Political Turnover and Innovation: Evidence from China

Xiaoming Zhang¹ · Weijie Luo² · Di Xiang³

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Abstract
This paper explores cycles in innovative outcomes corresponding with the timing of political turnover. Using data on local government officials and firm level innovation activities in China, firm innovation is found to be negatively associated with a turnover of local political leaders. We examine several potential explanations and find evidence supporting the premise that political turnover reduces firms’ incentives to innovate until the uncertainty is resolved. This paper also indicates that local political turnover significantly inhibits firms’ research and development investment, government subsidies, and expansion decisions, leading to less innovative outcomes. Moreover, reductions in innovation are greater in cities with higher levels of government expenditure or intellectual property rights trials, or in smaller firms or non-state-owned enterprises during the rotation of local government leaders.

Keywords Political turnover · Innovation

Introduction
How does political uncertainty affect firms’ investment decisions? Referencing Julio and Yook [20], Luo and Zhang [29] analyze the effect of political uncertainty (such as political turnover) on firms’ incentives to innovate. Their theoretical argument is that firms’ intensity of research and development (R&D) input declines during the

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Weijie Luo
luoweijie@cufe.edu.cn; w.luo@york.ac.uk

¹ School of Public Policy & Management, Tsinghua University, Beijing, People’s Republic of China

² Center for China Fiscal Development, Central University of Finance and Economics, Beijing, People’s Republic of China

³ Economic Department, University of Chinese Academy of Social Sciences, Beijing, People’s Republic of China
time of political turnover because investment decisions are postponed until some or all of the uncertainty is resolved.

This paper further develops the Luo and Zhang [29] hypothesis to consider how political uncertainty affects firms’ incentives to innovate, in particular the effect of local political turnover. The main theoretical prediction is that innovative outcomes will demonstrate a falling trend over the period of political turnover as investment and expansion decisions are suspended. The logic is similar to Luo and Zhang [29]. The uncertainties related to rotations in local political leadership and/or government policy have an influence on firms’ innovation behavior. Analogous to the China-US trade war and the recent pandemic, there is considerable uncertainty regarding how local governments will respond to and address such challenges. This uncertainty may inhibit recovery by leading firms to temporarily cease investment and innovative activities, resulting in less innovation until the uncertainty associated with future policy is resolved.

In most theoretical literature, investment is the only outcome variable of the “uncertainty-economic outcomes” debate (see [3, 5]). However, investment is not the only outcome variable referred to economic growth. After the reform and opening-up policy, the performance of China’s economy is undoubtedly spectacular and exceptional. Unfortunately, as observed, the annual growth rate has unexpectedly “broken eight” (percent) since 2012 and moderated further. According to the National Bureau of Statistics, China’s annual growth rate has slowed to below 8% from 2012 onwards. This is unexpected, and yet somehow inevitable, given the increased level of labor cost and shrinking working-age cohort. Beyond that, weak innovation output due to political turnover in local leaders can also partially account for the moderation of growth, as it has been argued that innovation plays a key role in economic growth [35]. The moderation of growth implies that China’s economy is transforming from quantity-focused into quality-oriented development. Top leaders in China consider innovation to be one of the key driving forces for the country’s future economic growth.1 For example, the Chinese government began to evaluate and award the cities with the title of “National Intellectual Property Rights Model City” in 2012, and innovation was listed as the first guiding principle of economic policy in the 13th Five-Year Plan released in 2016. Despite this, the performance of growth-promoted innovation falls far from expectations.

Figure 1 plots the average number of patents for listed Chinese companies between 2005 and 2017. The figure demonstrates that companies experienced an upward trend in the earlier years followed by a period of stasis since around 2016. Notably, in 2006, the State Council of China released the “Outline of the National Medium-to-Long Term Science and Technology Development Program (2006–2020),” and concurrently, China agreed to follow World Trade Organization conventions, implementing a complete revision to the nation’s intellectual property rights (IPR) legal framework, which resulted in a steady increase in innovation.

This paper focuses on panel data covering 3,044 Chinese listed firms over the period 2008–2017. The central empirical question we examine is how local political

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1 Teets and Noesselt [41] explore the state of the field for governance and policy innovation in China.
turnover affects Chinese firms’ innovative output (i.e., the number of patent applications). We treat the turnover of the secretary of the municipal party committee and/or the mayor of the municipalities as the measurement of political uncertainty because the local officials have the political power to affect the implementation of certain policies on behalf of the government [19]. Specifically, we compare the innovation output of listed firms located in cities with turnover in mayor and/or municipal party secretary, to that of listed firms located in cities without this uncertainty.

Our analysis uses data on local government officials and firm-level data to reveal three main findings. First, decreases in innovation are significantly larger in cities with a turnover in mayor and/or municipal party secretary. On average, the (log) number of patents falls by 0.027 in the political turnover city compared to counterparts. Second, the reduction in innovation is greater in cities with higher degrees of government expenditure or IPR trials, or in smaller firms during the rotation in the local government leaders. Third, we find evidence supporting that local political turnover significantly reduces firms’ R&D investment, the level of government subsidies, and the firms’ decision of expansion, resulting in smaller size of innovative outcomes.

This paper makes two crucial contributions to the current literature. First, previous literature working on the politics-economic outcomes analysis primarily focuses on developed countries, whereas this paper investigates this theory in a developing country. A further attempt to analyze the effect of politics on innovation beyond firms’ investment decisions is also presented. Second, given that China is currently

![Fig. 1 The trend in total number of patents of Chinese listed companies](image-url)
shifting to innovation-encouraged strategies (i.e., from imitation to innovation), our results demonstrate local political turnover as a new explanation of the slowdown in innovation in China in recent years, shedding light on the future economic transition to potentially inform strategic policymaking.

This paper is also related to the literature on the role of political turnover in firm innovation [29]. Luo and Zhang [29] show that corporate R&D investment tends to fall during periods of political turnover. The innovation effect we investigate differs from their assessment in at least three ways. First, we examine the impact of political turnover on innovative outcomes, such as the number of patent applications, using the category of patents (i.e., invention patents and utility patents), whereas Luo and Zhang [29] only capture the influence on the intensity of firm R&D input. Second, we extend to the assessment to the quality of innovation changes with political turnover (i.e., the granted number and breadth of patents), which Luo and Zhang [29] do not concentrate on. Third, the relationship between firm R&D investment and political turnover analyzed by Luo and Zhang [29] represents one possible mechanism in our analysis, given that the rotation of political leaders has an impact on fiscal policy and R&D input.

