How Can Local Policy Uncertainty Encourage Firm Innovation: A Competitive Advantage Channel

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Abstract: Exploring turnovers of city heads in China, we find that local policy uncertainty can encourage firm innovation. This positive relation concentrates in state-owned enterprises, which possess competitive advantage in spike of local policy uncertainty because of their innate government connections and therefore better understanding of future policy changes. Within SOEs, the effect is more pronounced for those located in cities where local official's turnover is more frequent and local non-SOE competitors exist, and with higher sales growth and lower market shares. Our findings indicate that heightened local policy uncertainty opens up opportunities for firms with information superiority to strategically explore competitive advantages through innovative activities.

Keywords: Local Policy Uncertainty; Firm Innovation; Competitive Advantage; Information Superiority; State-owned Enterprises

JEL Code: G31; G38; G34

1. Introduction

It is well-established that uncertainty can affect the value of real options to wait, which delays investment and hinders economic growth.[1] Cross-country analysis shows that the same logic applies to innovative investments (Bhattacharya et al., 2017). In this paper, we revisit the negative link between uncertainty and investment and ask whether there are situations in which uncertainty can encourage investment, specifically, firm innovation. We show that in spike of local policy uncertainty, firms with innate government connections and therefore better understanding of future policy changes can strategically establish first-move advantages over their rivals through innovative activities. That is, local policy uncertainty can encourage firm innovation through a *competitive advantage* channel.

Theoretically, whether local policy uncertainty encourages or impedes firm innovation can be controversial. The traditional real option theory argues that uncertainty increases the value of the option to wait. If innovative investments are not fully reversible, firms will be cautious and choose to *wait-and-see* on investment (Bernanke, 1983; Dixit and Pindyck, 1994; Abel and Eberly, 1996). Therefore, as revealed by Bhattacharya et al. (2017), policy uncertainty can discourage innovative investments in the same way as regular investments.

However, several prior researches indicate that the effect of uncertainty on investment can be positive, especially for those like innovative projects that are partially reversible because of lags between investment and project completion (Pindyck, 1993; Bar-Ilan and Strange, 1996). Specifically, when including strategic considerations into analyses, in spike

[1] For theoretically literature, see Bernanke (1983), McDonald and Siegel (1986), Dixit and Pindyck (1994), Abel and Eberly (1996), among others; for empirical literature, see Julio and Yook (2012), Baker, Bloom, and Davis (2016), Gulen and Ion (2016), Jens (2017), among others.

of policy uncertainty, for firms with better understanding of future policy changes, the options to wait are less valuable, and the preemptive effect tends to be significant (Kulatilaka and Perotti, 1998; Weeds, 2002; Folta and O'Brien, 2004). A natural conjecture is then that heightened policy uncertainty can create an opportunity for firms with better understanding of future policy changes to strategically explore competitive advantages through innovative activities.

Our focus on China is motivated by the availability of a great number of state-owned enterprises (henceforth SOEs) which possess innate and stable connections with the government because their managers are semi-officials in the bureaucratic system (Aharony et al., 2000; Li and Zhou, 2005; Allen et al., 2017). Specifically, we conjecture that SOEs possess competitive advantages in spike of local policy uncertainty for several reasons.

First, the innate and stable connections of SOEs with the government enable them to communicate with government officials easily even when political turnover occurs because they are always owned by the government no matter who is in power (Liu et al., 2017). For non-state owned enterprises (henceforth non-SOEs, the counterparties of listed firms in the U.S.), however, although they can voluntarily build connections with the government (e.g. appointing government directors, and making political contributions), these connections are costly and easily broken when political turnover occurs (Piotroski and Zhang, 2014).[2] Therefore, the stable connections provide SOEs with information superiorities over their

[2] In China, as the promotion of local politicians depends largely on their GDP performance (Li and Zhou, 2005; Xu, 2011), local officials have strong concerns on their promotion prospects and therefore tend to carry out projects in a radical way of *new brooms sweep clean*. Ru (2018) indicates that to increase local GDP quickly over the short term, city secretaries tend to borrow from the China Development Bank (CDB) and in turn invest as much and as early as possible during their terms. Therefore, when political turnover occurs, non-SOEs can suffer tremendous losses due to the break of established political connections. Huang et al. (2015) document that the incentive to get promoted may initiate economic activities that can lead to immediate, "real" social outcomes by renationalizing privatized firms. Zhu and Zhang (2017) interview a Singaporean entrepreneur doing operations in China who complains that "when a new leader came, we were even asked to pay back the waived taxes in the previous years by the former head.

non-SOE rivals, which are more valuable when local policy uncertainty heightens.

Second, Chinese local officials are appointed and replaced by higher-level Party Committees rather than elected competitively, so both the timing of local official turnovers and the policies of new officials are beyond the control of local enterprises. This opaque political system makes information superiority during high-uncertainty periods more valuable than in countries with public elections.[3]

We utilize a hand-collected dataset on changes of secretaries of prefectural Party Committee (henceforth city heads) in China to identify the effect of local policy uncertainty.[4] There are more than 300 prefecture-level cities in China, and their local officials are replaced in different years, which create both cross-sectional and longitudinal variation in the degree of local policy uncertainty. By matching the dataset with information of listed non-financial firms on A-share market during 1999-2010, we find that firms' innovation outputs increase significantly in the next year of local official turnover: On average, the number of invention patent applications filed increases by 3.05%, and the number of invention patent applications filed and eventually granted increases by 3.67%.[5]

We then validate the causal effect of local policy uncertainty on firm innovation in the

[3] Unlike developed economies, such as the U.S. or western European countries where politicians express their views extensively on TV shows, newspapers, and interviews to attract voters around elections, local politicians in China have no incentives to do so as there is no public elections. Also, they seldom express their views publicly because the majority of them are members of the Chinese Communist Party, which has strict rules to punish members who publicly express improper views. Therefore, except for government staffs that can get access to internal documents, personal contact with local officials, outside investors can only learn limited basic information of local officials such as education background, work experience from the government website, or read their expressions on state-controlled media, which are less informative (You et al., 2018). Therefore, even if the appointment has been made and people know who the new leader is, market participants can still have concerns on what the new leader will do in his or her tenure. We will further discuss this issue in Section 2.

[4] The secretary of the Party Committee is the most powerful official in a prefectural city in China, which equivalents to a mayor in the United States (Ru, 2018). While the government is responsible for the routine administrative work (economy, public health, education, social security, etc.), secretaries of Party Committee have the power to scrutinize mayors, and have significant influence on important affairs. The mayor usually serves as the vice secretary of Party Committee. Thus, our main interest lies in the turnover of party secretaries.

[5] The disclosure of R&D expenditure was not mandatory for listed firms on A-share market until 2007. We use data between 2006 and 2013 and find that local policy uncertainty in China is positively associated with innovation input. We report these results in Table 6.

following several sessions. Primarily, we conduct two-fold tests. To address the concern that firms' innovation activities may trigger the turnover of local officials, since good innovation performance of local firms may demonstrate local officials' ability to promote economic development thus increasing the likelihood of promotion, we conduct a dynamic test around the year when the turnover of city head occurs and find that local policy uncertainty indeed precedes the increase in innovation outputs. Next, firms experiencing local policy uncertainty could be fundamentally different from others, which raise omitted variable concerns. Therefore, we construct a propensity-score-matched sample and re-examine the baseline findings and obtain similar results.

We then investigate the heterogeneous effects of local policy uncertainty on firm innovation between SOEs and non-SOEs. When we partitioning the sample according to the property of ultimate controlling shareholders, the empirical analyses show that the positive correlation between local policy uncertainty and firm innovation is significant only for SOEs, indicating that SOEs actively engage in more innovative activities under heightened local policy uncertainty, suggesting that the preemptive effects of doing so are prominent enough due to their better understanding of future policy changes.

We further explore cross-sectional differences within SOEs to see whether these patterns are consistent with the predictions of theoretically models of strategic considerations under uncertainty. Kulatilaka and Perotti (1998) theoretically predict that the opportunity cost of waiting for firms possessing competitive advantage over competitors' increases with the degree of uncertainty, since delaying investments prevents the firm from obtaining early-mover advantages. Also, immediate actions typically have strategic preemptive effects under imperfect competition. Moreover, more valuable growth options encourage investment, allowing firms to take better advantage of future growth opportunities in the industry (Folta and O'Brien, 2004). Therefore, the main effect should be more pronounced in logical subsamples: (1) when the degree of uncertainty is high; (2) in the presence of non-cooperative large competitors; and (3) for firms possess higher growth opportunities. We calculate each city's frequency of city head turnover during the sample period to proxy for the degree of uncertainty, and check for whether there are listed non-SOEs within the same 2-digit industry located the same city. Consistent with our conjectures, the effect of local policy uncertainty is significant only for SOEs located in cities with high-frequency political turnover and with listed local non-SOE competitors, and possess higher sales growth.

We also consider whether the increase in innovation is driven by industry leaders or followers. Weeds (2002) predicts that when acting non-cooperatively, leaders may hold back from investing in the fear of starting a patent race, while the threat of rival innovation reduces the follower's option value of delay, tending to hasten its investment. Therefore, the initiation of patenting activities in spike of local policy uncertainty is more likely driven by industry followers. Indeed, we find that the effect is more pronounced for SOEs with below-median market shares within an industry. These findings confirm that local policy uncertainty encourages firm innovation through inducing strategic considerations of SOEs.

