# Political Turnover and Breakthrough Innovation: Evidence from China

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**Abstract.** This study investigates how political turnover affects breakthrough inventions in Chinese cities. Our empirical evidence reveals a positive correlation between political turnover and breakthrough inventions when analyzing industry-region pairs instead of focusing on individual firms or regions. The results hold firm across diverse model specifications and subsample analyses. Extending the analysis to dynamic patterns indicates that the turnover of leaders does not influence breakthrough inventions before the turnover event. As a turnover event occurs, its positive impact becomes quickly evident, but diminishes and becomes insignificant once the uncertainty is resolved. Our research further reveals that the impact of political turnover on breakthrough inventions varies significantly across industries. Specifically, the positive impact is more pronounced in complex industries and industries that do not have a relative technological advantage.

**Keywords:** Political turnover; Breakthrough inventions; Industries; China.

## 1 Introduction

China's impressive economic growth in the last four decades has been closely linked to the dedication of local government officials in securing external investment and developing local infrastructure [1]. Many scholars have acknowledged the importance of local government officials, as their competence, efficiency, and policy preferences can influence local government policy-making and consequently affect regional performance [2]. However, we still do not have a comprehensive understanding of the specific incentives that political uncertainty has on innovation, particularly when it comes to breakthrough innovation.

On the one hand, the role of political uncertainty in the innovation process has long been debated. Some studies propose that in the face of uncertainty, firms tend to be cautious and withhold investment until the uncertainty is resolved [3]. Conversely, some studies highlight the opposite effect of political uncertainty on patents. They argue that patents provide applicants with the flexibility to defer investments while


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waiting for more information about the future [4,5]. On the other hand, prior studies have regularly overlooked the effect of political turnover on innovation quality. We prioritize innovation quality due to the significant variability in the value of patents [6]. There are a few high-value patents and a majority of low-value patents. Breakthroughs, rather than ordinary innovations, hold the potential to reshape existing markets, technology trajectories, and innovation landscapes, ultimately driving long-term economic growth [7].

In this context, this paper aims to capture breakthrough innovation and subsequently to examine the impact of political turnover on these breakthroughs in China. We identify breakthrough innovation, or more specifically, breakthrough inventions, at the industry-region pairs level by combining the count of forward citations and whether it integrates two unrelated technologies for the first time.[1] In addition, we consider the turnover of mayors as an indicator of political uncertainty, as they are primarily responsible for economic policies and related affairs. Empirically, we compile an 11-year dataset (2002-2012) that covers over 250 Chinese prefecture-level cities and approximately 620 industries.

The baseline results first show that political turnover results in at least an 8% standard deviation increase in breakthrough inventions in the following year. The positive effects remain robust across a series of robustness checks. Extending the analysis to dynamic patterns indicates that the turnover of leaders does not influence breakthrough inventions before the turnover event. As a turnover event occurs, its positive impact becomes quickly evident, but diminishes and becomes insignificant once the uncertainty is resolved. Our research further reveals that the impact of political turnover on breakthrough inventions varies significantly across industries. Specifically, the positive impact is more pronounced in complex industries and industries that do not have a relative technological advantage.

The remainder of this paper is structured as follows. Section 2 provides an overview of the institutional background. Section 3 describes the data. Section 4 presents the baseline estimates and examines robustness through various tests. The last section concludes.

## 2 Institutional background

The phenomenon of political turnover, being a significant socio-political event, can reflect the inherent laws of economic transformation and social change [1]. In the early 1980s, it became a practical necessity for China's modernization to address the serious aging problem faced by the cadre team of the party and the country, and to achieve a gradual replacement of new and old cadres. In 1980, the Fifth Plenary Session of the Eleventh Central Committee proposed the abolition of life-long tenure for

[1] Typically, inventions are considered to have more value compared to utility models and design patents. Inventions require a "substantive examination", which implies stricter standards and higher levels of inventiveness, while the other two types show limited technological progress. Consequently, we develop our breakthrough measures solely based on invention filings.