The remainder of the paper is organized into five sections. The next section introduces the existing literature. “Theory” section presents the theory related to the study. “Data and Methodology” section describes the data and the methodology. “Empirical Results” section details the estimation results, and “Conclusion” section concludes.

**Literature Review**

Political turnover is commonly regarded as reconstructing the relationship between government, enterprise, and resource allocation patterns in the local area [32]. The turnover of officials destabilizes the political environment and leads to political risk and information asymmetry, which could have a negative influence on the corporate behavior (see [6, 24]), and innovation efforts. This influence can be divided into three categories. First, political turnover or political uncertainty could reduce the quality of market information and increase the “value of waiting,” causing a reduction in investment [20]. Among all kinds of investment, R&D investment is more likely to be affected by such uncertainty [16]. In addition, access to loans positively affects the probability that a firm will invest in innovation, whereas the positive effect of private debt on innovation investment is significantly moderated by political instability [10].

Second, political turnover generates discontinuity and instability in economic policy, which could have an adverse impact on local economic growth [19]. Given the background of fiscal decentralization [33] and promotion competition in China [25], local government policymakers tend to adopt a set of short-term-oriented policies regardless of long-term benefit and/or cost. Under these circumstances, the political uncertainty of political turnover could lead to policy discontinuity and hinder innovation activities that are more likely to thrive in a more stable environment with more predictable future benefit.
Third, political turnover could raise investment risk and have an impact on the return on investment, bond rates, and exchange rates [24, 30]. For example, Pastor and Veronesi [31] assert that during recession periods, political uncertainty will have an influence on capital pricing. Arnold and Vrugt [2] also note that political turnover could result in a potential adjustment of current economic policy, increasing difficulties in firms’ calculation of expected return on investment. This rise in uncertainty further reduces firms’ investment. Specifically, Gulen and Ion [17] estimate that firms decrease investment by 4.8% during a nationwide election period. Although previous literature has demonstrated that political turnover has a negative impact on enterprises’ investment and innovation behavior, some scholars purport an opposite view. Julio et al. [22] argue that political uncertainty could increase a patent’s option value, demonstrating that under the assumption that the expected value of underlying assets remains unchanged, political uncertainty has a positive effect on patent applications. However, this positive association is related to the education level of officials and the political regimes. Shi et al. [38] determine that official rotation significantly promotes corporate innovation, including enterprises’ innovation investment, quantity, and quality. The effect of official rotation on corporate innovation varies due to the heterogeneity of both officials and regions. In view of the discussions above, we believe that the influence of policy uncertainty and/or political turnover on enterprises’ innovation behavior is complex, depending on multiple factors, such as culture, politics, regional variations, and officials’ personal characteristics.2

Additionally, previous literature predominantly focuses on developed countries, such as the US, the UK, and Germany, which have established mature and perfect market-oriented economies [24, 30, 36]. Compared with developed countries, the government of China has a much more significant influence on economic activities. Theoretically, political turnover in China could generate heightened uncertainty in the market. Besides, due to the infrequency of nationwide elections, many scholars have used cross-country election data to investigate the impact of political uncertainty on economic outcomes [4, 20, 21]; however, different countries might have considerably diverse features in histories, institutions, and other highly relevant considerations. Such unobservable variables could result in biased estimations when the cross-country data is employed. To address this issue, we use data on political turnover at prefecture-level cities in China to investigate this relationship, which is expected to achieve more reliable estimation results.

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2 A series of recent literature (i.e., [15, 28, 34]) investigates the relationship between policy uncertainty on firm performance in China, while others attempt to test the Porter hypothesis in China [37]. In the meantime, Zhang et al. [47] emphasize the importance of local leaders during the prevention and control of COVID-19 in China and Luo [26] argues that the professional experience of local leader has a key influence on China’s local government size, under the premise of frequent political turnover of local officials in China [27].
**Theory**

There is a prevalence of interest in the coalition relationships between government and firms in the market [12]. In contrast to western countries, China’s local officials serve as the legal representatives of government powers in the region in charge. With the major power of resource allocation, local officials have a positive and key influence on economic development [48]. As major participants in local economy, local firms directly or indirectly contribute the highest proportion to local economy and tax revenue. Given the inherent incentives and motivations of China’s competitive promotion mechanism, local governments led by local officials have a strong political motivation to affect or even intervene with local firms. Firms also have an incentive to conduct political rent-seeking to acquire political advantages in the process of market resource allocation and attain great interests and influence [23, 39, 40]. Therefore, it is easy to achieve tacit cooperation between local governments and firms, further developing an interest coalition. Local officials have the motivation and capacity to intervene with firms in the region where they are in charge [32]. Additionally, such political coalitions can have an impact on firms’ behavior, such as mergers and acquisitions, financing, and investment [13, 45, 46]. China’s current system of leading cadre rotation has normalized the turnover of local officials. The rotation of officials indicates a transfer of political power and changes in officialdom competition within a region. The fluctuations of the political environment have a direct effect on firms’ production and operating activities [43]. In theory, there are three channels through which political turnover affects firm innovation.

First, the existence of short-term of tenure, promotion competition, and weeding out mechanisms intensifies officials’ propensities for short-term resource allocation, leading to minimal support for firm innovation. As local officials are normally rotated within two or three years [27], under the performance evaluation system, incumbent officials are likely to adopt more short-term economic simulation policies to achieve more demonstrable results during their tenure compared to predecessors. They may conduct short-term vanity projects or expansion strategies, such as increasing land conveyance, high investment, and excessive leverage [43, 44], however, as the period for which supportive policies encouraging firm innovation is long-term, local officials do not prefer such strategies, firms’ innovative activities are hardly endorsed by local governments.

