Monetary Incentives and Innovation in Chinese SMEs

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Abstract

We investigate the impact of monetary incentives on the innovation performance of a unique sample of private Chinese SMEs. Building on an agency-theoretic framework, we find evidence that firm-specific incentives matter, but their impact is contingent on the nature of the incentive, the employees at whom it is directed, and the measure of innovation employed. However, contrary to our hypothesis and the evidence in other countries, pay-for-performance measures for managers are found to positively impact patenting activity, a result not consistent with agency theory and one that we ascribe to the Chinese institutional environment notably state incentives for innovation.

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1. INTRODUCTION

Innovation is widely seen as a necessary ingredient for rising productivity and incomes, and this is particularly true for emerging markets seeking to embark on a sustainable growth path (Zanello et al, 2015). The importance of innovation has been recognized in China, notably in the most recent Five-Year Plan (Xinhua, December, 2015), indicating that both the Chinese government and Chinese firms are acutely aware of the importance of innovation as a determinant of long-run competitiveness (Yip and McKern, 2014).

In terms of both R&D spending (inputs) and patenting (outputs) there is evidence that China is devoting significant resources to improve its innovative capacity, with some success (Hu and Jefferson, 2009; Yip and McKern, 2014; Fan, 2014). Still, there are concerns regarding China's capacity to innovate, and calls for more "bottom up" innovation (Abrami et al, 2014). At the same time, evidence also suggests that private firms are more productive in terms of innovation than their state-owned counterparts (Breznitz and Murphree, 2011; Jefferson et al, 2013). The Chinese government fully recognizes the promise of private sector innovation by actively promoting ``popular entrepreneurship and mass innovation'' as the ``twin engines'' of growth, and is placing a particular emphasis on the potential of smaller enterprises (Xinhua, 2015). Thus, in this study we focus on the innovation performance of private SMEs in Zhejiang, China.

Given its importance, it is not surprising that researchers have begun to focus on the determinants of innovative activity at the firm level in China. It is now well-documented that in China, R&D expenditures positively affect innovation output (Jefferson et al, 2006; Sun and Du, 2010; Zhao et el., 2014). In addition, a variety of other positive innovation determinants have been identified, including foreign knowledge access (Wang and Kafouros, 2009; Li et al, 2010a), management and strategy (Chow and Liu 2007; Zhang and Li, 2009; Li et al, 2010b), ownership structure (Choi, Lee and Williams, 2011; Choi, Park and Hong, 2012; Chen et al, 2014; Deng, Hofman and Newman, 2013) and various dimensions of corporate governance (Shapiro, et al, 2015). At the same time, some attention has been paid to the role of institutional constraints in limiting innovation in China and other emerging markets, (Zhu et al, 2012; Zanello et al, 2015).

One gap in the literature to date is an examination of the role of incentives as a determinant of firm-level innovative activity in China. With the exception of Lin et al (2011), who examine the impact of CEO incentives on the innovative performance of Chinese firms, this subject has not been addressed in a Chinese context. In general, there is little research on the impact of incentives on innovation in emerging economies, including China (Honoré et al, 2015). Accordingly, in this paper, we address this empirical gap and at the same time extend the theoretical understanding of innovation incentives by carefully distinguishing among different incentives, measures of innovation, and employees at whom the incentives are directed.

Using a broad agency-theoretic approach, we argue that patenting and new product sales capture different aspects of innovation (Hong et al, 2012; Shapiro et al, 2015) and therefore that the incentives associated with each are also different, both in terms of incentive type and employment status. Specifically, we hypothesize that incentives directed at *managers* in the form of shareholdings are more likely to encourage long run innovation (patents), but performance-based pay directed at managers will have the opposite effect. At the same time, we hypothesize that performance-based pay incentives directed at *non-managers* are more likely to improve shorter term innovation outcomes, in this case the production and sale of actual products, a measurable short-term goal. We also suggest that non-management shareholding will increase innovation because the effective sale of new products can enhance firm value, and can do so in response to increased effort by non-management employees.

Thus, we examine the impact of *both* shareholding and performance-based pay incentives directed at *both* manager and non-manager employees on the innovative performance of a unique sample of 288 private, non-traded SMEs in Zhejiang, China between 2004 and 2006. By focusing on a particular region, we avoid some of the governance issues that arise because of differences in institutional quality across China (Zhou et al, 2016; Chen et al, 2015). Based on Probit, truncated Poisson, and log-normal regressions, we do find that both managerial and non-managerial incentives matter, thus providing a degree of support for the relevance of monetary incentives in China. We also find that although incentives matter, they matter in somewhat different ways. We find that *both* shareholding and performance-based pay schemes for managers have significant positive effects on the granting of new patents, with the latter result being contrary to our hypothesis. As for non-manager employees, performance-based pay is positively related to new product sales, but shareholding by these employees has no significant effects.

Our results support the view that monetary incentives are important in our sample of Chinese firms, and that there are differences between managerial and non-managerial incentives. Although we do obtain results consistent with an agency perspective, we also find evidence that the Chinese institutional context matters. Contrary to our hypothesis and the evidence in other countries, pay for performance measures for managers are found to be positively associated with patenting activity, a result we ascribe to the unique incentive environment in Zhejiang province. Moreover, in controlling for ownership concentration, we also find evidence consistent with the view that Principal-Principal (PP) issues, often found in emerging markets, are important in China (Peng & Sauerwald, 2013; Zhou et al, 2016).

Our study contributes to the general literature on innovation and incentives by clearly and explicitly arguing that the impact of incentives is contingent on the nature of the incentive, the employees at whom it is directed, and the measure of innovation employed. Empirically, we contribute to the range of evidence that comes from contexts other than the U.S., and in particular China. Our results broadly confirm that monetary incentives have positive effects on innovation in China, but not always in ways that are consistent with agency theory. We find evidence that the Chinese institutional context matters because government incentives to innovation appear to overcome any managerial tendencies favouring short-term goals over innovation. We conclude that future research on innovation incentives should therefore account for the external context of innovation incentives, and these are likely to be country-specific.

In the next section, we develop hypotheses regarding the roles of different incentive schemes. Sections 3 and 4 present our data, empirical strategy and results, followed by a discussion of the results and conclusions.

2. THEORETICAL BACKGROUND AND HYPOTHESES

Arguably the strongest case in favour of the importance and impact of monetary incentives is made in the finance and economics literature, and in particular through agency theory. Agency theory is often used to evaluate the impact of monetary incentives on innovation by examining the relationship between principals and agents (Bonner and Sprinkle, 2002). Because innovative activities require the effort of employees (agents), assumed to be risk averse, and because these activities have uncertain outcomes and are therefore risky, agency theory suggests that a firm should provide incentives to induce employees to engage in innovative activities (Jensen and Meckling, 1976; Holmstrom, 1979; Baker, 1992). As we document below, there is considerable empirical evidence in support of the general proposition that various types of monetary incentives encourage innovation, and so we root our analysis in agency theory.