As we have mentioned above, the selection of Chinese local officials is immune from lobbying, local political turnover is largely exogenous to local firms. Nevertheless, there are still endogeneity concerns. To further address this issue, following Ru (2018), we capture the exogenous component of local policy uncertainty by exploring predetermined turnover cycles of city heads, which occur every five years on average and depend solely on past information uncorrelated with concurrent economic conditions. To calculate the predicted first year of the current city head, we take the first year of the city head in the previous term and add five years. Therefore, the instrumented local political turnover, *PT_Predict*, equals to one if the city head of firm's location is predicted to be replaced in year t, and zero otherwise. We obtain quantitative similar results by regressing predicted local political turnover on firm innovation, which further buttresses our main findings.

We also conduct instrumental variable two-stage regressions by introducing two variables as instruments: the age of the predecessor of the current city head when he or she takes the position, and a dummy variable indicates whether local political turnover is induced by the turnover of provincial-level secretary of Party Committee. Age affects the likelihood of political turnover because old officials have to retire (Li and Zhou, 2005). The likelihood of city-level turnover is associated with that of provincial-level because newly-appointed higher-level politicians tend to replace several city heads simultaneously to fulfill their political goals. We obtain estimation results that are consistent with our predictions.[6] In addition, we confirm the main findings by employing different econometric specifications, various subsamples, and alternative definitions of main variables.

To further strengthen our main arguments, we examine whether patenting in spike of local policy uncertainty really brings about competitive advantages for SOEs. We find that invention patents that filed during periods of high local policy uncertainty contribute to

[6] We report these results in Table A2 in the Appendix. We notice that although IV estimates provide suggestive evidence on causal inference, they tend to estimate the local average treatment effects for a narrow set of subgroup of firms whose decisions are actually respond to the instrument (Imbens and Angrist 1994). Therefore, these estimates likely represent the upper bound of the main effect and are unlikely to represent the average effect for the full sample. We believe the effect of local policy uncertainty is better characterized by the main results and the estimation based on predicted timing of local political turnover.

higher sales growth and more product market shares for SOEs, but not for non-SOEs. These results further confirm that SOEs increase their innovative activities under heightened local policy uncertainty for strategic considerations.

Last, we discuss several alternative explanations of our findings. We notice that the documented effects can be driven by local officials' career concerns, as they tend to increase local GDP quickly over the short term, and increased innovation can be outcomes of such incentives. However, we fail to observe more pronounced effects for younger local officials who should have stronger career concerns, and the main effects hold even for higher-level SOEs that are out of control by local governments. The latter evidence is inconsistent with the career concern view in particular, but strengthens the competitive advantage view because higher-level SOEs have better access to obtain private information regarding city-level policy developments and seize opportunities on local product markets in spike of local policy uncertainty. We then examine whether new officials help firms alleviate financial constraints and increase innovation, and find this story is not supported by the evidence. Alternatively, we also investigate whether local policy uncertainty exacerbates financial constraints, which can substitute for external governance and help improve investment efficiency and encourage innovative investments. However, the evidence indicates that this effect is not the main driver of our findings.

Although our main findings suggest that heightened local policy uncertainty is associated with increased innovation outputs, especially for SOEs, they do not imply that frequent political turnover is beneficial to the economy. Nor do they suggest that stable political connection always encourages innovation. In fact, our findings are driven by SOEs that are more *willing* and more *able* to adapt to external changes (that face more threats from large product-market rivals, possess more growth opportunities and high potential of creating market shares), indicating that market-oriented reforms in the past decades are effective. These findings call for more legal and institutional reforms to improve the operating efficiencies of SOEs, and thus the overall efficiency of the economy.

Our paper contributes to the literature on how uncertainty can encourage certain types of investments. The idea that uncertainty can encourage investment under certain conditions is not new (e.g. Bar-Ilan and Strange, 1996; Kulatilaka and Perotti, 1998; Weeds, 2002; Folta and O'Brien, 2004; Oriani and Sobrero, 2008; Stein and Stone, 2013). We contribute to this literature by providing a clear empirical setting and reveal a specific channel that can yield a positive relation between uncertainty and innovative investments.

Our paper is closely related with Bhattacharya et al. (2017). Using a cross-country dataset, they find that industry-level technological innovation drops significantly during times of heightened policy uncertainty associated with national elections. As China is not included in their sample, our paper serves as an out-of-sample test.[7] Our results indicate that the *competitive advantage* channel can dominate the classical *wait-and-see* channel in an environment where government intervention is prominent and stable political connections are pervasive. Our findings might be generalizable to several countries where local governments play an important role in economic activities.

Our paper is also related with two concurrent papers concerning how policy uncertainty affects firm innovation in the U.S. Atanassov et al. (2016) use gubernatorial elections as the

[7] Also, we focus on a single country where all firms are subject to similar institutions and macroeconomic conditions, our setting mitigates the omitted variable problem typically associated with cross-country studies.

source of policy uncertainty and show that policy uncertainty *encourages* firm-level innovative activities. Xu (2017) finds that an increase in economic policy uncertainty (EPU) results in *lower* innovative activities. In comparison with local policy uncertainty, the EPU index captures the possibility of country-level changes to economic policy, which is often driven by non-political events (Jens and Page, 2017). Therefore, it is less likely for political-connected firms to possess information advantage when facing with overall economic uncertainty. The competitive advantage channel revealed in this paper may reconcile these two seemingly contradictory effects.[8]

Our paper also contributes to the research on factors that can immunize enterprises from adverse effects of policy uncertainty. Amore and Minichilli (2016) find that family firms are more likely than other firms to invest during political uncertainty times, thanks to their lower agency costs and stronger ability to deal with the political system. Wellman (2017) finds that political connections help firms to obtain more information and partially offset the negative effect of political uncertainty on investment. We add to the discussion by revealing that rather than simply mitigate the adverse effects of external shocks, SOEs can *actively* seize strategic advantages in the presence of heightened local policy uncertainty. In view of strategic considerations underlying innovative activities, our paper is related with Grieser and Liu (2016), which argue that firms may seize upon the opportunity offered by the competitors' financial constraints to make more patent applications.

The remainder of the paper is organized as follows: Section 2 discusses institutional background; Section 3 illustrates data and methodology; Section 4 presents empirical results;

[8] We admit that given the observable differences in institutions between China and the U.S., there could be other channels at play which result in differential effects of these two sorts of uncertainties on innovation. Our paper provides an interesting angle to explain such patterns, and calls for more research in this area.

Section 5 discusses possible mechanisms; Section 6 concludes.

2. Institutional Background

2.1 China's political institution

China's political system consists of five layers: the central government, provinces, prefectures, counties, and townships. We focus on the Local policy uncertainty at the prefecture level for two reasons. First, the prefectural government plays a major role in economic development, as it has direct control of SOEs and indirect influence on private sectors through regulation, licenses, and networks (Piotroski and Zhang, 2014). Second, by comparison, the provincial sample is less attractive due to its small sample size and lack of variation.[9] In 2013, there were 333 prefectural regions, including 286 prefectural cities, 14 prefectural areas, 30 autonomous prefectures, and three prefectural leagues.[10]

The top two leaders at the city level are the city's Communist Party Secretary and the mayor. The party secretary, the leader of the communist party, is the most powerful position in each city. The higher-level Party Committee appoints and replaces the party secretary. While the government is responsible for routine administrative work, such as economy, public health, education, and social security, the party secretary has ultimate authority in all the important local affairs, including formulating major economic policies, appointing local officials, and maintaining social stability. The mayor usually serves as the vice party secretary. Additionally,

[9] There are 31 provincial regions in mainland China. Although there are a large number of counties, the information of party secretaries for most counties is not publicly available.

[10] The data is from National Bureau of Statistics of People's Republic of China, for detailed information see http://www.stats.gov.cn/tjsj/tjbz/xzqhdm/201401/t20140116_501070.html. We also include the four province-level centrally administrated cities—Beijing, Tianjin, Shanghai and Chongqing, in our sample. We will refer to these 337 regions as "cities" in the rest of the paper. Our results are robust to the exclusion of these four cities.

although the mayor candidate is generally decided by the higher-level Party Committee and government, he or she must be elected by the local People's Congress, and therefore the timing of mayor turnover is less exogenous. Thus, our primary interest lies in the turnover of the party secretary, who will be referred to as the "city head" for simplicity hence after.

Local officials in China have great power on regional affairs and have significant effects on firm growth. Cull et al. (2015) documents that Chinese local governments provide firms with information about products, markets, and innovation, and help firms to arrange loans. A large empirical literature (e.g. Montinola et al., 1995; Jin et al., 2005; Cheung et al., 2010) also describes how Chinese local officials can provide the helping hand to the economy. However, another strand of literature argues that in some circumstances Chinese local governments can be the grabbing hand. Local governments may ask local firms for informal levies, extra-legal payments, luxury office complexes, travel expenses, and entertainment fees (Cheung et al., 2010; Du et al., 2015).

2.2 Local policy uncertainty and the role of SOEs' innate connections

Local political turnover results in policy uncertainty. It is a common practice for new local officials to propose new economic plans and industrial policies, which are usually different with those of their predecessors. For example, the original official may encourage the production of new energy cars, and the new official may prefer gasoline cars. Because it usually takes time to formulate and announce polices, enterprises do not know the new policies immediately after the official takes office, which creates uncertainty. The uncertainty in our context differs with that in most developed countries. It is mainly about the policies that the new official will adopt instead of the uncertain election outcomes.