Second, the rotation of officials disrupts the existing political ecology. For the firms that participate in interest coalitions in particular, political turnover interrupts the original relationship between governments and firms. The political rent acquired by firms falls dramatically, and investment and credit resources are also affected [42]. When the coalition between governments and firms is re-established, asymmetric information regarding the incumbent official has an influence on the establishment and maintenance of such relationship. This naturally increases firms’ rent-seeking expenditure [11], crowding out innovative input. Despite this, it is difficult to observe what rent-seeking activities entail and the proportion of firms that are engaged in rent-seeking, as this is both unobservable.
and not publicly disclosed. However, it is also possible for firms to avoid bribing officials to protect property rights and achieve innovation. Under the premise of raised wages and the fade-away favorable dependency ratio in China, the “Outline of the National Intellectual Property Strategy” was launched by the State Council of China in 2008, aiming to encourage firms’ innovative output through improving IPR protection standards. In this context, cities need to apply for the title of “National Intellectual Property Rights Model City” and to be evaluated by the Chinese State Intellectual Property Office. This (whether firms can avoid bribing officials to protect property rights and achieve innovation) remains an open question, as the applications for this title are managed by local governments.

Third, political turnover results in discontinuity and uncertainty regarding policy, further affecting firm innovation. As local officials are economic policymakers and executors, their rotation generates discontinuities in policy between the predecessor and the incumbent, intensifying the risk of policy changes and the risk of exit and shutdown for firms [43]. This leads to uncertain expectations among micro economic agents, weakening firms’ incentive to conduct R&D and innovation. Subsequently, policy uncertainty due to political turnover increases firms’ policy costs [9]. As the extent of information asymmetry in the market due to the rotation rises, it is difficult for firms to evaluate the style of the incoming government in relation to the policy trend of the incumbent. In response, firms tend to adopt expenditure reductions, such as postponing or cutting investment and innovation expenditure [1, 7, 29, 42] to allow time to better understand and respond to changes in political environment.

Data and Methodology

This paper uses a firm-level panel dataset to examine how political turnover in local leaders affects innovative output in China. Following Chen and Puttitanun [8] and Fang et al. [14], we use patents as a proxy for firm-level innovation. The key dependent variable is the natural logarithm of the number of patent applications, ln(patent + 1), measured at the (listed) firm level over the period 2008–2017. We also use two patent types as alternative measurements of innovation in the econometric analysis below. The first patent category is invention patents, ln(invention patent + 1), which signal the highest innovative content since they incorporate novel technologies, and the second is the category of utility patents, ln(utility patent + 1), accounting for new applications that are applicable to existing technologies. Table 1 presents descriptive statistics of the variables used in the regression analysis.

Under the premise of raised wages and the fade-away favorable dependency ratio in China, the “Outline of the National Intellectual Property Strategy” was launched by the State Council of China in 2008, aiming to encourage firms’ innovative output. As a result, the quantity of Chinese patent fillings and approvals has exploded over

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3 The related patent data for Chinese firms are from the China Stock Market & Accounting Research (CSMAR) Database.
the last decade. The number of domestic valid ownership of patents for inventions had a dramatic jump, from 96,000 to 1.356 million, between 2007 and 2017, and the number of granted patents for invention per 10,000 people increased from 0.6 to 9.8. 4

Following Luo and Zhang [29], political turnover is measured for firms located in a city with a rotation in mayor and/or party secretary in the current year. 5 The political circumstances in China are unique, in which the turnover in local governments primarily depends on the turnover in local government leaders. The Provisions on the Exchange of Party and Government Leading Cadres (promulgated by

Table 1 Descriptive statistics

| Variable                          | Obs  | Mean  | Std.dev | Min  | Max  |
|----------------------------------|------|-------|---------|------|------|
| ln(patent + 1)                   | 26,017 | 1.130 | 1.509   | 0    | 5.278 |
| ln(invention patent + 1)         | 26,017 | 0.771 | 1.177   | 0    | 4.431 |
| ln(utility patent + 1)           | 26,017 | 0.717 | 1.191   | 0    | 4.466 |
| Political turnover               | 26,017 | 0.391 | 0.488   | 0    | 1    |
| Size                             | 26,017 | 7.362 | 1.319   | 4.127| 10.92 |
| SOE                              | 26,017 | 0.328 | 0.469   | 0    | 1    |
| ROE                              | 26,017 | 12.51 | 14.13   | -35.37| 63.66 |
| Leverage                         | 26,017 | 3.649 | 0.589   | 1.800| 4.560 |
| Cash flow                        | 26,017 | 2.508 | 2.703   | 0.257| 17.32 |
| Tertiary industry                | 26,017 | 51.74 | 13.24   | 25.79| 80.23 |
| Science expenses                 | 26,017 | 0.0368| 0.0210  | 0.00392| 0.0958 |
| Education expenses               | 26,017 | 0.165 | 0.0367  | 0.0819| 0.267 |
| GDP growth                       | 26,017 | 0.0888| 0.135   | -0.610| 0.279 |
| ln(granted patent + 1)           | 26,017 | 0.847 | 1.311   | 0    | 5.050 |
| ln(granted invention patent + 1) | 26,017 | 0.266 | 0.637   | 0    | 3.045 |
| ln(granted utility patent + 1)   | 26,017 | 0.667 | 1.161   | 0    | 4.663 |
| IPC per patent                   | 11,115 | 0.799 | 0.462   | 0.100| 2.667 |
| IPC per invention patent         | 9,960  | 0.872 | 0.548   | 0.0909| 3    |
| IPC per utility patent           | 8,598  | 0.771 | 0.409   | 0.0975| 2    |
| R&D intensity                    | 19,920 | 59.99 | 114.5   | -100.5| 820.0 |
| Subsidy intensity                | 20,588 | 1.248 | 1.952   | 0    | 11.44 |
| ln(loans + 1)                    | 19,623 | 10.54 | 2.052   | 5.210| 15.55 |
| ln(interest + 1)                 | 21,648 | 7.209 | 2.474   | 0    | 12.49 |

The table presents descriptive statistics for the variables

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4 In addition to the domestic achievement, China also had an impressive performance at the international level. For instance, the number of “Patent Cooperation Treaty” patent applications reached at 51,000 in 2017, ranking second in the world.

5 In Appendix Table 7, we also find that the relationship holds more firmly in cities with a turnover in municipal party secretary than mayor turnover, in support of the argument that the municipal party secretary plays a more significant role in local government.