Agency theory was developed in the context of developed financial markets and governance institutions, raising the question of whether it is an appropriate framework in all national contexts. Certainly there is some debate as to whether “best practice” governance standards, which themselves rely on agency theory, and which emanate from developed countries, are appropriate in different settings such as China (Li et al, 2011; Zhou et al, 2016). Indeed, almost all existing studies on incentives to innovation focus on firms in developed economies, and most focus on the US (Honoré et al, 2015), with the implication that the results to date may not apply in other contexts. This may be particularly true of countries rooted in Confucian values where the importance of contractually-based incentives may be less important (Miles and Goo, 2013). To date there is little research on managerial compensation and innovation in emerging economies, including China, and so the question of context has not been fully addressed. There is, however, limited evidence to suggest that China is not dissimilar from the US in terms of incentive adoption (Merchant et al, 2011).

While we base our hypotheses on an agency-theoretic view of the firm, we also suggest that this approach is appropriate in the Chinese SME context. We assume that owners wish to maximize the value of the firm over a relatively long period, an assumption that we believe is appropriate for non-SOE firms in China. Although the assumption that shareholders have a long-term orientation has been questioned in other contexts (see Honoré et al, 2015 for a concise review of the literature on this point), we suggest that it is more likely to be true of private firms in China, for two reasons. The first is that ownership is typically concentrated in individual or family hands, and these owners are more likely to have a long-term orientation (Le Breton Miller and Miller, 2006). The second is that Confucian values may foster a longer-term orientation based on relationships (Lee and Dawes, 2005; Luo et al, 2011; Miles and Goo, 2013). Thus we assume that shareholders of private Chinese firms take a long view and are supportive of investments leading to innovation.

In the extensive literature on the relationship between incentive-based compensation and firm performance (Gerhart and Milkovich, 1990; Roth and O'Donnell, 1996; Stroh, et al, 1996; Coles et al, 2006; Gomez-Mejia, et al, 2010), several papers examine the effects of compensation practices on innovation. In general, these papers find that incentives for managers that are based on the short-term performance of a firm do *not* encourage innovative activities. However, longer-term incentives for managers, such as stocks and options, can lead to greater innovative activity as measured by R&D expenditures, new products, patenting, and patents of greater originality (Hoskisson, et al, 1993; Holthausen, et al, 1995; Zahra, et al, 2000; Lerner and Wulf, 2007). Importantly for this paper, Chan et al (2014) suggest that executive stock options are positively associated with innovative activity, but have different impacts on different types of innovation, while Chang et al (2015) suggest that stock options for non-executive employees can enhance innovative activity. Almost all existing studies focus on firms in developed economies, and indeed most focus on the US (Honoré et al, 2015). However European evidence regarding the incentive effects of compensation schemes on R&D spending is more mixed (Lhuillery, 2011; Driver and Coelho Guedes, 2012), suggesting the need for further research in a broader range of countries, and perhaps raising the question of whether agency theory is appropriate in all national contexts. Similarly, the few studies that directly examine innovation incentives in Confucian societies, also arrive at mixed conclusions. For example, Kanama and Nishikawa (2015) find that monetary incentives for R&D workers in Japan do not promote new product development and sales, whereas Chien et al (2010) find that performance-based pay enhanced the performance of R&D professionals in Taiwan.

Essentially we argue that because longer-term innovative activities such as those associated with patenting generate uncertain outcomes that will only be revealed with a time lag, shareholding is the best long-term incentive for managers to pursue innovation. Relative to non-manager employees, managers typically hold more shares and have more control over the allocation of long-term resources, making shareholding a suitable tool to align their interests with the firms' with respect to innovation. Non-manager employees on the other hand are more likely to be motivated by performance-based pay because performance-based pay is often contingent on short-term, measurable performance goals over which they have some control. Thus, we suggest that performance-based pay is more effective in providing incentives for non-managers to achieve better new product sales, a measurable short-term goal.

We begin with managers. Managers have considerable influence on investments in innovation because they can decide on the amount of resources and other support available for such activities (Kanter, 1985). Collis (2016) refers to this as deliberate strategy. In the long run, firms will gain competitive advantage and economic benefits from successful innovation. However, due to the uncertain nature of investments in innovation, an investment that is *ex ante* optimal may turn out to be a failure *ex post*. Such failures will jeopardize the careers of managers, and will expose them to job security risk. Without incentives, risk-averse and effort-averse managers will invest in innovation at a level suboptimal to the firm. Because the outcomes of these investments will not be revealed in the short run, long run incentives, such as stock ownership and options, are required to appropriately motivate managers (Dechow and Sloan, 1991). Empirical studies based on US data (Holthausen et al, 1995; Zahra et al, 2000; Lerner and Wulf, 2007; Chen et al, 2014) typically find that stronger long-term incentives are associated with better innovation outcomes, measured by R&D or patents. Therefore, we hypothesize that by linking compensation to long run success, managerial shareholding will encourage more patenting, a long run outcome.

Hypothesis 1: *firms in which the shareholding of managers is higher will engage in more patenting activity.*

Performance-based pay links compensation to short-term performance measures such as revenue and profit. Although the positive relation between performance-based pay for managers and firm performance has been well studied (Jensen and Murphy, 1990; Murphy, 1999; Firth, Fung, and Rui, 2006), the relationship between performance-based pay for managers and innovation is less straightforward. Managers are multitasking agents charged with responsibilities for innovation over the long run, but they are also responsible for short-term performance. Mixing the two responsibilities, one harder to measure and the other easier to measure, often leads to an inefficient allocation of effort or risk (Holmstrom, 1989). Although innovation investments can enhance firm performance in the long run, it may reduce short-term profit by increasing current costs. The theory of multitasking agents suggests that since innovative efforts are hard to measure and short-term performance-enhancing activities compete with them for the resources under the control of managers, it is undesirable to provide performance-based pay if the goal is long term performance (Holmstrom and Milgrom, 1991). Relative to the optimal allocation of managers' efforts, such performance-based pay will divert efforts from innovation to short-term targets.

This prediction of theory is consistent with evidence reported in Dechow and Sloan (1991) who find that under earnings-based incentives, CEOs in their final years of tenure spend less on R&D to enhance short-term earnings of firms, but such under-spending is mitigated by shareholding of CEOs. Similarly, Hoskisson et al (1993) find that short-term incentives based on actual financial performance reduce R&D spending. However, we do note that Lin et al (2011) find that profit and sales incentives for CEOs in China are positively associated with R&D.

