
Firm Size	0.0134	0.0111	0.0127	0.0106	0.2908	0.2874
	(7.796)***	(6.302)***	(7.421)***	(6.063)***	(12.971)***	(12.800)***
Firm Age	-0.0005	-0.0005	-0.0006	-0.0005	-0.0066	-0.0073
	(2.897)***	(2.720)***	(3.149)***	(2.973)***	(2.958)***	(3.283)***
Population	0.0155	0.0144	0.0168	0.0157	0.2381	0.2635
	(3.029)***	(2.817)***	(3.266)***	(3.072)***	(3.684)***	(4.054)***
GDP growth	0.0040	0.0015	0.0049	0.0027	0.0234	0.0446
	(0.844)	(0.327)	(1.025)	(0.568)	(0.403)	(0.759)
University	0.0004	0.0003	0.0004	0.0003	0.0049	0.0047
	(1.973)**	(1.567)	(1.848)*	(1.507)	(1.797)*	(1.728)*
Competition Dummies	yes	yes	yes	yes	yes	yes
Industry Dummies	yes	yes	yes	yes	yes	yes
Constant	-0.3280	-0.3181	-0.3372	-0.3339	-4.7747	-5.0952
	(4.660)***	(4.516)***	(4.752)***	(4.694)***	(5.490)***	(5.795)***
Observations	3192	3192	3192	3192	3192	3192

Note: ***, **, * indicate significance at 1%, 5%, and 10%, respectively. T-statistics are in parentheses. Following Fisman and Svensson (2007), the instruments are industry-location average of the potentially endogenous variables (CEO share, Incentive Compensation, Profit incentive contract, Sales incentive contract, delta, ROA). Columns (1) to (4) are based on IV Trobit estimation. Columns (5) and (6) are based on IV Probit estimation.

Table 8: Robust Tests on R&D Intensity: Firm size dummies and size square term

	(1)	(2)	(3)	(4)
CEO Share	0.1498	0.1594	0.0864	0.6546
	(4.995)***	(5.335)***	(3.553)***	(2.172)**
Incentive Compensation	0.0325	0.0288		
	(5.311)***	(4.672)***		
Profit incentive contract			0.0321	0.3631
			(4.612)***	(3.974)***
Sales incentive contract			0.0683	0.8240
			(4.790)***	(4.392)***
Delta			0.0156	1.7193
			(0.285)	(1.997)**
College		0.0292		0.2339
		(4.626)***		(3.140)***
Official		0.0367		0.3946
		(3.195)***		(2.648)***
Professional		0.0175		0.1114
		(4.047)***		(2.081)**
CEO tenure		0.0046		0.0889
		(1.081)		(1.686)*
ROA	0.0764	0.0893	0.0855	2.0033
	(1.966)**	(2.299)**	(2.187)**	(4.153)***
Large firm	0.0391	0.0308		
	(7.052)***	(5.474)***		
Median firm	0.0169	0.0113		
	(3.316)***	(2.206)**		
Firm Size			0.0134	0.3007
			(7.310)***	(12.724)***
Firm Size Square			-0.0000	-0.0000
			(1.033)	(1.773)*
Firm Age	-0.0005	-0.0004	-0.0006	-0.0074
	(2.678)***	(2.476)**	(3.160)***	(3.303)***
Population	0.0164	0.0153	0.0166	0.2611
	(3.196)***	(2.990)***	(3.217)***	(4.015)***
GDP growth	0.0058	0.0030	0.0050	0.0497
	(1.227)	(0.643)	(1.039)	(0.846)
University	0.0004	0.0003	0.0004	0.0049
	(1.792)*	(1.344)	(1.895)*	(1.792)*
Competition Dummies	yes	yes	yes	yes
Industry Dummies	yes	yes	yes	yes
Constant	-0.2980	-0.2936	-0.3396	-5.1997
	(4.200)***	(4.143)***	(4.783)***	(5.901)***
Observations	3192	3192	3192	3192

Note: The regressions are run with IV Tobit models. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively. T-statistics are in parentheses. The dependent variable is R&D intensity, which is the amount of R&D spending as a percentage of total sales. Based on the sample distribution, a firm is classified as a large firm if there are more than 329 employees in the firm. A firm is classified as a medium size firm if there are more than 109 but less than 329 employees in the firm. The benchmark group is the group of small firms. The detailed definitions of other variables can be found in Table 2.

Table 9: Managerial Incentives, CEO characteristics and New Product Sales

	(1)	(2)	(3)	(4)
CEO Share	0.5377	0.5327	0.3877	0.3718
	(3.696)***	(3.651)***	(3.346)***	(3.201)***
Incentive Compensation	0.1341	0.1393		
	(4.565)***	(4.646)***		
Profit incentive contract			0.1112	0.1150
			(3.302)***	(3.378)***
Sales incentive contract			0.1902	0.2062
			(2.692)***	(2.867)***
Delta			0.2547	0.2434
			(0.935)	(0.893)
College		0.0205		0.0203
		(0.704)		(0.700)
Official		-0.0604		-0.0489
		(0.963)		(0.779)
Professional		-0.0250		-0.0250
		(1.204)		(1.205)
CEO tenure		0.0262		0.0280
		(1.280)		(1.369)
ROA	1.1896	1.1759	1.1867	1.1729
	(6.478)***	(6.359)***	(6.449)***	(6.329)***
Firm Size	0.0755	0.0765	0.0749	0.0760
	(9.183)***	(8.970)***	(9.133)***	(8.923)***
Firm Age	-0.0007	-0.0006	-0.0008	-0.0008
	(0.785)	(0.710)	(0.993)	(0.940)
Population	0.0666	0.0664	0.0689	0.0690
	(2.703)***	(2.693)***	(2.791)***	(2.794)***
GDP growth	0.0285	0.0286	0.0305	0.0308
	(1.250)	(1.247)	(1.331)	(1.338)
University	0.0035	0.0036	0.0035	0.0036
	(3.363)***	(3.367)***	(3.343)***	(3.350)***
Competition Dummies	yes	yes	yes	yes
Industry Dummies	yes	yes	yes	yes
Constant	-1.5796	-1.6387	-1.5944	-1.6617
	(4.696)***	(4.825)***	(4.720)***	(4.867)***
Observations	3192	3192	3192	3192

Note: The regressions are run with IV Tobit models. T-statistics are in parentheses. The dependent variable is sales of new product, measured as a percentage of total sales. The detailed definitions of other variables can be found in Table 2. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.