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the Communist Party of China Central Committee on August 6, 2006) requires that local party committees and government leaders at or above the county level must rotate if they have served in the same position for more than 10 years, and those who have held leadership positions at the same level in the party and government leadership groups in the same region for more than 10 years should rotate. On the basis of the provisions above, in accordance with Article 58 of The Organization Law of the Local People’s Congresses and Local People’s Governments of the People’s Republic of China, the tenure of office of local governments at various levels is five years.

The evaluation and appointment process of local political leaders in China differs considerably from the democratic regimes (see [25]). Note that China’s local government leaders are appointed by officials seated on higher up the political ladder. However, this process is still away from transparent. Moreover, a turnover in local leaders can happen at any time, further generating political uncertainty. As a result, political turnover at the local level in China establishes an ideal opportunity to conduct a quasi-experiment to examine the effect of politics on innovation. The argument advanced in this paper is that innovation falls in firms located in cities with political turnover.

In the following regression analysis, we use a number of firm-level control variables, such as size (measured by the natural logarithm of employees), ownership (a dummy variable that equals one if the firm belongs to the category of state-owned enterprise and zero otherwise), the level of ROE, financial leverage, and cash flow. We also include city characteristics as further controls, such as the share of tertiary industry, science expenses (as a share of fiscal expenses), education expenses (as a share of fiscal expenses) and GDP growth. To sum up, the model central to this is

\[
\ln(\text{patent} + 1)_{i,t} = \alpha_0 + \beta(\text{Political turnover})_{i,t} + X_{i,t}'\Gamma + \alpha_i + \eta_t + u_{i,t} \tag{1}
\]

where \(i\) represents each firm, \(t\) represents each time period, and \(u_{i,t}\) is the error term. The left-hand-side variable, \(\ln(\text{patent} + 1)_{i,t}\), is a measure of innovation at firm \(i\) in year \(t\). The variable of interest is \(\text{Political turnover}\), a dummy that equals one if the firm is located in a city with a rotation in either mayor or party secretary and zero otherwise. The coefficient, \(\beta\), indicates the impact of political turnover on innovation. A positive and significant \(\beta\) suggests that political turnover exerts a positive effect on innovative outcomes, whilst a negative and significant \(\beta\) implies that the turnover lowers the level of innovation. Control variables analyzed above are included in the vector \(X_{i,t}'\). We also include a year-specific dummy variable, \(\eta_t\), to control for shocks and trends that shape innovation over time, and a firm-specific dummy variable, \(\alpha_i\), to control for time-invariant, unobserved firm characteristics that shape innovation across firms.

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6 Data on firm-level basic information (and those mentioned below) are also extracted from the CSMAR database.

7 Data on those city-level control variables are taken from the China City Statistical Yearbook.
Table 2  Basic estimation results

| DEP VAR = log of      | (1) patent + 1 | (2) invention patent + 1 | (3) utility patent + 1 | (4) patent + 1 | (5) invention patent + 1 | (6) utility patent + 1 | (7) patent + 1 | (8) invention patent + 1 | (9) utility patent + 1 |
|-----------------------|----------------|--------------------------|------------------------|----------------|--------------------------|-----------------------|----------------|--------------------------|-----------------------|
| **Political turnover**| -0.028***      | -0.016**                 | -0.019**               | -0.027***      | -0.015**                 | -0.019**              | -0.027***      | -0.015**                 | -0.019**              |
|                       | (0.010)        | (0.007)                  | (0.009)                | (0.008)        | (0.006)                  | (0.009)               | (0.009)        | (0.007)                  | (0.009)               |
| **Size**              | 0.257***       | 0.190***                 | 0.161***               | 0.255***       | 0.188***                 | 0.161***              | 0.255***       | 0.188***                 | 0.161***              |
|                       | (0.050)        | (0.038)                  | (0.047)                | (0.049)        | (0.037)                  | (0.046)               | (0.049)        | (0.037)                  | (0.046)               |
| **SOE**               | 0.343***       | 0.256***                 | 0.242***               | 0.340***       | 0.253***                 | 0.241***              | 0.340***       | 0.253***                 | 0.241***              |
|                       | (0.102)        | (0.081)                  | (0.083)                | (0.102)        | (0.081)                  | (0.083)               | (0.102)        | (0.081)                  | (0.083)               |
| **ROE**               | -0.016***      | -0.010***                | -0.010***              | -0.016***      | -0.010***                | -0.010***             | -0.016***      | -0.010***                | -0.010***             |
|                       | (0.002)        | (0.001)                  | (0.002)                | (0.002)        | (0.001)                  | (0.002)               | (0.002)        | (0.001)                  | (0.002)               |
| **Leverage**          | -0.478***      | -0.268***                | -0.316***              | -0.477***      | -0.267***                | -0.315***             | -0.477***      | -0.267***                | -0.315***             |
|                       | (0.059)        | (0.036)                  | (0.059)                | (0.058)        | (0.035)                  | (0.059)               | (0.058)        | (0.035)                  | (0.059)               |
| **Cash flow**         | -0.001         | 0.003                    | -0.004                 | -0.001         | 0.003                    | -0.004                | -0.001         | 0.003                    | -0.004                |
|                       | (0.006)        | (0.005)                  | (0.006)                | (0.006)        | (0.005)                  | (0.006)               | (0.006)        | (0.005)                  | (0.006)               |
| **Tertiary industry** | -0.033         | -0.001                   | -0.004*                | -0.033         | -0.001                   | -0.004*               | -0.033         | -0.001                   | -0.004*               |
|                       | (0.003)        | (0.002)                  | (0.002)                | (0.003)        | (0.002)                  | (0.002)               | (0.003)        | (0.002)                  | (0.002)               |
| **Science expenses**  | 2.115**        | 2.556***                 | 1.187*                 | 2.115**        | 2.556***                 | 1.187*                | 2.115**        | 2.556***                 | 1.187*                |
|                       | (1.016)        | (0.873)                  | (0.639)                | (1.016)        | (0.873)                  | (0.639)               | (1.016)        | (0.873)                  | (0.639)               |
| **Education expenses**| 1.212**        | 1.025***                 | 0.681                  | 1.212**        | 1.025***                 | 0.681                 | 1.212**        | 1.025***                 | 0.681                 |
|                       | (0.492)        | (0.370)                  | (0.443)                | (0.492)        | (0.370)                  | (0.443)               | (0.492)        | (0.370)                  | (0.443)               |
| **GDP growth**        | 0.049          | 0.036                    | -0.033                 | 0.049          | 0.036                    | -0.033                | 0.049          | 0.036                    | -0.033                |
|                       | (0.108)        | (0.074)                  | (0.088)                | (0.108)        | (0.074)                  | (0.088)               | (0.108)        | (0.074)                  | (0.088)               |
| **Year FE**           | Yes            | Yes                      | Yes                    | Yes            | Yes                      | Yes                   | Yes            | Yes                      | Yes                   |
| **Firm FE**           | Yes            | Yes                      | Yes                    | Yes            | Yes                      | Yes                   | Yes            | Yes                      | Yes                   |
| **Observations**      | 26,017         | 26,017                   | 26,017                 | 26,017         | 26,017                   | 26,017                | 26,017         | 26,017                   | 26,017                |
| **Firms**             | 3,044          | 3,044                    | 3,044                  | 3,044          | 3,044                    | 3,044                 | 3,044          | 3,044                    | 3,044                 |
In columns (1), (4) and (7) the dependent variable is the natural logarithm of the number of patent applications, ln(patent + 1). In columns (2), (5) and (8) the dependent variable is the natural logarithm of the number of invention patent applications, ln(invention patent + 1). In columns (3), (6) and (9) the dependent variable is the natural logarithm of the number of utility patent applications, ln(utility patent + 1). Estimations use panel regression with firm fixed effects and robust standard errors clustered by industry in parentheses. Year dummies are included in all regressions. Columns (1)-(3) are simple specification with just the turnover dummy using annual data OLS regression. Columns (4)-(6) extend columns (1)-(3) to include the firm-level characteristics (i.e. Size, SOE, ROE, Leverage and Cash flow) as control variables. Columns (7)-(9) then add the city-level characteristics (i.e. Tertiary industry, Science expenses, Education expenses and GDP growth) on the right-hand side. *, **, and *** respectively denote significance levels at 10%, 5% and 1%.