In addition, when managers are exposed to substantial risk in income due to the performance-based pay mechanism, they may take action to reduce variability in firm performance (Kren and Kerr, 1993; Bloom and Milkovich, 1998). One possible action can be reducing support for long run innovation activities. These various arguments lead us to expect that performance-based pay for managers has negative effects on the patenting activities of a firm.

Hypothesis 2: *firms in which performance-based pay paid to managers is higher will experience lower levels of patenting activity.*

Firms also provide incentives to non-managers, and these are typically not analyzed in discussions of innovation, Chang et al (2015) being a notable exception. In this case, the theoretical lens of agency theory is somewhat less clear, since it was designed to analyse the relationship between shareholder principals and manager agents. Nevertheless, non-managerial employees are also agents and should respond to incentives. In this case we introduce the distinction made by Shapiro et al (2015) between innovative activity that is long run in nature and therefore less certain, like patents, and innovation that is shorter term in nature, like new product development and sales. A similar idea is found in Collis (2016) who argues that employees who are not top managers may not determine strategy, but they are critical to the implementation and improvement of the strategy.

We suggest that non-managerial employees have relatively greater responsibility for producing, improving and in particular selling new products. These employees will therefore be the ones who ensure that the products are of high quality and that customers are well-serviced (Collis, 2016). Their actions have possible long-term consequences for the firm in that the sale of high quality new products will enhance the value of the firm. Thus non-managers who own shares will have an incentive to contribute to the development and sale of new products. In addition, shareholding by non-executive employees, because they are jointly held, may encourage information sharing and teamwork, which in turn can result in higher quality products and service (Hochberg and Lindsey, 2010).

There are relatively few studies on equity-based incentives for non-manager employees. Most of them focus on options, which differ from the shareholding studied here. For instance, Core and Guay (2001) study what types of firms use stock options to provide incentives for non-executive employees. Frye (2004) finds that equity-based compensation targeted at non-executive employees, including both options and shareholding, enhances firm performance while Chang et al (2015) find the same for innovation.

It is true that relative to managerial employees, non-managers will typically hold fewer shares and, and this may mute the incentive impact of non-managerial shareholdings on innovation performance. Nevertheless, we argue that as in the case of shareholding of managers, the shareholding of non-manager employees also aligns employees with the goals of the firm and promotes common effort, in this case by fostering the development and sales of new products.

Hypothesis 3: *firms in which the shareholding of non-managers is higher will be more successful in developing and selling new products.*

To the extent that non-managerial employees perceive that new product sales will improve the financial performance of the firm, and to the extent that they can influence its performance, performance-based pay will have positive effects on new product sales. From the point of view of the firm, since non-managerial employees' efforts are likely to have substantial effects on new product sales because of the direct impact on product quality and customer relationships (Collis, 2016), performance-based incentives are an efficient motivating tool (Baker, 1992). Inderst (2009) also shows that performance-based pay is a robust instrument to encourage implementation of successful new product innovations. For example, employees may try to improve the quality of new products in the manufacturing stage, or expend more effort to market and sell new products. In the case of sales-force compensation, based on a synthesis of literature, Coughlan and

Narasimhan (1992) suggest that if effort has a substantial effect on sales, performance-based pay is effective in motivating employees. Empirically, Banker et al (1996) find that a performance-based incentive plan targeted at front-line workers increased sales in a retail establishment. Although as discussed above the evidence from Asian countries is somewhat more mixed (Kanama and Nishikawa, 2015; Chien et al, 2010) on balance we expect non-managers will respond to performance-based pay by increasing their efforts to ensure the market success of a new product.

We therefore argue that non-managerial employees can be motivated by performance-based pay because performance-based pay is often contingent on short-term, measurable performance outcomes over which these employees have some control. Thus, we suggest that performance-based pay is effective in providing incentives for non-managers to achieve better new product sales.

Hypothesis 4: *firms in which performance-based pay paid to non-managers is higher will experience higher levels of new product sales.*

Our four hypotheses are summarized in Figure 1. We note that implicit in our hypotheses is the view that while managerial incentives are effective stimulants to patenting, and non-managerial incentives are effective in stimulating new product sales, managerial incentives do not impact new product sales, and non-managerial incentives do not impact patents. We base this speculation primarily on the degree of control the relevant agent has on the outcome considered. We do not offer hypotheses in this regard, but do evaluate whether the data supports our speculation in Table 5.

Figure 1 about here

3 METHOD

3.1 Data Description

We use data based on surveys of firms from Zhejiang province. The use of survey data in studies of innovation is now widespread (Hong et al, 2012). Zhejiang province is particularly suitable for research on private firms for several reasons. First, Zhejiang's economy is relatively large and rich. Zhejiang's population of 55 million, large in absolute terms, accounted for 4.0% of China's population.[6] However, the Zhejiang economy, with a GDP of $546 billion in 2012, contributed 6.7% of the national GDP ($8,227 billion).[7] Zhejiang is therefore significantly richer than the rest of China, with GDP per capita ($10,022 in 2012) higher than the national average ($6,076).

Second, Zhejiang is a province that actively participates in innovation. The R&D expenditure to GDP ratio in Zhejiang was 2.04%, slightly above the national ratio of 1.97%, but R&D spending in Zhejiang is particularly productive. In 2012, 188,000 patents were granted to Zhejiang applicants which amounts to 16.4% of all patents granted to domestic applicants (1.14 million). In addition, Zhejiang offers strong incentives to firms to register patents, both at home and abroad, with direct payments

[6] The sources of the provincial and national statistics presented here are the Statistical Communique of the People's Republic of China on the 2012 National Economic and Social Development, and Statistical Communique of the Zhejiang Province on the 2012 National Economic and Social Development.
[7] In this study, all figures in the USD dollar are obtained by applying the market exchange rate to figures in yuan.

made to firms who do so (Science and Technology Department of Zhejiang Province, 2004).[8] These payments were in place during the period that we study.

Third, Zhejiang boasts an economy dominated by private firms and supports a vibrant entrepreneurship environment. Non-state-owned firms accounted for 82% of all firms in Zhejiang (Gu and Jiang, 2011). These private firms produced 83% of Zhejiang's industrial output. Lacking natural endowments, entrepreneurship is widely perceived as a critical factor behind Zhejiang's economic performance (Economist, 2011). For instance, Zhejiang is the home of the now-famous Alibaba Group. Consequently, although Zhejiang is not a representative province in China, it is very suitable for studying innovation by private firms, and it does allow us to avoid problems created by institutional differences across China.