Facing with heightened policy uncertainty, SOEs have information advantages over non-SOEs. Thanks to SOEs' innate connection with governments, their managers can easily communicate with local officials during the policy formation process. As a result, they can better predict the future policies. In contrast, it may be difficult for non-SOEs to have access to information superiority, especially when they lose the established connection with government leaders after political turnover occurs. Knowing the future policy developments in advance, SOEs may conduct more innovative investments in order to develop competitive advantages. Innovative investments can contribute to competitive advantages because their outcomes are valuable, unique, and difficult to imitate (Barney, 1991; Lengnick-Hall, 1992; Amit and Schoemaker, 1993). In addition, they have strategic preemptive effects. For example, once the firm acquires a patent, it can prevent competitors from using similar technologies, which discourages entrants and enhances the market share. In conclusion, SOEs may exploit their information superiority by investing in innovation projects.

We illustrate the main point of these arguments through an example. Assume there is an automobile company A that produces gasoline cars. In spike of policy uncertainty, it is optimal for the firm to postpone both regular and innovative investments until the new policy is announced, because the local government may turn to encourage electric cars and does not support the production of gasoline cars anymore. There is another automobile company B, a competitor of company A, which has access to inside information on future policy changes. In normal times, there is less uncertainty regarding government policies, and this information advantage is less valuable. However, when local policy uncertainty heightens, knowing that firm A hesitates in investment decisions, firm B has a chance to gain the early-mover advantage by exploiting its information superiority. Specifically, it can patent on technologies that are likely to be favored by the new government official to gain technological monopoly power. Therefore, heightened local policy uncertainty opens up opportunities for firms with better understanding on future policy changes to establish competitive advantages. [11]

The analysis builds on the assumption that SOEs have strong motivation to pursue economic profits. This should not be a concern. The boom of the private sector forced the Chinese government to improve the efficiency of SOEs (Song and Xiong, 2017). Most SOEs in China were corporatized in 1990s, which enhanced economic incentives of SOE managers. In addition, the State Asset Supervision and Administration Commission has been established to monitor SOEs, and its evaluation criteria are mostly market oriented, such as profit growth, ROE, and ROA. Guo et al. (2017) document that SOEs' middle managers take an active role in dealing with political actors to achieve market efficiency. Hsieh and Song (2015) find that total factor productivity (TFP) growth of state-owned firms was faster than that of private firms during 1998-2007, and the SOE reform was responsible for 20 percent of aggregate TFP growth from 1998 to 2007.

3. Data and Methodology

3.1 Data description

[11] An alternative view is that non-SOEs, rather than SOEs, have competitive advantages when policy uncertainty spikes. This view conjectures that SOEs are more sensitive to policy uncertainty because they are owned by the government, while non-SOEs are on their own anyway so they are less affected by policy uncertainty (Liu et al., 2017). Therefore, when SOEs suffer from temporary distortion induced by policy uncertainty, non-SOEs may take the opportunity to make more innovative investments. However, our empirical findings fail to support this view. In fact, empirical findings of Liu et al., (2017) and Zhou (2017) indicate that compared with non-SOEs, SOEs are more insensitive to policy uncertainty.

We adopt annual data of Chinese A-share listed firms. The sample period spans from 1999 to 2010. We require that the firm should not be in special situations (ST, *ST, suspension and delisted firms) or has missing values for main variables. We also exclude firms in financial industry (CSRC code=J). In addition, all continuous variables are winsorized at the top and bottom 1% of each variable's distribution to exclude the impact of outliers.

3.2 Measuring local policy uncertainty

Following previous literature (e.g. An et al., 2016; Amore and Minichilli, 2017), our definition of local policy uncertainty is based on hand-collected information of the turnover of local government officials.[12] We use a dummy variable, *PT*, which equals 1 if the city head of a given firm's location is replaced during a given year, and equals 0 otherwise, to proxy for local policy uncertainty. The occurrence of local political turnover (*PT*=1) indicates a spike of the degree of local policy uncertainty.

3.3 Measuring innovation

We obtain patent information of Chinese A-share listed firms from the Chinese Patent Database Project (CPDP), and the data of innovation spans from 2001 to 2010.[13] This can also help us to avoid the impact of the largest and most pervasive anti-corruption campaign in

[12] We mainly obtain personal resumes of secretaries of party committees and government officials from Baidu Wikipedia (http://baike.baidu.com), and then cross check among the News of the Communist Party of China (http://cpc.people.com.cn/), the China Economic Net (http://www.ce.cn/), the Xinhua Net (http://www.xinhuanet.com/), and the Zecheng Web (http://www.hotelaah.com), etc.
[13] This dataset can be accessed from https://sites.google.com/site/sipopdb. The original patent grant information of this dataset is obtained from the State Intellectual Property Office of China (SIPO). For a more detailed description of this dataset, see He et al. (2013).

the history of modern China launched in 2012. There are three types of patents granted under the Chinese patent law: invention patents, utility model patents, and design patents. As indicated by Tan et al. (2015), invention patents are the most original ones among all three types of patents.[14] Therefore, we mainly focus on invention patent applications. We use *Patent_apply*, which is the number of invention patent applications filed by a firm in a given year, to measure innovation quantity. Existing literature uses the number of future citations a patent receives to measure its quality, assuming that more influential patents receive a larger number of subsequent citations. However, there is no sufficient and reliable information on citations for Chinese patents. Consequently, we use *Patent_grant*, which is the number of invention patent applications filed and *eventually granted* in a given year, to measure innovation quality. We also consider a series of alternative measures of innovation for robustness.

3.4 Control variables

Following prior literature, we control for firm size, firm leverage, firm age, market-to-book ratio, operating cash flow, sales growth, working capital, capital investment, state ownership, largest shareholder ownership, industry concentration and its square. We provide detailed definitions of these variables in Table A1 in the Appendix.

Table 1 provides summary statistics of main variables in this paper. These statistics correspond to samples used in Columns (2) and (5) in Table 2. On average, a firm in our

[14] Invention patents are granted for a new technical solution relating to a product, a process, or an improvement; utility model patents are granted for new and practical technical solutions related to the shape and/or structure of a product; design patents are granted for new designs related to the shape, pattern or their combinations, or the combination of color, shape, and/or pattern that is aesthetically pleasing and industrially applicable. For a more detailed description of Chinese patents, see Tan et al. (2015).

sample files 6.21 invention patent applications per year (and 2.36 applications eventually get granted). The mean value of *PT* is 0.232, indicating that on average, a firm will experience a local policy uncertainty every five years.[15]

Due to the right skewness of patent counts, following previous literature, we use the natural logarithm of patent counts in our main analysis. To avoid losing firm-year observations with zero patents, we add one to the actual values when calculating the natural logarithm. Therefore, in empirical tests, these two measures are transformed into *LogPatent_apply* and *LogPatent_grant*, respectively.

[Insert Table 1 here]

3.5 Model specification

To examine the relation between local policy uncertainty and firm innovation, we estimate the following equation:

$$LogPatent\_apply(\_grant)_{it+1} = \alpha_i + \alpha_t + \alpha_{ind} \times \alpha_t + \beta_0 + \beta_1 PT_{it} + \gamma Controls_{it} + \varepsilon_{it} \qquad (1)$$

where i indexes firm, t indexes year, *ind* indexes CSRC (China's Securities Regulatory Commission) 2-digit industry. Following the literature (Fang et al., 2014; Bhattacharya et al., 2017), we use *LogPatent_apply* and *LogPatent_grant* in year t+1 as dependent variables, considering that innovative investments do not immediately result in patents. $PT_{i,t}$ is a dummy variable which equals to one if the city head of the firm's location is replaced in year t. α_i and α_t represent firm and year fixed effects, respectively. We also include industry

[15] The statutory term for a city head is 5 years, but it is common to serve for a second term or be replaced during a term. City heads are replaced by higher-level Party Committees when they are appointed to other positions, or dismissed from office due to crimination, or retire due to age limit. As a result, city head turnovers in different cities occur in different years, which are largely exogenous to firms' decisions and provide us both cross-city and time-series variations.

times year fixed effects, $\alpha_{ind} \times \alpha_t$, to control for time-variant omitted variables at the industry level (such as industry-specific shocks). In addition, we cluster the robust standard errors at the city level to account for the within-city correlation among firms.

4. Estimates of Local policy uncertainty on Firm Innovation

4.1 Local policy uncertainty and firm innovation: Basic approach

In Table 2, we estimate the impact of local policy uncertainty on firm innovation. In Columns (1), the dependent variable is *LogPatent_apply* in year t+1. The coefficient on *PT* in Column (1) is positive and significant at the 5% level (coefficient=0.027, t-statistic=2.166). In Column (2), the dependent variable is *LogPatent_grant* in year t+1. The coefficient on *PT* in Column (1) is also positive and significant at the 5% level (coefficient=0.032, t-statistic=2.565). In Column (3)-(4), after adding industry-times-year fixed effects in the model, the coefficients on *PT* are still positive and significant at the 5% level with a larger magnitude compared with Columns (1)-(2).[16] According to the estimation results in Columns (3)-(4), the economic significance of the impact of local policy uncertainty is noteworthy: on average, following the year when local policy uncertainty occurs, the number of invention patent applications filed increase by 3.05% (=$e^{0.030}$-1), and the number of invention patent applications filed and eventually granted increases by 3.67% (=$e^{0.036}$-1). These findings suggest that both the quantity and quality of firm's invention patent applications increase when policy uncertainty becomes stronger.

[16] The coefficients on *HHI* and HHI^2 are absorbed by the industry-times-year fixed effects.