| DEP VAR = log of | (1) patent + 1 | (2) invention patent + 1 | (3) utility patent + 1 | (4) patent + 1 | (5) invention patent + 1 | (6) utility patent + 1 | (7) patent + 1 | (8) invention patent + 1 | (9) utility patent + 1 |
|-----------------|----------------|--------------------------|----------------------|----------------|---------------------------|----------------------|----------------|--------------------------|----------------------|
| Rs² (within)    | 0.122          | 0.117                    | 0.084                | 0.209          | 0.176                     | 0.137                | 0.210          | 0.177                    | 0.138                |
Empirical Results

This section is to test whether and how innovation across different firms systematically changes with political turnover. Column 1 of Table 2 presents a simple specification including only a measure of turnover dummy in the presence of fixed firm and year effects, applying an annual data OLS regression, with robust standard errors clustered by industry. This demonstrates the raw correlation in which we see a negative and significant relationship. Columns 2 and 3 instead use the alternative measures of innovation, invention and utility patents, respectively. Columns 4–6 then extend columns 1–3 to include the firm-level characteristics (i.e., size, ownership, the level of ROE, Leverage, and Cash flow) as control variables. In these specifications the sign of the coefficient estimate relating to the turnover dummy is negative in all cases, and statistically significant at (at least) the 5% level. This is consistent with our argument—a frequent turnover in local political leaders (firms operating in a more uncertain environment) inhibits innovation. Columns 7–9 further add city-level characteristics (i.e., Tertiary industry, Science expenses, Education expenses, and GDP growth) on the right-hand side. The results using full controls support those already found. The estimated statistical significance of turnover dummy is unaffected and even remains at the 1% level in column 7. Using the estimate from column 7 of Table 2, patent applications are found to fall by about 3% in the years with political turnover, holding all else equal.

Table 3 explores robustness checks in the presence of full control variables, fixed firm and year effects. The analysis so far concentrates on the quantity of patents, whilst this is hardly the only crucial measure of innovation. For this reason, it is essential to assess whether and how the quality of patents varies with political turnover. Columns 1–3 thus present the results with respect to the granted number (in the next 3 years following application) according to the patent category as the measure of patent quality, whereas columns 4–6 instead use the breadth of corresponding patents (such as the number of the International Patent Classification groups based on the first four letters per patent application) as the left-hand-side variable. These estimated results clearly demonstrate that the turnover dummy is statistically insignificant in relation to patent quality. This suggests that the number of patent applications declines as a result of turnover, whilst its influence on quality is rather limited.

The industrial policies outlined in the 12th and 13th Five-Year Plans can also shape innovation across industries. Therefore, column 7 of Table 3 extends column 7 of Table 2 to incorporate an interaction term of industry and year dummies to control industrial policy shocks. Since a turnover in both mayor and party secretary in one city in the same year may bring about a substantial shock on innovation, column 8, based on column 7, then excludes observations with simultaneous turnover. In Appendix Table 8, we find that when party secretary and mayor are rotated in the same year, this can create a particularly substantial shock compared to the rotation of either position. In this table, we use Simultaneous turnover (0 = neither turnover, 1 = turnover in either municipal party secretary or mayor, 2 = both turnover) as the key independent variable instead of Political turnover. As expected, the rotation of both posts has a greater effect on the government-business relationship compared to the turnover of one position.