In 2007, the Association of Private Enterprises of Zhejiang Provincial Administration for Industry and Commerce (*Zhejiangsheng Gongshangju Siying Qiye Xiehui*)[9] conducted the survey which leads to the data employed in this study. The survey covered firm performance, innovation measures, and compensation and corporate governance practices for 2004, 2005 and 2006. The majority of firms were private and in manufacturing industries, and of the private firms all but one was *not* listed on the stock market. Hence our sample provides a novel opportunity to study innovation in young private firms. SOEs make up less than 4% of the sample. Although our primary focus is on private

[8] We are indebted to Shaowei He for bringing this to our attention.
[9] This was the name of the association in 2007. In 2009, the association adopted a new name, the Zhejiang Federation for Development of Non-state-owned Enterprises (*Zhejiangsheng Minying Qiye Fazhan Lianhehui*).

firms, we also present results that include the SOEs to provide a comparative perspective. Because the SOEs typically enjoy favorable treatment by banks, and privileged access to government grants for R&D, it is important to understand their performance relative to private firms, particularly in a context where private firms are so prevalent.

Out of 2400 surveys sent, surveyors received back about 1000 that were nearly completed. Six survey workers called these firms and requested that firm employees redo the surveys. After comparing data from the 1000 surveys initially returned to the data collected from phone calls, they found consistency in 95% of the data entries. Consequently, the quality of the completed surveys appears to be high. Among these high-quality surveys, we focus on manufacturing firms that report all information required for our regression analysis. This leaves us with an unbalanced panel of 330 firms (288 of which are private) and 1030 firm-year observations. Applying the definition of the National Development and Reform Commission of China, small enterprises account for 56% of the sample, and 96% of the sample are small and medium-sized.[10]

3.2 Measurement

We use two dependent variables, patents and new product sales to measure the innovation performance of firms. Shapiro et al (2015) argued that these two measures represent different constructs, and we therefore use patents as a measure of long-term product and process innovation possibilities, and new product sales as a measure of more current

[10] In the 2003 definition, a manufacturing firm is an SME if it has less than 2,000 employees, or a revenue less than 300 million yuan ($36.2 million), or capital stock less than 400 million yuan ($48 million). A small enterprise is a firm that has fewer than 300 employees, or revenue below 30 million yuan ($3.6million), or capital stock below 40 million yuan ($4.8 million).

commercially successful product innovation outcomes. This distinction is important given the evidence that Chinese firms sometimes fail to effectively bring to market their innovations (Sun and Du 2010). Patents are measured as the number of new invention patents granted by the State Intellectual Property Office of China from 2004 to 2006, while new product sales refers to revenue from new product sales in a calendar year. Patents are a measure of the technical and conceptual aspects of innovation and incorporate both product and process innovations. In comparison, process innovation is not included in new product sales. It mostly reflects the market success achieved by introducing new products. In China, the designation of new products is obtained through certification by the central or provincial government.

The independent variables used to test our hypotheses are the fraction of managers who are shareholders, the fraction of managers who are subject to performance-based pay, the fraction of non-manager employees who are shareholders, and the fraction of non-manager employees subject to performance-based pay. Managers are defined as employees who supervise a positive number of other employees.

The nature of the survey questions limits the number of control variables at our disposal. Consistent with the literature on firm innovation, our control variables include log R&D expenditures (an input to patent outputs and new product sales), log assets (a measure of firm size), age of firms, and industry dummy variables. Following Shapiro et al (2015) who find ownership concentration is an important determinant of patenting, we include the shareholding of the largest shareholder but only in the patent equation, because the relevant principal agent problem for patents is between owners and managers. Ownership concentration is specified to be non-linear to account for possible Principal-Principal issues, such that patenting may increase with ownership concentration as owners focus on the long-term, but may decline after a point where high levels of ownership concentration result in owners' attention being diverted to potential gains from the expropriation of minority shareholders. To account for firm heterogeneity in innovation capacity, and to minimize the need for other firm-specific control variables, we use lagged patent counts and new product sales as controls. Although the lagged dependent variables likely account for considerable firm heterogeneity, we nevertheless include dummy variables for 27 2-digit industries. In addition, all other independent variables are lagged to avoid problems of endogeneity.

3.3 Empirical Specification and Estimation

Patent counts are either zero or positive. The zeros occur as a corner solution when firms decide not to pursue patenting or when innovation efforts fail to generate a significant breakthrough. Because in our sample 75.4% of firms report no new innovation patents from 2004 to 2006, it is important to account for these zeros in the econometric model. Thus we specify two models of patents. The first is a classic Poisson model

$$\text{Prob}(\text{Patents}(i,t)-\text{patents}(i,t-2))=f[(X(i,t-2))'\beta]. \qquad (1)$$

The function f is the distribution function of Poisson, the vector X contains the independent variables implied by the hypotheses and control variables, and vector β is the model parameters. Following the lead-lag structure used in Lerner and Wulf (2007), we specify that new patents between 2004 and 2006 are a function of independent and control variables in 2004.

The classic Poisson model posits that patents arrive at a probability independent from the existing patent stock. In particular, the chance of getting the first patent from an R&D project is the same as getting the 100^{th} patent. If there exists learning-by-doing or returns to scale in innovation, firms with a large patent stock are more likely to obtain new patents, violating the assumption of the Poisson model. For the private SMEs in our sample, it is plausible that the first patent is the most difficult one to obtain. To account for the possible nonlinear nature of innovation, we use the Probit-Possoin Hurdle model as a second model for new patents.[11] To determine whether a firm will report new patents at all during the sample period, we use a Probit model as the first stage of the hurdle model. In particular, the chance of observing positive new patents is a function of the independent and control variables

$$\text{Prob}(\text{Patents}(i,t)-\text{patents}(i,t-2)>0)=\Phi[(X(i,t-2))'\gamma] \qquad (2)$$

where Φ is a normal distribution function, X the same vector as in (1), and γ the parameter vector.

[11] Another possibility is use a negative binomial model as the second stage of the hurdle model. We do not use such a hurdle model because it yields a log-likelihood value lower than the Probit-Poisson hurdle model.

After a firm clears the "hurdle" to report new patents, we specify that the number of patents is described by a truncated Poisson distribution, conditional on X. To be specific, the second stage of the hurdle model is:

$$\text{Prob}(\text{Patents}(i,t)\text{-patents}(i,t\text{-}2)|\text{Patents}(i,t)\text{-patents}(i,t\text{-}2)>0)$$
$$=g[(X(i,t\text{-}2))'\delta] \qquad (3)$$

in which g is the zero-truncated Poisson distribution function, X the same vector as defined in (1), and δ the vector of parameters.

Unobserved heterogeneity in innovation activity can lead to bias in estimating the determinants of innovation, and in particular the effect of compensation practices. It is possible that firms with strong potential in innovation adopt compensation schemes that incentivize innovation. In linear regressions, fixed effects can account for time-constant heterogeneity across firms. However, because both the Poisson model and the hurdle model are nonlinear, the inclusion of fixed effects would not provide consistent estimators of parameters of interest. In addition, we do not have sufficient annual observations in our panel to apply bias correction procedures such as Hahn and Newey (2004). To control for unobserved heterogeneity, we therefore include the number of patents held by firms in 2004 as a measure of initial capacity in innovation. We recognize that this is an imperfect way to account for firm heterogeneity and hence caution is required in interpreting results.