[Insert Table 2 here]

4.2 Dynamic tests

To examine whether the relation between local policy uncertainty and firm innovation suffers from a reverse causality problem, we conduct a series of dynamic tests in Table 3. To see how firm innovation changes around the time of local policy uncertainty, we estimate the following equation:

$$LogPatent\_apply(\_grant)_{it} = \alpha_i + \alpha_t + \alpha_{ind} \times \alpha_t + \beta_0 + \delta_1 PT\_l12_{i,t} + \delta_2 PT\_0_{i,t} + \delta_3 PT\_f1_{i,t} + \delta_4 PT\_f2_{i,t} + \gamma Controls_{i,t} + \varepsilon_{i,t} \quad (2)$$

In this test, the dependent variables are firm innovation outputs in year t. We replace the original explanatory variable of main interest, *PT*, with four other dummy variables: *PT_l12* (*PT_0*/*PT_f1*/*PT_f2*) equals to one if it is one or two years before (the current year of/one year after/two year after) the replacement of the city head of the firm's location. Estimation results in Columns (1)-(2) indicate that the positive effect of local policy uncertainty concentrates in the year after local policy uncertainty occurs: The coefficient on *PT_f1* is positive and significant (coefficient=0.034, t-statistic=2.099 in Column (1); coefficient=0.036, t-statistic=2.271 in Column (2)), while the coefficients on other dummy variables are insignificant. Columns (3)-(4) controls industry-times-year fixed effects, and the coefficients on *PT_f1* become even larger than in Columns (1)-(2) (coefficient=0.047, t-statistic=2.569 in Column (3); coefficient=0.048, t-statistic=2.453 in Column (4)). These findings indicate that firm innovation increases after rather than before local policy uncertainty.

[Insert Table 3 here]

4.3 Propensity score matching

Firms experiencing local policy uncertainty could be fundamentally different from those not subject to such changes. In Table 4, we use a propensity-score-matching approach as a means of identification. For each firm exposed to local policy uncertainty in a given year, we perform a nearest-neighbor matching with a logit model and select one matched firms. The eligible candidates should come from the same industry, and we select the nearest neighbor on the basis of the control variables in equation (1). Panel A compares the control variables between the treatment group (firms that experience local policy uncertainty in a given year) and the control group (firms that do not experience local policy uncertainty in a given year). It reveals that the matching process has successfully removed meaningful observable differences between the treatments and the controls.

Panel B uses the matched sample to conduct estimation corresponding to Columns (1)-(4) in Table 2. The coefficients on *PT* are still positive and significant in all columns, and their magnitudes are larger than corresponding estimates in Columns (1)-(4) of Table 2. According to the estimation results in Columns (3)-(4), on average, following the year when local policy uncertainty occurs, the number of invention patent applications filed increase by 4.50% ($=e^{0.044}-1$), and the number of invention patent applications filed and eventually granted increases by 5.65% ($=e^{0.055}-1$). These results indicate that the heterogeneity between treatment and control groups will bias our main findings downward rather than upward.

[Insert Table 4 here]

5. Cross-sectional Analyses

In this section, we provide some evidence to pin down the channel through which local policy uncertainty positively affects firm innovation. In Section 5.1, we explore cross-sectional heterogeneity regarding ownership structure. In Section 5.2, we further explore cross-sectional differences regarding the degree of local policy uncertainty, and the existence of local competitors within SOEs. In Section 5.3, we discuss several alternative explanations.

5.1 SOEs versus Non-SOEs

In Table 5, we examine whether the relation between local policy uncertainty and firm innovation can be affected by ownership structure. We predict that if the competitive advantage channel holds, the positive effects of local policy uncertainty on firm innovation should be more pronounced for SOEs because these firms possess innate political connections and have access to private information regarding changes in government policies. We conduct analyses separately in the subsamples of SOEs and non-SOEs. Consistent with our conjectures, estimation results indicate that the impact of local policy uncertainty is significant only for SOEs.

[Insert Table 5 here]

5.2 Cross-sectional differences within SOEs

As we have find that SOEs drive the positive relation between local policy turnover and firm innovation in the previous section, we focus on this subgroup and conduct further analyses. Fore here, our focus is whether we can obtain empirical patterns that are consistent with the predictions of theoretically models. We report estimation results in Table 6.

In Panel A, we examine whether the degree of local policy uncertainty can affect the impact of local policy uncertainty on firm innovation. Kulatilaka and Perotti (1998) theoretically predict that the opportunity cost of waiting for firms possessing competitive advantage over competitors' increases with the degree of uncertainty, since delaying investments prevents the firm from obtaining early-mover advantages. Following An et al. (2016), we calculate the turnover frequency for each firm during the sample period. We predict that the higher the turnover frequency, the more likely SOE's competitors will postpone innovative investments, the greater the opportunities to seize first-move advantages for SOEs. Estimation results indicate that the positive effect of local policy uncertainty is concentrated in firms located in cities with a higher turnover frequency, which confirms our conjecture.

In Panel B, we examine the impact of local policy uncertainty considering whether there are local non-SOE competitors or not. Kulatilaka and Perotti (1998) derive that immediate actions typically have strategic preemptive effects under imperfect competition. Therefore, we predict that in the presence of local non-SOE competitors, SOEs will have stronger incentives to exploit their information superiority when policy uncertainty heightens. We divide the SOE subsample according to whether there are any listed local non-SOE competitors, which are defined as non-SOEs within the same 2-digit industry in the same city.

Consistent with our conjectures, the effect of local policy uncertainty is significant only for SOEs located in cities with local non-SOE competitors. These results buttress our argument that the positive relation between local policy turnover and firm innovation is consistent with an information advantage channel.

In Panel C, as more valuable growth options encourage investment, allowing firms to take better advantage of future growth opportunities in the industry (Folta and O'Brien, 2004), we predict the main results will be more pronounced for SOEs that possess more growth opportunities. We employ sales growth as the measure of growth opportunities, and split the sample into two subgroups using the sample median in each year as the cutoff. Estimation results indicate that the positive effects of local policy uncertainty concentrate in SOEs with higher sales growth, which is in support of the conjectures of Folta and O'Brien (2004).

In Panel D, we consider whether the increase in innovation is driven by industry leaders or followers. Weeds (2002) predicts that when acting non-cooperatively, leaders may hold back from investing in the fear of starting a patent race, while the threat of rival innovation reduces the follower's option value of delay, tending to hasten its investment. Therefore, the initiation of patenting activities in spike of local policy uncertainty is more likely driven by industry followers. Indeed, we find that the effect is more pronounced for SOEs with below-median market shares within an industry. These findings confirm that local policy uncertainty encourages firm innovation through inducing strategic considerations of SOEs.

[Insert Table 6 here]

6. Further Analysis

6.1 Instrumental variable analysis

Although local policy uncertainty in China is largely immune from firm lobbying, our empirical results can still suffer from potential endogeneity concerns. The estimated coefficient of political turnover may deviate from its real effect on firm innovation. On the one hand, the coefficient of political turnover can be artificially larger if good performance in firm innovation triggers the promotion of local officials. On the other hand, the coefficient of political turnover can be artificially smaller if bad performance in firm innovation results in the demotion of local officials. To further support a positive causal relation between local policy uncertainty and firm innovation, we utilize an Instrumental Variable (IV) approach.

Following Ru (2018), we exploit exogenous variation in local policy uncertainty of predetermined turnover cycles of city heads, which occur every five years on average. We take the first year of the city head in the previous term and add five years to calculate the predicted first year of the current city head, and construct *PT_Predict*, which equals to one if the city head of firm's location is predicted to be replaced in year t, and zero otherwise. The advantage of this setting is that these predetermined predicted municipal turnover cycles depend solely on past information, which teases out exogenous variation from the actual turnover cycles that might be correlated with concurrent economic conditions.

We report estimation results in Table 7. For SOEs, the coefficient on *PT_Predict* is positive and significant in Columns (1) and (3), while the effect is still insignificant for non-SOEs. The overall patterns here are similar to actual turnover cycles but are a bit stronger in magnitude. For example, according to the estimation in Column (1), on average, the invention patent applications increase by 12.7% compared to corresponding estimates based on actual turnover in Column (1), Table 5 (6.3%). These estimation results further strengthen a casual interpretation of our main results.

[Insert Table 7 here]

In Table A2 in the Appendix, we also use two variables as instruments for local policy uncertainty and conduct a two-stage least square (2SLS) estimation. The first one is the age of the predecessor of the current city head when he or she takes the office (*Pre_Top1_age*).[17] The second one is a dummy variable, *PT_Higher*, which equals one if the turnover of the head of provincial-level Party Committee occurs in the current year or in the previous year.

Both of the two variables are likely to be valid instruments for local policy uncertainty. On the one hand, they are correlated with the probability of local policy uncertainty in the current year, therefore the revelance restriction is satisfied. On the other hand, there is no existing research indicate that these two variables affect firm innovation through other channels. However, one concern is that these two variables are correlated with local economic conditions, which may affect innovation outputs. To alleviate such concern, we include economic growth rate as an additional control variable.