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8 Data on the quality of patents are also obtained from the CSMAR database.
9 In Appendix Table 8, we find that when party secretary and mayor are rotated in the same year, this can create a particularly substantial shock compared to the rotation of either position. In this table, we use Simultaneous turnover (0 = neither turnover, 1 = turnover in either municipal party secretary or mayor, 2 = both turnover) as the key independent variable instead of Political turnover. As expected, the rotation of both posts has a greater effect on the government-business relationship compared to the turnover of one position.
Table 3 Robustness check

| DEP VAR = | (1) log of granted patent + 1 | (2) log of granted invention patent + 1 | (3) log of granted utility patent + 1 | (4) IPC per patent | (5) IPC per invention patent | (6) IPC per utility patent | (7) log of patent + 1 | (8) log of patent + 1 | (9) log of patent + 1 |
|-----------|-----------------------------|----------------------------------------|---------------------------------------|--------------------|-----------------------------|--------------------------|----------------------|----------------------|----------------------|
| Political turnover | -0.018 | 0.000 | -0.018 | -0.009 | -0.001 | -0.004 | -0.022*** | -0.031*** | -0.033*** |
| | (0.012) | (0.007) | (0.013) | (0.007) | (0.008) | (0.007) | (0.008) | (0.011) | (0.011) |
| Firm characteristics | Included | Included | Included | Included | Included | Included | Included | Included | Included |
| City characteristics | Included | Included | Included | Included | Included | Included | Included | Included | Included |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm FE × Industry FE | No | No | No | No | No | No | No | No | No |
| Sample | Full | Full | Full | Full | Full | Full | Full | Full | Full |
| Observations | 26,017 | 26,017 | 26,017 | 26,017 | 26,017 | 26,017 | 26,017 | 26,017 | 26,017 |
| Firms | 3,044 | 3,044 | 3,044 | 3,044 | 3,044 | 3,044 | 3,044 | 3,044 | 3,044 |
| $R^2$(within) | 0.122 | 0.117 | 0.084 | 0.209 | 0.176 | 0.137 | 0.210 | 0.177 | 0.138 |

In column (1) the dependent variable is the natural logarithm of the number of granted patent applications (in the next three years), ln(granted patent + 1). In column (2) the dependent variable is the natural logarithm of the number of granted invention patent applications (in the next three years), ln(granted invention patent + 1). In column (3) the dependent variable is the natural logarithm of the number granted utility patent applications (in the next three years), ln(granted utility patent + 1). In column (4) the dependent variable is the number of the International Patent Classification (IPC) groups (according to the first four letters) per patent application, IPC per patent. In column (5) the dependent variable is the number of the IPC groups (according to the first four letters) per invention patent application, IPC per invention patent. In column (6) the dependent variable is the number of the IPC groups (according to the first four letters) per utility patent application, IPC per utility patent. In columns (7)-(9) the dependent variable is the natural logarithm of the number of patent applications, ln(patent + 1). Estimations use panel regression with firm fixed effects and robust standard errors clustered by industry in parentheses. Full control variables (i.e., Size, SOE, ROE, Leverage, Cash flow, Tertiary industry, Science expenses, Education expenses and GDP growth) and year dummies are included in all regressions. Column (7) includes an interaction term of industry and year dummies. Column (8), based on column (7), excludes the observations that both the municipal party secretary and mayor in the same city experience political turnover in the same year. Column (9), based on column (7), only considers the observations after 2012. *, **, and *** respectively denote significance levels at 10%, 5% and 1%.
is also of interest to examine whether the results vary in an era of anti-corruption since the 18th National Congress of the Communist Party of China, as the turnover in local leaders becomes more frequent but unexpected.\textsuperscript{10} The last column contains results with the subsample after 2012. The significant findings again confirm our argument.

To avoid the estimated results being generated by contemporary stochastic factors, we also conduct a placebo test as a robustness check. To be specific, the timing of turnover is randomly distributed following the Monte Carlo method. Then we repeat the fixed effects estimation 1000 times, and extract the $t$-statistic in the placebo test. Figure 2 presents the results. As we can see, as for the indicators of firm innovation, the natural logarithm of the number of patent applications, the natural logarithm of the number of invention patent applications, and the natural logarithm of the number of utility patent applications, the distribution of the $t$-statistic (of the coefficient we are interested in) mostly clusters around the value of 0, and their $t$-statistic is predominantly less than that in the actual regression (3.12, 2.28, 2.05). This states that the estimated results are unlikely to be affected by contemporary stochastic factors, and our results are robust.

Table 4 presents the heterogeneity and uses the same specifications as columns 7–9 of Table 2. The analysis investigates the relationship across the characteristics of firm’s location, such as the level of public expenditure and the number of IPR trials, in the first-half of the table, and reveals two notable findings. First, cities with a higher level of public expenses naturally have more government intervention. Once the business environment in which firms operate becomes relatively uncertain, then the effect on innovation is more significant. Second, cities with more IPR trials indicate more powerful protection; thus, innovation in these cities is more sensitive to a local leader turnover, as the protection mainly relies on government regulation.\textsuperscript{11}

Additionally, it is natural to see whether or not the reported results vary under the ownership of the firm. The third panel of Table 4 contains the results for firms classified as state-owned or non-state-owned enterprises. When the sample is split, it is clear that the negative association between political turnover and innovation holds for the subsample of non-state-owned enterprises, for the state-owned enterprises will be relatively well looked after regardless of turnover. It is also similar to examine whether the results change based on firm size. The last panel splits the sample by firm size according to the median value of the number of employees. The

\textsuperscript{10} Since Xi Jinping became the General Secretary of the Communist Party of China in China, enormous political changes has taken place in China (see [18]).

\textsuperscript{11} We also explore how the estimated results change with the level of marketization in Appendix Table 9. In the areas with a higher level of marketization, the number of patent applications (in particular, the number of invention patent applications) falls further after the rotation of local leader. Typically, firms located in a place with lower level of marketization are more likely to establish informal relationships with local government (i.e., bribery, therefore, political turnover has an impact on these informal relationships, and firms will face greater uncertainty during the period of turnover, leading to a significant decline in innovative output. Our results show that the rotation of local leader does not affect informal relationships, since political resources (provided by the local leader, who might have rotated) continue to play a key role in the success of firms.
**Fig. 2** Results of the placebo test
### Table 4 Heterogeneity

| Panel A | Higher level of government expenditure | Lower level of government expenditure |
|---------|----------------------------------------|---------------------------------------|
| **Political turnover** | -0.068** (-0.030) | -0.044** (0.020) | -0.058** (0.028) | -0.002 (0.010) | 0.002 (0.010) | -0.001 (0.010) |
| **Observations** | 12,996 | 12,996 | 12,996 | 13,021 | 13,021 | 13,021 |
| **Firms** | 1,505 | 1,505 | 1,505 | 1,539 | 1,539 | 1,539 |
| **$R^2$(within)** | 0.190 | 0.163 | 0.117 | 0.234 | 0.194 | 0.163 |