Similar to patent counts, new product sales take non-negative values with zeros representing corner solutions. In our study, 52.9%, 47.6%, and 45.7% of firms had zero new product sale in 2004, 2005, and 2006, respectively. Because new product sales, unlike patents, is a continuous variable, we estimate two models for continuous variables with corner solutions. The first is the conventional Type I Tobit model and the second the Probit-lognormal hurdle Model.

The Type I Tobit model specifies that

$$\text{new product sales}^*(i,t)=X(i,t-1)'\zeta+u(i)+e(i,t) \tag{4}$$

where new product sales*(it) is the latent variable underlying new product sales of firm i in period t; X(i,t-1) the vector of one period lags of explanatory variables in section 3.2[12]; ζ the vector of parameters; u(i) the random effect and; e(it) an iid error. As in the model for patents, we include the lag of patent stock in X(i,t-1) to control for firm heterogeneity. The value of new product sales*(i,t) is observed when it is positive:

new product sales (i,t)= new product sales *(i,t), if new product sales*(i,t)>0

new product sales (i,t)=0, if new product sales *(i,t)<=0

The Tobit model above is restrictive because a single stochastic process is assumed to determine both whether new product sales are positive, and the quantity of new product

[12] Our choice of lag length was dictated by the time period of the survey data. Lags of longer than one year severely reduced sample size, although the results were not affected.

sales (Wooldridge, 2001). Thus, if a variable has positive effects on whether new product sales are positive, then it must also increase the amount of new product sales. Because the technological success of creating a new product and the determination of its sales are likely to be different, we estimate the Probit-lognormal hurdle Model to allow for such differences. For the first stage of the Probit-lognormal hurdle, we estimate a Probit model for the probability of observing positive new product sales:

$$\text{Prob(new product sales (i,t)>0)=Phi[(X(i,t-1))'}\eta] \qquad (5)$$

where η is the parameter vector. The second stage of the Probit-lognormal hurdle model is a log-normal regression for firm-year observations reporting positive new product sales

$$\text{new product sales (i,t)=exp[(X(i,t-1))'}\theta\text{+u(it)]} \qquad (6)$$

in which θ is the vector of parameters, and u(it) the error term.

4. EMPIRICAL RESULTS

4.1 Summary Statistics

In Table 1, we report means, standard deviations, and the correlation matrix of the variables in our sample. The number of new invention patents is defined as the change in patents owned from 2004 to 2006. For other variables, we report the statistics for the years 2004, 2005, and 2006 combined.

The mean number of invention patents is 1.19, while on average patents increased by 0.97 from 2004 to 2006. The average of annual new product sales was equal to 32.59 million yuan ($3.94 million)13. On average, 18.2% of the managers are shareholders, while 58.4% are subject to performance-based pay. For non-manager employees, an average of only 2.7% own shares of the firm, but an average of 34.3% are subject to performance-based pay.

Ownership concentration is high in these SMEs, with the largest shareholder accounting for 58.9% of the shares on average. On average the firms spent 3.84 million yuan ($0.46 million) on R&D expenditure. With an average age of about 10 years, the firms in our sample were young. Applying the relevant definition of SMEs in China during the time, most of the firms are small or medium-sized. The average value of assets was 163.7 million yuan ($19.79 million).

4.2 Regression Results.

We present the main regression results for private firms only in Table 2. We report results for the simple Poisson model of patents in column (1). The first stage (Probit) and second stage (zero-truncated Poisson) of the Probit-Poisson hurdle model are reported in columns (2) and (3). The coefficient on a right-hand-side variable is its marginal effect on patents at the sample mean. Because the log-likelihood of the Probit-Poisson model (-507.05, reported in column 3) is higher than the log-likelihood of the simple Poisson

[13] We use the CPI to deflate all monetary variables to obtain figures in 2004 yuan.

model (-932.60, in column 1), the fit of the Probit-Poisson model is better than the simple Poisson model.

In the simple Poisson model, the shareholding of managers has no significant effect on patents, while performance-based pay has a positive effect. The coefficient of 0.01 implies that a 1% increase in the proportion of managers subject to performance-based pay is associated with an increase in patents of 0.01. Thus, the simple Poisson model provides no support for either H1 or H2, but this is not our preferred model.

The Probit-Poisson hazard model paints a somewhat different picture. As indicated by column (2), the only factors contributing to whether a firm files new patents are past patents, past R&D expenditures, and lagged age. However, conditional on a positive number of new patents, as reported in column (3) both shareholding and performance-based pay for managers are positively related to patents. In addition to the differences in the variables of interest, we also find that the significant ownership effects found in Model (1) are no longer found in Model (3).

Therefore, we conclude that H1 (positive effect of manager shareholding on patents) is supported when we focus on firms with positive patent counts. H2 is rejected in both specifications because we find performance-based pay for managers had a positive effect on patents. We note that these results are consistent with those reported by Lin et al (2011), who found that incentive compensation schemes for CEOs also increased patenting activity in China, but are not consistent with the agency theoretic view that led to H2. We speculate that this result is partly attributable to the specific institutional context of Zhejiang province, where monetary rewards were provided to firms who filed patents. In addition, as provided by a series of documents issued by the Ministry of Science and Technology between 1996 and 2010, the central government also grant tax benefits to companies that are certified as high-tech. Thus, patenting activity improves the short run financial performance of the firm, creating an incentive for managers with performance-based pay incentives to file for patents.

We present the regressions for new product sale in columns (4) to (6). Column (4) corresponds to the Tobit model. Columns (5) and (6) are the first stage (Probit) and second stage (truncated log normal[14]) of the Probit-log normal hurdle model, respectively. The coefficients in columns (4) and (5) are marginal effects evaluated at the sample mean. We favor the Probit-log normal model because its log-likelihood (-485.51, reported in column 6), is higher than that of the Tobit model (-718.35, in column 4).

In all new product sale regressions, the shareholding of non-managers is statistically insignificant. However, in both the Tobit model (column 4) and the truncated log normal stage of the hazard model (column 6), there is evidence that performance-based pay for non-managers contributed to the amount of new product sales. In the Probit stage of the hazard model (column 5), we find that lagged patents and R&D expenditures are positively related to the chance of firms reporting positive new product sales. Lagged log

[14] Based on the variance inflation factor test, we find no evidence of multicolinearity in the log-normal regression. Note that because other econometric models we use are nonlinear, multicolinearity is not a concern.

assets are negative related to the chance of positive new product sales but positively related to the amount of new product sale in firms with positive new product sales.