Column (1) presents estimation results of the first stage regression. The coefficient on *Pre_Top1_age* is negative and significant at the 1% level, indicating that younger politicians are more likely to be appointed to other places. The coefficient on *PT_Higher* is positive and significant at the 1% level, implying that province-level political turnover is likely to induce

[17] For example, Jinlong Guo becomes the city head of Beijing in 2012. Qi Liu, born in 1942, was Jinlong Guo's predecessor. He was 60 when he took the office in 2002. In this case, we use the age of the predecessor when he took the office (60) to predict his tenure (10 years), and therefore when the current city head will take the office (2012).

city-level political turnover. The F-statistic (=11.32) suggests that these two IVs have strong explanatory power for local political turnover. Column (2) present results of the second stage. The coefficient on *PT* is positive and significant at the 5% level (coefficient=0.428, t-statistic=2.046). The results in Columns (3)-(4) largely correspond to the first two columns, where we also obtain positive and significant coefficient on *PT* (coefficient=0.265, t-statistic=1.962).

To summarize, we examine the validity of the main results using dynamic tests, constructing a propensity-score-matched sample, and using instrumental variables. We consistently find that local policy uncertainty leads to more innovation outputs. Therefore, endogeneity issues do not appear to explain the association between local policy uncertainty and firm innovation.

6.2 Robustness checks

6.2.1 Alternative specifications

In Table 8, we conduct a series of other robustness checks, which can help us further confirm the main findings. The tests include using various model specifications, and several subsample analyses and sub-period analyses. As some city heads are appointed in the last few months of a given year, their impact on government policies may not be reflected in the current year. Therefore, in Columns (1)-(2), we introduce an adjusted measure of local policy uncertainty, *PT_adj*, which equals to one if a city head is replaced between January 1 and June 30 in the current year, or between July 1 and December 31 in the previous year, and zero otherwise. In Columns (3)-(4), due to the count-based nature of patent data, we follow Blanco and Wehrheim (2017) and use the Negative Binominal Regression and the dependent variables are the number of patents rather than in logarithmic form. Our baseline findings still hold. In Columns (5)-(6), we adjust the standard errors by clustering at the province level to account for the within-province correlation among firms. Our results are robust to these alternative specifications. In Columns (7)-(8), we only keep observations that have a non-zero patent count in year t+1 to address the concern that the main results could be driven by the right-skewed distribution of the patent variable. Although the results are weaker, our main findings are largely unchanged.

We also conduct additional subsample tests. In Columns (9)-(10), we exclude firms headquartered in Beijing, Shanghai, Tianjin, and Chongqing. These four cities are directly controlled by the Chinese central government. Some firms may locate their headquarters in these four cities to acquire political favors while set up subsidiaries and producing patents in other cities, which may bias the estimation results. In Columns (11)-(12), we only keep manufacturing firms, which are the majority of listed-firms in China. These results buttress our main findings.

[Insert Table 8 here]

6.2.2 Alternative measures of firm innovation

In this section, we introduce several alternative proxies to measure firm innovation. We report estimation results in Table 9. In Panel A, we consider the effect of local policy uncertainty on alternative measures of innovation outputs. In the main context of the paper, we use *flow* measures of invention patents as dependent variables. In Column (1), following

Fang et al. (2017), we calculate a *stock* measure of invention patent, *LogPatent_stock*. Our baseline finding is robust to using this stock measure of invention patent. In Columns (2)-(4), we use the number of utility patents applications filed, *LogPatent_utility*, the number of design patents applications filed, *LogPatent_design*, and the number of all three kinds of patents applications filed, *LogPatent_total*, as dependent variables, respectively. Estimation results indicate that local policy uncertainty has positive and significant influence on the applications of invention and utility patents, and the effect becomes weaker for design patents, which are less innovative.

We focus on firms' innovation outputs in the previous sections. In Panel B, we also examine whether local policy uncertainty can positively determine firms' innovation inputs. In Columns (1)-(2), the dependent variable, *RD_Sale*, is defined as R&D expenditures to total sales. Estimation results indicate that local policy uncertainty is positively associated with innovation inputs. In Columns (3)-(4), we use the absolute scale of R&D expenditures, *LogRD*, to measure innovation inputs, and the positive impact of local policy uncertainty becomes more pronounced. These tests reveal a positive and significant relation between local policy uncertainty and both innovation inputs and outputs.

[Insert Table 9 here]

6.3 The effect on product market performance

By far, we have documented stable positive relation between local policy uncertainty and firm innovation for SOEs, and we interpret these findings as consistent with a competitive advantage view that emphasizes the importance of information superiorities regarding future policy changes in spike of local policy uncertainty. In this section, we further examine whether patenting activities under heightened local policy uncertainty indeed benefit SOEs on local product markets. We predict that if strategic consideration drives the results, the innovation outputs created during periods of high local policy uncertainty may directly help firms increase their sales growth and product market shares.

To conduct this test, we construct the interaction terms of innovation outputs in year t and local policy uncertainty in year t-1 as main explanatory variables. In addition to control variables used in previous sections, we include sales growth in year t-1 in the model to control for the autocorrelation of product market performances. Following previous literature (e.g. Campello, 2003, 2006; Fresard, 2010; Billett et al., 2017), our first measure of product market performance is industry-adjusted sales growth, *Gsale_Adj*, which equals to *Gsale* minus the industry median of *Gsale*.[18] We also calculate *Sale_Share*, the ratio of the firm's sales to the entire industry's sales, and then calculate industry-share growth Δ*Sale_Share* as the second measure of product performances, which is the percentage change in *Sale_Share* from year t-1 through year t.

We report estimation results in Table 10. In Columns (1)-(2), the dependent variable is industry-adjusted sales growth. It reveals that the interaction term of $LogPatent\_apply_t$ and PT_{t-1}, and $LogPatent\_grant_t$ and PT_{t-1} are positive and significant at the 5% level respectively. In Columns (3)-(4), we also obtain positive and significant coefficients on the main explanatory variables when the dependent variable switches to industry-share growth. These results indicate that innovation outputs under higher local policy uncertainty are more

[18] The results are quantitative similar if we use *Gsale* as the dependent variable.

pertinent with strategic reasons, which leads to higher increases in product market shares.

[Insert Table 10 here]

6.4 Alternative explanations

In the last section, we consider several alternative explanations, namely local officials' career incentives, the mitigation effects of financial constraints, and the external governance effects. We report estimation results in Table 11.

6.4.1 Local officials' career incentives

In Panel A, we consider whether local officials' career concerns can drive the main results. Under China's political system, local government officials have strong incentives to boost local economic performances in order to increase their promotion prospect (Li and Zhou, 2005). If newly-appointed officials have strong incentives to encourage local GDP growth, they may tend to strive for better innovative performances, and we will observe a positive relation between local political turnover and firm innovation.

To see whether these arguments are true, our tests are two folds. In Panel A, we partition the sample according to whether the age of the local official when he or she takes the office is above or below the sample median. We predict that a younger city head has more promotion opportunities, and therefore is more motivated to encourage firms to engage in innovative projects in order to pursue the policy goals. However, inconsistent with this conjecture, we find that the effects of local policy uncertainty on invention patent applications are similar for the two subsamples, which is even stronger for elder local officials when the dependent variables are invention patents applied and eventually granted.

In Panel B, to further pin down this channel, we explore the fact that SOEs in China are controlled by different levels of governments. Local government officials have direct influences on firms' investment strategies only for those under their jurisdiction controls (Liu et al., 2016). Therefore, if the observed increase in innovation outputs is driven by local officials' career incentives, there should be no effect for SOEs that are controlled by the higher-level governments. We define a SOE as higher-level (local) if it is controlled by Central or provincial-level (prefectural-level) government. When we split the sample according to firms' levels, we obtain positive and significant coefficients on *PT* for both higher-level and local SOEs. Given that many of higher-level SOEs are located in prefectural-level cities and directly involve in local product market competition, we regard these findings as further evidence on the competitive advantage channel. Higher-level SOEs have better access to inside information, which enable them to judge the prospect of prefectural-level policy changes and intentionally alter innovation strategies in spike of local policy uncertainty. Therefore, we conclude that local officials' career incentives are insufficient to explain increased innovation outputs in react to heightened local policy uncertainty.

6.4.2 Other explanations

In Panel C, we examine whether the increase in innovation outputs under heightened local policy uncertainty can be explained by newly-appointed city heads use their helping hands to mitigate firms' financial constraints. If this argument is true, the positive impact of local policy uncertainty should be more pronounced in firms face with severer financial constraints. The existing literature indicates that firm size is almost the most reliable measure of financial constraints (Hadlock and Pierce, 2010; Chen et al., 2012): Smaller firms usually suffer from more severe financial constraints. Therefore, we split the sample according to the sample median of firm size in each year, and investigate whether the effect of local political turnover differs between the two groups. Estimation results show that our main results are more pronounced in larger firms rather than smaller firms, implying that increased innovation outputs cannot be explained by relieved financial constraints.

In Panel D, we consider policy uncertainty can oppositely sometimes exacerbate financial constraints, which can substitute for corporate governance and act as an external disciplinary force (Nguyen and Phan, 2017). A group of studies have shown that firm investment declines in spike of policy uncertainty (e.g. Julio B and Yook, 2012; An et al., 2016). As overinvestment is perceived to be prevalent in China (An et al., 2016), the main results can be explained as the discipline effect of policy uncertainty curtails overinvestment and improves investment efficiency. We predict that if this argument is true, the positive impact of local policy uncertainty should be more pronounced in firms that are more likely to be *ex-ante* overinvestment. Following Biddle et al. (2009), as firms with large cash balances are more likely to over-invest (Jensen, 1986; Harford, 1999), and firms suffer from debt overhang problem are prone to under-invest (Myers, 1977), we construct a ranked variable, *Over*, based on the average of a ranked measure of cash and leverage.[19] A higher level of *Over* indicates severer overinvestment problem. In Columns (5)-(8), we split the sample according to the sample median of *over* in each year. Estimation results indicate that the main findings concentrate in subsamples that are less likely to be *ex-ante* overinvestment.