| Panel B | More IPR trials | Less IPR trials |
|---------|------------------|------------------|
| **Political turnover** | -0.052*** (0.016) | -0.033** (0.013) | -0.037* (0.021) | -0.022* (0.011) | -0.010 (0.010) | -0.013 (0.008) |
| **Observations** | 13,099 | 13,099 | 13,099 | 12,918 | 12,918 | 12,918 |
| **Firms** | 1,577 | 1,577 | 1,577 | 1,467 | 1,467 | 1,467 |
| **$R^2$(within)** | 0.226 | 0.182 | 0.148 | 0.198 | 0.176 | 0.132 |

| Panel C | SOE | Non-SOE |
|---------|-----|---------|
| **Political turnover** | -0.016 (0.014) | -0.009 (0.012) | -0.006 (0.012) | -0.028*** (0.011) | -0.015* (0.009) | -0.023* (0.012) |
| **Observations** | 9,695 | 9,695 | 9,695 | 16,322 | 16,322 | 16,322 |
| **Firms** | 1,022 | 1,022 | 1,022 | 2,022 | 2,022 | 2,022 |
| **$R^2$(within)** | 0.094 | 0.093 | 0.069 | 0.278 | 0.232 | 0.188 |

| Panel D | Larger size | Smaller size |
|---------|-------------|-------------|
| **Political turnover** | -0.025 (0.021) | -0.013 (0.014) | -0.019 (0.018) | -0.029* (0.015) | -0.018* (0.010) | -0.018 (0.015) |
| **Observations** | 13,003 | 13,003 | 13,003 | 13,014 | 13,014 | 13,014 |
| **Firms** | 1,452 | 1,452 | 1,452 | 1,592 | 1,592 | 1,592 |
| **$R^2$(within)** | 0.160 | 0.147 | 0.113 | 0.270 | 0.222 | 0.181 |
| DEP VAR = log of      | (1) patent + 1 | (2) invention patent + 1 | (3) utility patent + 1 | (4) patent + 1 | (5) invention patent + 1 | (6) utility patent + 1 |
|-----------------------|----------------|--------------------------|-----------------------|----------------|--------------------------|-----------------------|
| Firm characteristics  | Included       | Included                 | Included              | Included       | Included                 | Included              |
| City characteristics  | Included       | Included                 | Included              | Included       | Included                 | Included              |
| Year FE               | Yes            | Yes                      | Yes                   | Yes            | Yes                      | Yes                   |
| Firm FE               | Yes            | Yes                      | Yes                   | Yes            | Yes                      | Yes                   |

Regression specifications are the same as columns (7)-(9) of Table 2. Panel A divides the observations according to the level of government expenditure (measured as public expenses as a share of GDP) in the cities where the firms are located. Panel B divides the observations according to the number of intellectual property rights-related trials in the cities where the firms are located. Panel C divides the observations according to firm ownership (i.e., state-owned and non-state-owned enterprise). Panel D divides the observations according to firm size. *, **, and *** respectively denote significance levels at 10%, 5% and 1%.
innovation-turnover relationship is somewhat looser in larger firms, as innovative activities entail a great deal of risk that larger firms have the capacity to afford.

In Table 5, we assess the impact of political turnover on innovation through potential mechanisms. The first channel, shown in column 1, is through which firms undertake higher intensity of R&D, measured as the ratio of R&D expenses to profit, R&D intensity. The manner of government support, as presented in column 2, includes whether firms enjoy favorable government subsidy policies, which ultimately spurs innovation. From the perspective of expansion decisions, as outlined in the last two columns, we explore whether and how political turnover affects firms’ level of loans and interest. We assume that loans and interest are measures of expansion, as firms require funds to expand production. Across the table, we find evidence that the potential mechanism that political turnover affects innovative activities is by means of a fall in R&D expenses, government support, and a delay in expansion decisions, in support of the argument proposed.

As innovation performance is an increasingly significant aspect of local officials’ evaluation in China, the observed decline in patent applications in the turnover year is induced by the dramatic strategic innovation prior to turnover. Therefore, the last table (Table 6) explores the dynamic effects of local political turnover on firms’ patent applications to eliminate the potential impact on patent applications due to strategic innovation. We only obtain the result with negative and weak significance levels one year following the turnover. This indicates that the reduced incentives of firms to innovate due to political turnover are temporary, and will be recovered if the uncertainty is resolved, supporting the argument proposed—when facing a turnover, firms become concerned regarding the uncertainty and postpone innovation activities.

### Table 5  Mechanism test

|                  | (1)       | (2)       | (3)       | (4)       |
|------------------|-----------|-----------|-----------|-----------|
| **DEP VAR**      | R&D intensity | Subsidy intensity | log of loan + 1 | log of interest + 1 |
| Political turnover | -3.891*** | -0.044*   | -0.034*** | -0.034**  |
|                   | (1.347)   | (0.024)   | (0.011)   | (0.014)   |
| Firm characteristics | Included | Included | Included | Included |
| Year FE           | Yes       | Yes       | Yes       | Yes       |
| Firm FE           | Yes       | Yes       | Yes       | Yes       |
| Observations      | 18,852    | 20,588    | 19,623    | 21,648    |
| Firms             | 2,718     | 3,026     | 2,853     | 3,000     |
| $R^2$ (within)    | 0.118     | 0.104     | 0.440     | 0.312     |