Thus we find no evidence in support of H3 (positive effect of shareholding of non-managers on new product sales). While in theory shareholding should provide positive incentives for new product sales, with an average of 2.7% of non-managers holding shares in our sample, very few non-managers are in reality shareholders. Thus, it is possible that such shareholding schemes generate too small an incentive to move new product sales significantly. On the other hand, performance-based pay for non-managers was positively related to the amount of new product sales, lending supporting to H4 (positive effect of performance-based pay of non-managers on new product sale).

Our confidence in these results for both patents and new product sales is heightened by the fact that the signs on most of the other explanatory variables is consistent with previous literature on innovation. In particular, we note that the R&D term is consistently positive and statistically significant, as is the lagged patent term. The latter results point to the persistence of innovative capabilities, a result commonly found in the literature (for example, Geroski et al, 1997).

Similar to Shapiro et al (2015), concentration measured by shareholding of the largest shareholder has a positive but non-linear effect but only in Model (1). We define a firm to have high ownership concentration if the shares owned by the largest shareholder are equal to or above 29%. We choose the cutoff of 29% because it yields the highest log-likelihood among all possible integer cutoff values. Thus for example in equation (1) of Table 2, when concentration is below 29%, a 1% increase in ownership concentration leads to an increase in patents of 0.05, but the effect is reduced to 0.01 for ownership concentration equal to or above 29%. The latter effect is computed as the sum of the coefficient on concentration (largest sh %) and the coefficient on the concentration and high-concentration indictor (high concentration dummy * largest sh %). The negative term is consistent with the possibility that at sufficiently high levels of ownership, owners either become more risk averse or find it more profitable to engage in other activities such as the expropriation of minority shareholders. However, this result is not found in the Probit-Poisson model.

We conduct four sets of robustness checks. In the first, we use all firms from the survey instead of just the domestically-owned private firms reported in Table 2. In Table 3, we add state-owned enterprises and foreign-owned enterprises to the regressions and include indicators for these two types of firms. The results are similar to those reported in Table 2, notably for the variables relevant to our hypotheses. We note as well that we find no systematic evidence to suggest that foreign- or state-ownership in Zhejiang province has any significant impact on innovation activity of any kind. With respect to state ownership, the coefficient on the relevant dummy variable ranges considerably, with both positive and negative coefficients observed.

In the second set of robustness checks, we add the ownership concentration variables to the new product sale regressions and report the results in the first three columns of Table

4. Third, we add lagged new product sales as an additional control for firm heterogeneity in innovation in the new product sale regressions. The results are reported in the last three columns of Table 4.[15] In all sets of regressions, the coefficients are almost always very similar to those in Table 2 in both magnitude and significance levels.

Lastly, in Table 5, we include all four types of incentives in all regressions. In the hypothesis development section, we conjecture that incentives targeting managers do not affect new product sales, while incentives targeting non-managers have no effects on patents. The evidence in Table 5 confirms our conjecture. Because the specifications in Table 5 nest their counterparts in Table 2, we apply the log-likelihood ratio test to compare the fits of the two sets of specifications. The test result indicates that the specifications in Table 5 do not provide a statistically better fit than those in Table 2. Thus, the tests confirm our conjecture that incentives for non-managers do not affect patents, and that incentives for managers do not affect new product sales.

We conclude that there is some evidence in favour of H1 and H4, and no evidence in favour of H2 and H3. However, in the case of H2 the sign on the relevant coefficient is the opposite of what had been predicted by our agency-theoretic approach, and is statistically significant. Thus we conclude that managerial incentives in the form of both shareholding and performance-based compensation encourage innovation in the form of

[15] We could not add an indicator for positive lagged new product sales to the Probit model for new product sales because it would be perfectly correlated with another independent variable, R&D expenditures.

patents, and that non-managerial incentives in the form of performance-based compensation encourage innovation in the form of new product sales.

5 DISCUSSION AND CONCLUSIONS

As economic growth in China slows, innovation is becoming even more important for Chinese firms and the Chinese economy. Over the past decade, a rapidly expanding literature has shed light on various aspects of innovation in China. In this paper we focus on the relatively neglected question of whether incentives are successful in promoting innovation. We exploit a unique dataset of 288 private SMEs from Zhejiang China to study the impact of two incentive schemes (shareholding and performance-based compensation), directed at two categories of employees (managerial and non-managerial), on two measures innovation (patents and new product sales).

We have suggested that agency theory provides a useful approach to examining the role of innovation incentives, and we have also suggested why an agency theoretic argument might apply in China. We therefore employ an agency theoretic framework to suggest that managerial incentives in the form of shareholding will promote patenting activity by encouraging managers to engage in uncertain and risky innovation activities (H1). At the same time, we argue that performance-based compensation will divert management away from such activities and will lower patenting activity (H2). In fact, we find that *both* shareholding and performance-based pay for managers are positively associated with new patents granted. While the former result (H1) is consistent with the empirical literature in developed economies, the positive effect of performance-based pay contradicts both the hypothesized negative effect based on agency theory, as well as empirical evidence in developed countries, notably Hoskisson et al (1993).

Much of the theory behind the hypothesized negative effect of performance-based pay on innovation relies on the view that managers as multitasking agents tend to respond more to short-term goals such as profits at the expense of long-term innovation. One possible explanation for our results is that because ownership is typically concentrated in our sample firms (and other Chinese firms), monitoring is more effective and thus incentives based on shorter term measures may not divert managers away from long run goals. Such an explanation is largely consistent with current theory, and does not recognize any uniquely Chinese institutions or culture. However, we suggest that in fact the reason for our results is the institutional context of Zhejiang province and China, where monetary rewards and tax benefits are provided to firm who file patents and innovate, thus linking patenting to short run financial performance. We also note that similar results with respect to performance-based pay for CEOs are reported for the whole of China by Lin et al (2011), and that similar incentives to patenting exist at the national level. Thus, we conclude that an understanding of the role of innovation incentives must include both firm- and country-specific incentives.

We also find that incentives for non-managers in the form of performance-based pay have a positive effect on new product sales. In this case, we suggest that the incentive mechanism not only aligns the long run interests of the firm with those of its employees, it does so because the innovation measure being considered can respond to increased effort and efficiency of non-management employees. It is therefore an effective incentive. We note, however, that our results in this regard are contrary to those found in Japan by Kanama and Nishikawa (2015), suggesting the need for further research.

We are unable to find any evidence that non-managerial shareholding is related to new product sales. Relative to managerial employees, non-managers will typically hold fewer shares, and will not have control over the allocation of long-run resources that may lead to long-run performance outcomes. This lack of control over other decisions not necessarily related to innovation may limit the incentive effects of non-managerial shareholding, at least when innovation is measured by new product sales.