[19] When calculating this measure, leverage is multiplied by minus one before ranking so that both variables are increasing in the likelihood of overinvestment.

[Insert Table 11 here]

7. Conclusions

Based on city head turnover in China, this paper finds that local policy uncertainty is positively associated with firm innovation. During the next year following the replacement of the city head of the firm's location, both the firm's invention patent application and granted invention patent increase. This relation is significant only for SOEs, which have stable political connection with governments and enjoy information advantage. Within the SOE subsample, the effect of local policy uncertainty on innovation outputs is more pronounced for those located in cities where local official's turnover is more frequent and local non-SOE competitors exist, and with higher sales growth and lower market shares. These findings suggest a mechanism that SOEs exploit their information superiority over non-SOEs to obtain competitive advantages by implementing more innovative investments. Our research highlights that the effect of policy uncertainty on investment decision depends on the nature of investment projects as well as firm characteristics. Although the overall effect of policy uncertainty may be negative, it can have bright-side real effects on innovative investments for firms with information advantage.

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Appendix

Table A1 Variable Definitions

Variables	Definitions
Patent_apply	Innovation quantity, the number of invention patent applications filed by a firm in year t.
Patent_grant	Innovation quality, the number of invention patent applications filed and eventually granted by a firm in year t.
LogPatent_apply	The logarithm of one plus *Patent_apply* in year t.
LogPatent_grant	The logarithm of one plus *Patent_grant* in year t.
PT	Local policy uncertainty, a dummy variable equals to one if the city head of firm's location is replaced in year t, and zero otherwise.
PT_Predict	Predicted local policy uncertainty, a dummy variable equals to one if the city head of firm's location is predicted to be replaced in year t, and zero otherwise, constructed following Ru (2018).
PT_Adj	An adjusted measure of local policy uncertainty, a dummy variable equals to one if the city head of firm's location is replaced between January 1 and June 30 in year t or between July 1 and December 31 in year t-1, and zero otherwise.
PT_Higher	Local policy uncertainty associate with higher-level turnover, a dummy variable equals to one if the head of provincial-level Party Committee of the firm's location is replaced in year t or in year t-1, and zero otherwise.
Pre_Top1_age	The age of the predecessor of the current city head when he or she takes the office.
LogPatent_stock	The logarithm of one plus *Patent_stock* in year t. *Patent_stock* refers to *invention patent stock* constructed in Fang et al. (2017).
LogPatent_utility	The logarithm of one plus the number of utility model patent applications filed by a firm in year t.
LogPatent_total	The logarithm of one plus the number of all three types of patent (including invention, utility and design) applications filed by a firm in year t.
RD_sale	R&D expenditure ratio, the ratio of R&D investment to total sales in year t.
LogRD	R&D expenditure scale, the logarithm of one plus R&D investment in year t.
Logasset	Firm size, the logarithm of total assets in year t.
Leverage	Firm leverage, the ratio of total debt to total assets in year t.
Age	Firm age, number of years the firm is listed plus 1.
MB	Mark-to-book ratio, the market-to-book equity ratio in year t.
Opcf	Operating cash flow, the ratio of operating cash flow to total assets in year t.
Gsale	Sales growth, the percentage change in total sales from year t-1 through year t.
Wkd	Working capital, The ratio of net working capital(working capital minus cash and cash equivalents) to total assets in year t.
Inv	Capital investment, the ratio of capital expenditure to total assets in year t.
Soe	State ownership, the sum of the fractions of shares held by the state in year t
Top1	Largest shareholder ownership, the fraction of shares held by the largest shareholders in year t.
Sale_Share	Industry share, the ratio of the firm's sales to the entire 2-digit CSRC industry's sales.
HHI	Industry concentration, the Herfindahl-Hirschman Index calculated based on total sales for 2-digit CSRC industries in year t, which is the sum of squared *Sale_Share* for all firms in the same 2-digit CSRC industry.
HHI^2	The square of the Herfindahl-Hirschman Index calculated based on total sales for 2-digit CSRC industries in year t.
Over	The measure of ex-ante likelihood of overinvestment. A ranked variable calculated following Biddle et al. (2009), which is based on the average of a ranked (deciles) measure of cash holdings and leverage. Leverage is multiplied by minus one before ranking.

Gsale_Adj	Industry-adjusted sales growth, *Gsale* minus the median of *Gsale* in the same 2-digit CSRC industry.
⊿*Sale_Share*	Industry-share growth, the percentage change in *Sale_Share* from year t-1 through year t.

Table A2 Additional Instrumental Variable Analysis

This table estimates the impacts of local policy uncertainty on firm innovation in an Instrumental Variable approach. Columns (1) and (3) report 2SLS estimation results in the 1st stage. Columns (2) and (4) report 2SLS estimation results in the 2nd stage. *LogPatent_apply* indicates the logarithm of one plus the number of invention patent applications filed by a firm in year t. *LogPatent_grant* indicates the logarithm of one plus the number of invention patent applications filed and eventually granted by a firm in year t. *PT* is a dummy variable equals to one if the city head of firm's location is replaced in year t and zero otherwise. The sample period covers 1999 through 2009. Regressions in all columns control for firm and year fixed effects. Robust standard errors are clustered at the city level. T-statistics are reported in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

	1st stage	2nd stage	1st stage	2nd stage
	PT_t	$LogPatent\_apply_{t+1}$	PT_t	$LogPatent\_grant_{t+1}$
	(1)	(2)	(3)	(4)
PT_t		0.428**		0.265**
		(2.046)		(1.962)
$IV1=Pre\_Top1\_age_t$	-0.017***		-0.017***	
	(-5.061)		(-5.061)	
$IV2= PT\_Higher_t$	0.110***		0.110***	
	(6.414)		(6.414)	
Controls	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y
F-test(1st)	11.32		11.32	
Hansen-J test(p-value)		0.371		0.167
N	4,010	4,010	4,010	4,010
$Adj\text{-}R^2$	0.084	0.109	0.084	0.060

Table 1: Summary Statistics of Main Variables

	Num	Mean	Std. Dev.	P25	Median	P75
	(1)	(2)	(3)	(4)	(5)	(6)
$Patent\_apply_{t+1}$	13300	6.209	81.569	0.000	0.000	1.000
$Patent\_grant_{t+1}$	13300	2.359	33.788	0.000	0.000	0.000
PT_t	13300	0.232	0.422	0.000	0.000	0.000
$Logasset_t$	13300	21.222	1.082	20.516	21.106	21.827
$Leverage_t$	13300	0.526	0.574	0.343	0.487	0.625
Age_t	13300	1.995	0.580	1.609	2.079	2.485
MB_t	13300	1.949	1.687	0.816	1.442	2.501
$Opcf_t$	13300	0.050	0.090	0.007	0.048	0.093
$Gsale_t$	13300	19.352	46.104	-2.763	12.913	31.384
Wkd_t	13300	-0.064	0.411	-0.158	-0.032	0.090
Inv_t	13300	0.047	0.060	0.003	0.028	0.071
Soe_t	13300	26.565	25.550	0.000	24.372	49.990
$Top1_t$	13300	0.401	0.166	0.269	0.385	0.529
HHI_t	13300	0.115	0.144	0.046	0.066	0.110
HHI_t^2	13300	0.034	0.109	0.002	0.004	0.012

Table 2 Local Policy Uncertainty and Firm Innovation

This table estimates the effects of local policy uncertainty on firm innovation. *LogPatent_apply* indicates the logarithm of one plus the number of invention patent applications filed by a firm in year t. *LogPatent_grant* indicates the logarithm of one plus the number of invention patent applications filed and eventually granted by a firm in year t. *PT* is a dummy variable equals to one if the city head of firm's location is replaced in year t and zero otherwise. All other variables are defined in Table A1 in Appendix. Robust standard errors are clustered at the city level. T-statistics are reported in parentheses. Columns (1)-(2) control for firm- and year-fixed effects. Columns (3)-(4) control for firm-, year-, and industry-times-year-fixed effects. The sample year t is from 1999 to 2009. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

	$LogPatent\_apply_{t+1}$ (1)	$LogPatent\_grant_{t+1}$ (2)	$LogPatent\_apply_{t+1}$ (3)	$LogPatent\_grant_{t+1}$ (4)
PT_t	0.027**	0.032**	0.030**	0.036**
	(2.166)	(2.565)	(2.179)	(2.412)
$Logasset_t$	0.298***	0.156***	0.318***	0.151***
	(10.587)	(7.694)	(10.444)	(6.989)
$Leverage_t$	-0.055*	-0.009	-0.014	-0.001
	(-1.797)	(-0.618)	(-0.555)	(-0.042)
Age_t	-0.036	0.071*	-0.166**	0.070
	(-0.527)	(1.831)	(-2.344)	(1.627)
MB_t	0.024***	0.021***	0.038***	0.030***
	(3.374)	(3.880)	(4.607)	(4.729)
$Opcf_t$	-0.004	-0.003	0.105	0.042
	(-0.061)	(-0.060)	(1.505)	(0.819)
$Gsale_t$	-0.000***	-0.000	-0.000***	-0.000
	(-3.238)	(-0.785)	(-3.458)	(-1.069)
Wkd_t	-0.074*	-0.026	0.006	0.005
	(-1.858)	(-1.252)	(0.139)	(0.190)
$PP\&E_t$	0.054	0.204*	0.157	0.295***
	(0.395)	(1.721)	(1.282)	(2.742)
Soe	0.000	0.001	0.000	0.001
	(0.762)	(1.123)	(0.700)	(1.037)
Top1	-0.409***	-0.067	-0.219*	-0.063
	(-2.679)	(-0.804)	(-1.780)	(-0.784)
HHI	-1.554***	-0.184		
	(-4.206)	(-0.644)		
HHI^2	1.415***	0.232		
	(3.855)	(0.947)		
Year FE	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y
*Industry*Year FE*	N	N	Y	Y
N	13,300	13,300	13,094	13,094
Adj_R^2	0.673	0.593	0.717	0.632