In column (1) dependent variable is the ratio of R&D expenses to profit, R&D intensity. In column (2) dependent variable is the ratio of government subsidy to revenue, subsidy intensity. In column (3) dependent variable is the level of loan, ln(loan + 1). In column (4) dependent variable is the level of interest, ln(interest + 1). Estimations use panel regression with firm fixed effects and robust standard errors clustered by industry in parentheses. Full control variables and year dummies are included in all regressions. *, **, and *** respectively denote significance levels at 10%, 5% and 1%.
Table 6 Dynamic effects

| Panel | DEP VAR | Political turnover | Observations | Firms | $R^2$(within) | Firm characteristics | City characteristics | Year FE | Firm FE |
|-------|---------|-------------------|--------------|-------|--------------|----------------------|--------------------|---------|---------|
| Panel A. | $\ln(\text{patent } + 1)_{t-2}$ | -0.008 | 19,903 | 3,040 | 0.226 | Included | Included | Yes | Yes |
| Panel B. | $\ln(\text{patent } + 1)_{t-1}$ | -0.004 | 22,900 | 3,041 | 0.220 | Included | Included | Yes | Yes |
| Panel C. | $\ln(\text{patent } + 1)_{t+1}$ | -0.025* | 22,908 | 3,041 | 0.167 | Included | Included | Yes | Yes |
| Panel D. | $\ln(\text{patent } + 1)_{t+2}$ | -0.006 | 19,863 | 3,040 | 0.114 | Included | Included | Yes | Yes |

The table presents the results of dynamic effects. Panels A-D correspond to the effects of local political turnover in year $t$ on patent applications in years $t-2$, $t-1$, $t+1$, and $t+2$. Estimations use panel regression with firm fixed effects and robust standard errors clustered by industry in parentheses. Full control variables and year dummies are included in all regressions. *, **, and *** respectively denote significance levels at 10%, 5% and 1%.

**Conclusion**

Using data on local government officials and innovative activities at the firm level in China, this paper examines how political uncertainty affects firms’ innovative outcomes in the years surrounding local political turnover.

We find three noteworthy conclusions. First, the turnover of mayor and/or municipal party secretary is negatively associated with innovation, and the reduced incentives to innovate do not last for a long time, which will be recovered once the uncertainty is resolved. Second, the fall in innovation holds more firmly in cities with higher levels of...
public expenditure or IPR trials, or in smaller or private firms. Third, we find evidence that local political turnover significantly inhibits R&D investment, government subsidies, and the decision of expansion, leading to a smaller amount of innovative outcomes.

We believe our results contribute to the literature in two ways. First, our analysis examines the politics-economic outcomes theory in a developing country, under the premise that the existing literature mainly focuses on the case of developed countries. Second, we use local political turnover as one new explanation of the slowdown in innovation in China in recent years, which sheds light on further potential strategic remedies for successful economic transition.

One limitation of this paper is that our research has yet to identify the rich variations of listed firms. For example, state-owned firms and private firms could be affected differently by political turnover, as the current literature emphasizes the effect of connection measured by board members who are incumbent or retired officials. However, our paper still points out one further research direction. It is possible that political turnover could indirectly affect innovative outcomes through the entry of retired officials in corporate governance.

Appendix

Table 7 Political turnover of municipal party secretary and mayor

| DEP VAR = log of | (1) | (2) | (3) | (4) | (5) | (6) |
|-----------------|-----|-----|-----|-----|-----|-----|
| patent + 1      |     |     |     |     |     |     |
| invention patent + 1 |   0.003 |     |     |     |     |     |
| utility patent + 1 |     | -0.001 |     |     |     |     |
| Mayor turnover  |     |     |     |     |     |     |
| $(0.008)$       |     | $(0.005)$ |     |     |     |     |
| Secretary turnover |     |     |     |     |     |     |
| $(0.010)$       |     | $(0.007)$ |     |     |     |     |
| Firm characteristics |     |     |     |     |     |     |
| Included        |     | Included |     |     |     |     |
| City characteristics |     | Included | Included | Included | Included | Included |
| Year FE         | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm FE         | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations    | 26,017 | 26,017 | 26,017 | 26,017 | 26,017 | 26,017 |
| Firms           | 3,044 | 3,044 | 3,044 | 3,044 | 3,044 | 3,044 |
| $R^2$ (within)  | 0.210 | 0.177 | 0.138 | 0.210 | 0.177 | 0.138 |

Regression specifications are the same as columns (7)-(9) of Table 2. This table uses the turnover in mayor or the turnover in municipal party secretary as the key independent variable rather than political turnover.
Regression specifications are the same as columns (7) of Table 2. This table uses Simultaneous turnover (0 = neither turnover, 1 = turnover in either municipal party secretary or mayor, 2 = both turnover) as the key independent variable rather than political turnover.

|                        | (1)         |
|------------------------|-------------|
| **Simultaneous turnover** | -0.010*     |
|                        | (0.005)     |
| Firm characteristics   | Included    |
| City characteristics   | Included    |
| Year FE                | Yes         |
| Firm FE                | Yes         |
| Observations           | 26,017      |
| Firms                  | 3,044       |
| $R^2$ (within)         | 0.210       |

Table 8  Simultaneous turnover

\[
\text{DEP VAR} = \log \text{of } \text{patent} + 1
\]
Regression specifications are the same as columns (7)-(9) of Table 2. This table divides the observations according to the level of marketization (measured as marketization index) in the cities where the firms are located.
Declarations

Conflict of Interest I declare that the authors have no relevant or material financial interests that relate to the research described in this paper.

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Xiaoming Zhang is a doctoral student in the School of Public Policy & Management at Tsinghua University. His research interests are in public policy analysis, innovation economics and related studies. He received his undergraduate degree in Science and undergraduate degree in Economics from the Renmin University of China, and his master degree in economics from the University of Chinese Academy of Social Sciences. His research work has been published (or accepted for publication) in journals such as Journal of Chinese Political Science, Applied Economics Letters, etc.

Dr. Weijie Luo is an associate professor in economics at the Central University of Finance and Economics (CUFE). Prior to joining CUFE, Dr. Luo was a visiting researcher in economics at the University of Cambridge, and worked as an associate lecturer in economics at the University of York, where he completed his PhD in economics. His research interests are in macroeconomics, political economy and economic policy. His research work has been published (or accepted for publication) in journals such as Economics Letters, Journal of the Asia Pacific Economy, Pacific-Basin Finance Journal, Scottish Journal of Political Economy, etc. He is currently serving as an anonymous referee in journals such as International Review of Financial Analysis, North American Journal of Economics and Finance, World Development, etc.

Di Xiang is a doctoral student in the Economic Department at the University of Chinese Academy of Social Sciences, majoring in economics. Her research interest is in industrial economics, including industrial structure, industrial policy, industrial innovation and development.