While our focus has been on incentives, we also controlled for a variety of factors identified in the literature, such as R&D, lagged patenting activity, and ownership structure. Our results with respect to these variables are for the most part consistent with extant international literature, and suggest an innovation process at the firm level that has some commonality across countries, including China. In particular we find that R&D expenditures are important determinants of innovation outcomes, and that innovation tends to be persistent, suggesting that firm-specific innovative capabilities are important. However, consistent with the Principal-Principal literature (Peng and Sauerwald, 2013), we do find some evidence suggestive of the possibility that as ownership concentration reaches a critical level, owners focus less on innovation (patenting), perhaps at the expense of minority shareholders. In this regard, it would appear that Chinese SMEs are not very different from firms in other emerging markets.

Our results therefore highlight the theoretical importance of the idea that different types of incentives impact the innovation performance of firms through different channels (managers and non-managers), and that these incentives also have differential effects on innovation. Most of our results are consistent with standard agency theory and with the general literature on firm-level innovation, suggesting that the innovation process in Chinese firms is not totally unique. At the same time, we do find some evidence that institutional context matters, so that future research on the determinants of the innovation performance of Chinese firms may profitably explore the question of the degree to which there is a uniquely Chinese innovation model. Our results tend to suggest that this exploration should begin with the government, the ways in which it provides incentives for innovation, and the ways that these incentives interact with firm-specific incentives.

Our results have implications for the general literature on innovation and incentives. In particular, we find evidence that the impact of incentives is contingent on the nature of the incentive, the employees at whom it is directed, and the measure of innovation employed. This suggests that future research in any country should carefully account for these contingencies. At the same time our results also suggest that future research seeking to develop a full understanding of the role of innovation incentives must carefully and explicitly define the full range of relevant incentives, both internal and external to the firm. Such an approach will in turn provide a basis for understanding the role of country-specific factors that determine innovation outcomes.

Our study also contributes to the literature on innovation in China in three ways. First, previous studies on innovation in China have typically not examined the effects of incentives on innovation, with the exception of Lin et al (2011) who restrict their analysis to CEO incentives. This paper therefore adds to the very limited evidence on incentives and innovation in China. Our results broadly confirm that monetary incentives have positive effects on the innovative activities of private Chinese, but not always in ways that are consistent with agency theory. We suggest that government incentives also matter. At the same time, we also raise the question of the degree to which generalized theories are always applicable in a Chinese context. Second, we contribute to the understanding of firms that are expected to be major contributors to China's innovation goals: private SMEs. Private firms, particularly those that are small and domestically owned, have received very little attention in the literature on Chinese innovation. Our results suggest that in many, but not all dimensions, the determinants of innovation in these firms is similar to that found in more developed economies. Finally, we contribute to the understanding of how managers in China, and perhaps elsewhere, could design incentive systems that achieve well-understood goals by considering their different impacts, notably on two types of innovation outcomes, patents and new product sales. Our results suggest that in China different measures of innovation are not necessarily substitutable and, more importantly, do not necessarily respond to the same incentive systems. Chinese managers and those who study them, should be aware of these differences, while future research should determine the extent to which they hold across different national contexts.

We recognize that our results are obtained from survey data drawn from a region that is quite different from the rest of China, and future studies using broader samples would certainly be welcome. We also recognize that the sample period is relatively short and that future studies should attempt to extend the time frame.

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Figure 1
Hypotheses: Summary

	Shareholding	Performance-Based Pay
Managers	Patents (H1 +)	Patents (H2 -)
Non-Managers	New Product Sales (H3 +)	New Product Sales (H4 +)

Table 1: Descriptive statistics and correlation matrix

Variable	Obs.	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13
1, invention patents	1030	1.19	4.32	1.00												
2, new invention patents, 2004-2006	330	0.97	3.31	0.93*	1.00											
3, new product sales, millions of yuans	1030	32.59	89.42	0.15*	0.10	1.00										
4, R&D expenditure, millions of yuans	1030	3.84	10.65	0.15*	0.13*	0.57*	1.00									
5, holding of the largest shareholder, %	1030	58.88	21.21	-0.07	0.01	-0.07	-0.12*	1.00								
6, proportion of managers who are shareholders, %	1030	18.23	23.08	0.02	-0.02	0.01	0.04	-0.21*	1.00							
7, proportion of managers subject to PBP, %	1030	58.41	38.41	0.07	0.08	0.13*	0.15*	-0.11*	0.13*	1.00						
8, proportion of non-managers who are shareholders, %	1030	2.66	12.25	0.24*	0.15*	0.09*	0.09*	-0.09*	0.22*	-0.07	1.00					
9, proportion of non-managers subject to PBP, %	1030	34.28	40.57	0.04	0.06	0.17*	0.15*	-0.08*	0.08*	0.35	0.05	1.00				
10, firm age	1030	9.66	7.35	0.14*	0.04	0.09*	0.11*	-0.11*	0.05	0.15*	0.05	0.05	1.00			
11, total asset, millions of yuans	1030	163.70	429.19	0.08*	0.06	0.38*	0.42*	-0.05	-0.06	0.05	0.04	0.04	0.06	1.00		
12, indicator for State-Owned Enterprises	1030	0.04	0.21	-0.04	-0.06	-0.08*	-0.06	-0.05	0.15*	-0.04	0.06	-0.01	-0.08	-0.04	1.00	
13, indcator for Foreign-Owned Enterprises	1030	0.28	0.30	-0.003	0.04	0.01	-0.01	-0.01	-0.03	-0.01	-0.04	0.03	-0.11*	-0.01	-0.07	1.00

Note: * indicates statistical significance at 5% level.

Table 2: Benchmark regressions: private domestic firms

	Patents	Patents	Patents	NPS	NPS	NPS
	Poisson	Hurdle 1	Hurdle 2	Tobit	Hurdle 1	Hurdle 2
	(1)	(2)	(3)	(4)	(5)	(6)
lag shholder manager %	-.0003	-.003	0.01			
	(0.004)	(0.005)	(0.003)***			
lag PBP manager %	0.01	0.0008	0.01			
	(0.005)***	(0.003)	(0.004)***			
lag shholder nonmanager %				0.03	0.02	-.001
				(0.02)	(0.02)	(0.004)
lag PBP nonmanager %				0.01	0.002	0.004
				(0.005)***	(0.002)	(0.002)**
lag largest sh %	0.05	-.003	0.03			
	(0.02)**	(0.01)	(0.02)			
lag high concentration dummy × largest sh %	-.04	0.002	-.02			
	(0.02)**	(0.01)	(0.02)			
lag patents	0.14		0.1	0.02	0.15	0.01
	(0.01)***		(0.01)***	(0.02)	(0.06)***	(0.01)
lag patents>0		2.98				
		(0.22)***				
lag ln RnD expenditure	0.09	0.14	0.05	0.49	0.55	0.34
	(0.04)**	(0.04)***	(0.06)	(0.06)***	(0.06)***	(0.04)***
lag ln asset	0.03	-.02	0.09	0.11	-.23	0.28
	(0.09)	(0.08)	(0.09)	(0.09)	(0.1)**	(0.05)***
lag ln age	-.03	0.16	-.26	0.67	0.11	0.1
	(0.11)	(0.07)**	(0.16)*	(0.22)***	(0.12)	(0.11)
sector dummies	included	included	included	included	included	included
Obs.	605	558	173	574	517	301
Log-likelihood	-932.60		-507.05	-718.35		-485.51