Table 3 Dynamic Tests

This table estimates dynamic effects of the relation between local policy uncertainty and firm innovation. *LogPatent_apply* indicates the logarithm of one plus the number of invention patent applications filed by a firm in year t. *LogPatent_grant* indicates the logarithm of one plus the number of invention patent applications filed and eventually granted by a firm in year t. *PT* is a dummy variable equals to one if the city head of firm's location is replaced in year t and zero otherwise. *PT_l12* (*PT_0/PT_f1/PT_f2*) equals to one if it is one or two years before (the current year of/one year after/two year after) the replacement of the city head of the firm's location. All control variables are defined in Table A1 in Appendix. Robust standard errors are clustered at the city level. T-statistics are reported in parentheses. Columns (1)-(2) control for firm- and year-fixed effects. Columns (3)-(4) control for firm-, year-, and industry-times-year-fixed effects. The sample year t is from 1999 to 2009. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

	$LogPatent\_apply_t$	$LogPatent\_grant_t$	$LogPatent\_apply_t$	$LogPatent\_grant_t$
	(1)	(2)	(3)	(4)
PT_l12_t	0.018	0.007	0.025	0.011
	(1.027)	(0.530)	(1.563)	(0.800)
PT_0_t	0.012	0.010	0.026	0.023
	(0.690)	(0.673)	(1.541)	(1.260)
PT_f1_t	0.034**	0.036**	0.047**	0.048**
	(2.099)	(2.271)	(2.569)	(2.453)
PT_f2_t	0.017	0.002	0.031*	0.010
	(1.160)	(0.148)	(1.942)	(0.766)
Controls	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y
*Industry*Year FE*	N	N	Y	Y
N	14,199	14,199	14,100	14,100
Adj_R^2	0.676	0.599	0.720	0.637

Table 4 Propensity Score Matching

This table estimates the effects of local policy uncertainty on firm innovation based on a propensity-score-matched sample. *LogPatent_apply* indicates the logarithm of one plus the number of invention patent applications filed by a firm in year t. *LogPatent_grant* indicates the logarithm of one plus the number of invention patent applications filed and eventually granted by a firm in year t. *PT* is a dummy variable equals to one if the city head of firm's location is replaced in year t and zero otherwise. All control variables are defined in Table A1 in Appendix. Robust standard errors are clustered at the city level. T-statistics are reported in parentheses. Columns (1)-(2) control for firm- and year-fixed effects. Columns (3)-(4) control for firm-, year-, and industry-times-year-fixed effects. The sample year t is from 1999 to 2009. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

Panel A: Post-matching differences

	Treated	**Control**	**%Bias**	**t-value**
	(1)	(2)	(3)	(4)
Logasset	21.18	21.17	1.5	0.56
Lev	0.53	0.51	3.4	0.12
Logage	2.00	2.00	-0.6	0.81
MB	1.93	1.97	-2.7	0.28
Opcf	0.05	0.05	1.3	0.62
Gsale	20.62	20.36	0.6	0.83
Wkd	-0.07	-0.06	-3.4	0.14
PP&E	0.05	0.05	0.2	0.95
SOE	27.98	27.68	1.2	0.63
Top1	0.40	0.40	-0.8	0.75
HHI	0.12	0.11	1	0.69
HHI^2	0.03	0.03	0.7	0.78

Table 4 (Continued)

Panel B: Tests based on the matched sample

	$LogPatent\_apply_{t+1}$	$LogPatent\_apply_{t+1}$	$LogPatent\_grant_{t+1}$	$LogPatent\_grant_{t+1}$
	(1)	(2)	(3)	(4)
PT_t	0.056**	0.074**	0.044**	0.055**
	(2.196)	(2.590)	(2.066)	(2.195)
Controls	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y
*Industry*Year FE*	N	N	Y	Y
N	3,252	3,085	3,252	3,085
$Adj\text{-}R^2$	0.752	0.810	0.714	0.766

Table 5 Cross-sectional Analysis: SOEs versus Non-SOEs

This table estimates the effects of local policy uncertainty on firm innovation in SOEs and non-SOEs. *LogPatent_apply* indicates the logarithm of one plus the number of invention patent applications filed by a firm in year t. *LogPatent_grant* indicates the logarithm of one plus the number of invention patent applications filed and eventually granted by a firm in year t. *PT* is a dummy variable equals to one if the city head of firm's location is replaced in year t and zero otherwise. All control variables are defined in Table A1 in Appendix. Robust standard errors are clustered at the city level. T-statistics are reported in parentheses. All columns control for firm-, year-, and industry-times-year fixed effects. The sample year t is from 1999 to 2009. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

	$LogPatent\_apply_{t+1}$	$LogPatent\_apply_{t+1}$	$LogPatent\_grant_{t+1}$	$LogPatent\_grant_{t+1}$
	SOE	Non-SOE	SOE	Non-SOE
	(1)	(2)	(3)	(4)
PT_t	0.063***	0.005	0.051**	0.018
	(3.718)	(0.335)	(2.456)	(1.393)
Controls	Y	Y	Y	Y
Firm/Industry-Year FE	Y	Y	Y	Y
N	6,758	6,076	6,758	6,076
Adj_R^2	0.767	0.747	0.677	0.663

Table 6 Cross-sectional Analysis within SOEs

This table estimates the impacts of local policy uncertainty on firm innovation within SOEs. *LogPatent_apply* indicates the logarithm of one plus the number of invention patent applications filed by a firm in year t. *LogPatent_grant* indicates the logarithm of one plus the number of invention patent applications filed and eventually granted by a firm in year t. *PT* is a dummy variable equals to one if the city head of firm's location is replaced in year t and zero otherwise. All control variables are defined in Table A1 in Appendix. Robust standard errors are clustered at the city level. T-statistics are reported in parentheses. All columns control for firm-, year-, and industry-times-year fixed effects. The sample year t is from 1999 to 2009. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

Panel A: The frequency of local turnover

	$LogPatent\_apply_{t+1}$	$LogPatent\_apply_{t+1}$	$LogPatent\_grant_{t+1}$	$LogPatent\_grant_{t+1}$
	High	Low	High	Low
	(1)	(2)	(3)	(4)
PT_t	0.066***	0.034	0.060**	0.023
	(2.879)	(1.252)	(2.215)	(0.846)
Controls	Y	Y	Y	Y
Firm/Industry-Year FE	Y	Y	Y	Y
N	3,543	3,076	3,543	3,076
Adj_R^2	0.781	0.776	0.692	0.691

Panel B: The presence of large within-city non-SOE competitor

	$LogPatent\_apply_{t+1}$	$LogPatent\_apply_{t+1}$	$LogPatent\_grant_{t+1}$	$LogPatent\_grant_{t+1}$
	Yes	No	Yes	No
	(1)	(2)	(3)	(4)
PT_t	0.085**	0.031	0.059*	0.032
	(2.474)	(1.463)	(1.842)	(1.551)
Controls	Y	Y	Y	Y
Firm/Industry-Year FE	Y	Y	Y	Y
N	2,559	4,024	2,559	4,024
Adj_R^2	0.830	0.771	0.731	0.692

Table 6 (Continued)

Panel C: Sales growth				
	$LogPatent\_apply_{t+1}$		*$LogPatent\_grant_{t+1}$*	
	High sales growth	Low sales growth	High sales growth	Low sales growth
	(1)	(2)	(3)	(4)
PT_t	0.081**	0.044	0.066**	0.026
	(2.548)	(1.302)	(2.092)	(0.855)
Controls	Y	Y	Y	Y
Firm/Industry-Year FE	Y	Y	Y	Y
N	3,128	3,090	3,128	3,090
Adj_R^2	0.817	0.799	0.763	0.708

Panel D: Market share				
	$LogPatent\_apply_{t+1}$		*$LogPatent\_grant_{t+1}$*	
	Low market share	High market share	Low market share	High market share
	(1)	(2)	(3)	(4)
PT_t	0.069**	0.039	0.055**	0.034
	(2.299)	(1.425)	(2.085)	(1.210)
Controls	Y	Y	Y	Y
Firm/Industry-Year FE	Y	Y	Y	Y
N	3,071	3,429	3,071	3,429
Adj_R^2	0.708	0.826	0.636	0.742

Table 7 Predicted Timing of Local Political Turnover

This table estimates the effects of local policy uncertainty on firm innovation in SOEs and non-SOEs by using predicted timing of local political turnover. *LogPatent_apply* indicates the logarithm of one plus the number of invention patent applications filed by a firm in year t. *LogPatent_grant* indicates the logarithm of one plus the number of invention patent applications filed and eventually granted by a firm in year t. *PT_Predict* is a dummy variable equals to one if the city head of firm's location is predicted to be replaced in year t and zero otherwise. All control variables are defined in Table A1 in Appendix. Robust standard errors are clustered at the city level. T-statistics are reported in parentheses. All columns control for firm-, year-, and industry-times-year fixed effects. The sample year t is from 1999 to 2009. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