Notes: [1] The variables shown on the top row are dependent variables. NPS stands for new product sales. [2] *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels. The standard errors are clustered at 2-digit industry level. [3] The estimators are Poisson, Probit, truncated Poisson, Tobit, Probit, and log-normal regression, respectively. [4] The log-likelihood in column (3) is for the overall hurdle model for patents, comparable to the log-likelihood in column (1). The log-likelihood in column (6) is for the overall hurdle model for new product sales, comparable to column (4).

Table 3: Robustness check 1: all firms

	Patents	Patents	NPS	NPS
	Hurdle 1	Hurdle 2	Hurdle 1	Hurdle 2
	(1)	(2)	(3)	(4)
lag shholder manager %	-.003	0.01		
	(0.004)	(0.004)***		
lag PBP manager %	0.002	0.009		
	(0.002)	(0.004)**		
lag shholder nonmanager %			0.02	-.0008
			(0.01)	(0.004)
lag PBP nonmanager %			0.001	0.004
			(0.002)	(0.002)**
lag largest sh %	-.008	0.02		
	(0.01)	(0.02)		
lag high concentration dummy × largest sh %	0.007	-.01		
	(0.01)	(0.02)		
lag patents		0.1	0.15	0.01
		(0.007)***	(0.05)***	(0.01)
lag patents>0	2.93			
	(0.19)***			
lag ln RnD expenditure	0.14	0.08	0.56	0.37
	(0.04)***	(0.06)	(0.06)***	(0.04)***
lag ln asset	-.02	0.06	-.25	0.26
	(0.07)	(0.08)	(0.1)**	(0.05)***
lag ln age	0.12	-.40	0.11	0.06
	(0.07)	(0.19)**	(0.1)	(0.09)
lag state-owned enterprises	-.97	1.27	-.64	-.36
	(0.28)***	(0.31)***	(0.42)	(0.39)
lag foreign	0.22	-.07	0.63	-.13
	(0.33)	(0.33)	(0.33)*	(0.25)
sector dummies	included	included	included	included
Obs.	679	195	654	340
Log-likelihood		-614.17		-567.36

Notes: [1] The variables shown on the top row are dependent variables. NPS stands for new product sales. [2] *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels. The standard errors are clustered at 2-digit industry level. [3] The estimators are Probit, truncated Poisson, Probit, and log-normal regression, respectively. [4] The log-likelihood values in columns (2) and (4) is for the overall hurdle model for patents, and the overall hurdle model for new product sales, respectively.

Table 4: Robustness checks 2 and 3: additional controls for new product sales

	NPS	NPS	NPS	NPS
	Hurdle 1	Hurdle 2	Hurdle 1	Hurdle 2
	(1)	(2)	(3)	(4)
lag shholder nonmanager %	0.02	-.001	0.02	-.002
	(0.02)	(0.004)	(0.02)	(0.003)
lag PBP nonmanager %	0.003	0.004	0.002	0.003
	(0.002)	(0.002)**	(0.002)	(0.001)**
lag largest sh %	0.02	0.02		
	(0.03)	(0.01)		
lag high concentration dummy × largest sh %	-.02	-.01		
	(0.03)	(0.01)		
lag patents	0.15	0.01	0.15	0.01
	(0.06)***	(0.01)	(0.06)***	(0.01)
lag new product sale				0.11
				(0.02)***
lag ln RnD expenditure	0.55	0.37	0.55	0.27
	(0.06)***	(0.04)***	(0.06)***	(0.04)***
lag ln asset	-.23	0.3	-.23	0.29
	(0.11)**	(0.05)***	(0.1)**	(0.05)***
lag ln age	0.11	0.04	0.11	-.01
	(0.12)	(0.1)	(0.12)	(0.09)
sector dummies	included	included	included	included
Obs.	517	301	517	301
Log-likelihood		-483.98		-471.45

Notes: [1] The variables shown on the top row are dependent variables. NPS stands for new product sales. [2] *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels. The standard errors are clustered at 2-digit industry level. [3] The estimators are Probit, log-normal regression, Probit, and log-normal regression, respectively. [4] The log-likelihood values in columns (2) and (4) is for two hurdle model for new product sales, respectively.

Table 5: Robustness check 4: including all incentives

	Patents	Patents	NPS	NPS
	Hurdle 1	Hurdle 2	Hurdle 1	Hurdle 2
	(1)	(2)	(3)	(4)
lag shholder manager %	-.003	0.01	0.003	-.002
	(0.005)	(0.005)**	(0.006)	(0.003)
lag PBP manager %	0.001	0.01	-.0006	-.0003
	(0.003)	(0.004)***	(0.003)	(0.002)
lag shholder nonmanager %	0.0002	0.001	0.02	-.001
	(0.004)	(0.007)	(0.01)	(0.004)
lag PBP nonmanager %	-.0008	-.004	0.002	0.004
	(0.002)	(0.003)	(0.003)	(0.002)**
lag largest sh %	-.004	0.03		
	(0.01)	(0.02)		
lag high concentration dummy × lag largest sh %	0.003	-.02		
	(0.01)	(0.02)		
lag patents		0.1	0.15	0.01
		(0.02)***	(0.06)***	(0.01)
lag patents>0	2.98			
	(0.21)***			
lag ln RnD expenditure	0.14	0.06	0.55	0.36
	(0.04)***	(0.08)	(0.07)***	(0.04)***
lag ln asset	-.02	0.08	-.22	0.3
	(0.08)	(0.09)	(0.11)**	(0.05)***
lag ln age	0.16	-.21	0.11	0.04
	(0.08)**	(0.14)	(0.12)	(0.1)
sector dummies	included	included	included	included
Obs.	558	173	517	301
Log-likelihood		-503.36		-484.81

Notes: [1] The variables shown on the top row are dependent variables. NPS stands for new product sales. [2] *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels. The standard errors are clustered at 2-digit industry level. [3] The estimators are Probit, log-normal regression, Probit, and log-normal regression, respectively. [4] The log-likelihood values in columns (2) and (4) is for the overall hurdle model for patents, and the overall hurdle model for new product sales, respectively.