	$LogPatent\_apply_{t+1}$		$LogPatent\_grant_{t+1}$	
	SOE	Non-SOE	SOE	Non-SOE
	(1)	(2)	(3)	(4)
$PT\_Predict_t$	0.127***	-0.029	0.077*	0.031
	(2.964)	(-0.758)	(1.930)	(0.870)
Controls	Y	Y	Y	Y
Firm/Industry-Year FE	Y	Y	Y	Y
N	6,816	6,100	6,816	6,100
Adj_R^2	0.767	0.746	0.676	0.661

Table 8 Robustness Checks

This table examines the robustness of the effects of local policy uncertainty on firm innovation. *LogPatent_apply* indicates the logarithm of one plus the number of invention patent applications filed by a firm in year t. *LogPatent_grant* indicates the logarithm of one plus the number of invention patent applications filed and eventually granted by a firm in year t. *PT* is a dummy variable equals to one if the city head of firm's location is replaced in year t and zero otherwise. All control variables are defined in Table A1 in Appendix. Robust standard errors are clustered at the city level. T-statistics are reported in parentheses. All columns control for firm-, year-, and industry-times-year fixed effects. The sample year t is from 1999 to 2009. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

	Adjusted timing of policy uncertainty		Negative Binominal model	
	$LogPatent\_apply_{t+1}$	$LogPatent\_grant_{t+1}$	$Patent\_apply_{t+1}$	$Patent\_grant_{t+1}$
	(1)	(2)	(3)	(4)
PT_t			0.109**	0.091*
			(2.461)	(1.668)
PT_Adj_t	0.041*	0.033*		
	(1.899)	(1.953)		
Controls	Y	Y	Y	Y
Firm/Industry-Year FE	Y	Y	Y	Y
N	6,758	6,758	4,358	3,652
Adj_R^2	0.767	0.677	-	-
	Cluster at the province level		Keeping observations with non-zero patents	
	$LogPatent\_apply_{t+1}$	$LogPatent\_grant_{t+1}$	$LogPatent\_apply_{t+1}$	$LogPatent\_grant_{t+1}$
	(5)	(6)	(7)	(8)
PT_t	0.063***	0.051**	0.098***	0.115***
	(3.416)	(2.365)	(2.744)	(2.665)
Controls	Y	Y	Y	Y
Firm/Industry-Year FE	Y	Y	Y	Y
N	6,758	6,758	2,061	1,314
Adj_R^2	0.767	0.677	0.791	0.750
	Exclude samples headquartered in Beijing, Tianjin, Shanghai and Chongqing		Manufacturing firms	
	$LogPatent\_apply_{t+1}$	$LogPatent\_grant_{t+1}$	$LogPatent\_apply_{t+1}$	$LogPatent\_grant_{t+1}$
	(9)	(10)	(11)	(12)
PT_t	0.053***	0.040**	0.077***	0.064**
	(2.996)	(2.486)	(2.868)	(2.027)
Controls	Y	Y	Y	Y
Firm/Industry-Year FE	Y	Y	Y	Y
N	5,082	5,082	3,798	3,798
Adj_R^2	0.747	0.645	0.752	0.656

Table 9 Alternative Measures of Firm Innovation

This table estimates the effects of local policy uncertainty on firm innovation using alternative measures of firm innovation. All dependent and control variables are defined in Table A1 in Appendix. Robust standard errors are clustered at the city level. T-statistics are reported in parentheses. All columns control for firm-, year-, and industry-times-year fixed effects. In Panel A, the sample year t is from 1999 to 2009. In Panel B, the sample year t is from 2007 to 2013. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

Panel A: Alternative measures of patents

	$LogPatent\_stock_{t+1}$	$LogPatent\_utility_{t+1}$	$LogPatent\_design_{t+1}$	$LogPatent\_total_{t+1}$
	(1)	(2)	(3)	(4)
PT_t	0.038***	0.064***	0.031*	0.059**
	(2.983)	(3.147)	(1.819)	(2.569)
Controls	Y	Y	Y	Y
Firm/Industry-Year FE	Y	Y	Y	Y
N	4,154	6,422	6,422	6,758
Adj_R^2	0.908	0.800	0.769	0.814

Panel B: R&D expenditures

	RD_Sale_t	RD_Sale_{t+1}	$LogRD_t$	$LogRD_{t+1}$
	(5)	(6)	(7)	(8)
PT_t	0.001**	0.000*	0.357***	0.120
	(2.001)	(1.823)	(2.813)	(0.894)
Controls	Y	Y	Y	Y
Firm/Industry-Year FE	Y	Y	Y	Y
N	6,425	5,449	6,427	5,453
Adj_R^2	0.769	0.788	0.716	0.742

Table 10 Local Policy Uncertainty, Firm Innovation, and Product Market Performance

This table estimates the relation between local policy uncertainty, firm innovation, and product market performance. *Gsale_Adj* indicates industry-adjusted sales growth. *⊿Sale_Share* indicates the growth rate of sales shares with the industry. *LogPatent_apply* indicates the logarithm of one plus the number of invention patent applications filed by a firm in year t+1. *LogPatent_grant* indicates the logarithm of one plus the number of invention patent applications filed and eventually granted by a firm in year t+1. *PT* is a dummy variable equals to one if the city head of firm's location is replaced in year t and zero otherwise. All other variables are defined in Table A1 in Appendix. Robust standard errors are clustered at the city level. T-statistics are reported in parentheses. Columns (1)-(2) control for firm- and year-fixed effects. Columns (3)-(4) control for firm-, year-, and industry-times-year-fixed effects. The sample year t is from 1999 to 2009. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

	$Gsale\_Adj_t$	$Gsale\_Adj_t$	$⊿Sale\_Share_t$	$⊿Sale\_Share_t$
	(1)	(2)	(3)	(4)
$LogPatent\_apply_t$* PT_{t-1}	0.018**		0.021**	
	(2.038)		(2.263)	
$LogPatent\_grant_t$* PT_{t-1}		0.026**		0.020*
		(2.484)		(1.962)
$LogPatent\_apply_t$	-0.018**		-0.013	
	(-2.200)		(-1.614)	
$LogPatent\_grant_t$		-0.003		0.004
		(-0.348)		(0.432)
PT_{t-1}	-0.020*	-0.020*	-0.019	-0.014
	(-1.676)	(-1.790)	(-1.619)	(-1.253)
Controls	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y
*Industry*Year FE*	Y	Y	Y	Y
N	7,344	7,344	7,345	7,345
Adj_R^2	0.253	0.253	0.300	0.300

Table 11 Alternative Explanations

This table examines alternative explanations of the relation between local policy uncertainty and firm innovation. *LogPatent_apply* indicates the logarithm of one plus the number of invention patent applications filed by a firm in year t. *LogPatent_grant* indicates the logarithm of one plus the number of invention patent applications filed and eventually granted by a firm in year t. *PT* is a dummy variable equals to one if the city head of firm's location is replaced in year t and zero otherwise. All control variables are defined in Table A1 in Appendix. Robust standard errors are clustered at the city level. T-statistics are reported in parentheses. All columns control for firm-, year-, and industry-times-year fixed effects. The sample year t is from 1999 to 2009. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

Panel A: The age of city head

	$LogPatent\_apply_{t+1}$		$LogPatent\_grant_{t+1}$	
	Younger city head	Older city head	Younger city head	Older city head
	(1)	(2)	(3)	(4)
PT_t	0.062**	0.080**	0.021	0.069*
	(2.162)	(2.110)	(0.869)	(1.844)
Controls	Y	Y	Y	Y
Firm/Industry-Year FE	Y	Y	Y	Y
N	2,786	3,502	2,786	3,502
Adj_R^2	0.751	0.833	0.690	0.749

Panel B: The hierarchy of the firm

	$LogPatent\_apply_{t+1}$		$LogPatent\_grant_{t+1}$	
	Higher-level SOE	Local SOE	Higher-level SOE	Local SOE
	(1)	(2)	(3)	(4)
PT_t	0.066***	0.061**	0.065**	0.047*
	(2.730)	(2.307)	(2.529)	(1.697)
Controls	Y	Y	Y	Y
Firm/Industry-Year FE	Y	Y	Y	Y
N	2,914	3,643	2,914	3,643
Adj_R^2	0.804	0.770	0.716	0.689

Table 11 (Continued)

Panel C: Relieving financial constraints				
	$LogPatent\_apply_{t+1}$		*$LogPatent\_grant_{t+1}$*	
	Large size	Small size	Large size	Small size
	(1)	(2)	(3)	(4)
PT_t	0.053**	0.064**	0.037	0.063**
	(2.082)	(2.447)	(1.496)	(2.396)
Controls	Y	Y	Y	Y
Firm/Industry-Year FE	Y	Y	Y	Y
N	3,293	3,205	3,293	3,205
Adj_R^2	0.677	0.843	0.589	0.758

Panel D: Curtailing overinvestment				
	$LogPatent\_apply_{t+1}$		*$LogPatent\_grant_{t+1}$*	
	High tendency	Low tendency	High tendency	Low tendency
	(1)	(2)	(3)	(4)
PT_t	0.032	0.062**	0.001	0.067***
	(1.046)	(2.280)	(0.028)	(2.755)
Controls	Y	Y	Y	Y
Firm/Industry-Year FE	Y	Y	Y	Y
N	3,040	3,203	3,040	3,203
Adj_R^2	0.788	0.814	0.736	0.725