leading cadres. Subsequently in 1982, the Central Committee of the Communist Party of China (CCCPC) made the Decision on Establishing a Retirement System for Veteran Cadres, thereby instituting a system for cadres to retire or retire to the second line. Under these new regulations, ministerial and provincial leaders are typically required to be under 65 years old. Similarly, cadres at the director level are generally required to be under 60 years old. This provision remains in force today. Later, in 1990, the CCCPC issued the Decision on Implementing the Exchange System for Leading Cadres of the Party and State Organs in order to train and improve the quality of cadres. This decision aimed to establish a regular system of exchanges among leading cadres. In 1995, the CCCPC also issued the Interim Regulations on the Selection and Appointment of Party and Government Leaders. These regulations specifically required the rotation of leading members of local party committees and governments who have been in the same position for 10 years. This provision has been maintained through successive amendments to the regulation. Importantly, in the 2014 amendment to the regulation, an official who has served two consecutive terms in the same position will no longer be recommended, nominated or appointed to the same position. Furthermore, in 2006, the General Office of the CCCPC issued the Interim Provisions on Tenure of Office for Party and Government Leaders, stipulating that each term for a party or government leader is five years, with a maximum limit of two consecutive terms in any given position. The aforementioned policies make political turnover a normal state of affairs in China. Thus, China presents a particularly intriguing case for the analysis of local political uncertainty.

Notably, our paper not only investigating the relationship between political turnover and inventions, but also by capturing the most valuable aspect of the invention - breakthrough inventions. We do not hold a definitive position on which explanations are most valid; instead, we allow empirical evidence to guide our conclusions.

# 3 Data

## 3.1 Data and Sample

Our empirical analysis is based on four datasets. The primary dataset, sourced from the China National Intellectual Property Administration (CNIPA), comprises approximately 9.66 million invention records from 1985 to 2018. This dataset includes details such as application, filing date, International Patent Classification (IPC) code, and the applicant's name and address, among others. Second, due to the lack of citation information for Chinese patents in CNIPA, we extracted citation data from Google Patents and integrated it with our primary dataset. Third, we employ the Chinese Political Elite Database (CPED) to gather information on individual characteristics and career trajectories of city mayors and party secretaries spanning from 2000 to 2015 [8]. The fourth dataset consists of economic and social statistical data sourced from the China City Statistical Yearbook (2002-2016). This dataset is used to define commonly referenced control variables in economic literature.

We exclude observations where: (a) cities that have more than two years missing for any control variable in our database, and (b) industries that did not exist during a specific year.[2] As we consider a five-year moving window to identify breakthrough inventions, our final dataset encompasses approximately 620 industries across roughly 250 Chinese cities for the period of 2002-2013.

### 3.2 Variables

**Dependent variables.** We define breakthrough inventions as those that are both high-impact and radical [9]. First, the impact of inventions is typically quantified by the number of cumulative forward citations they receive [10]. Accordingly, we classify an invention as a breakthrough if it receives the top 5% of forward citations within a five-year window from its filing year [11]. A five-year window is beneficial to control for the fact that older inventions are more likely to be cited [6]. According to Singh & Fleming (2009), three commonly used thresholds for forward citations are the top 1%, 5% and 10%. We thus further check the robustness with the 10% of forward citations. The reason for not including the 1% threshold is that it would be too restrictive when we introduce the second condition below. Second, we propose to assess the radicalness of an invention by examining whether it introduces a new combination of any two technologies for the first time [11]. The technical category is determined by the complete IPC code.

We then introduce a dummy variable to signify breakthrough inventions. The variable is assigned a value of one if an invention surpasses both thresholds, and zero otherwise. We fully allocate each breakthrough invention to its corresponding industry, filing year, and region. As mentioned earlier, the industry is classified at the 4-digit IPC code level. Ultimately, we use the total number of breakthrough inventions in each technology as a proxy for the occurrence of breakthrough inventions.

**Explanatory variables.** Political turnover refers to the replacement of government officials [12,13]. In a typical Chinese city, there are two leaders: the municipal party committee secretary and the mayor. The secretary holds the highest position and is responsible for creating general policies and managing the administrative aspects of the party. The mayor is the second-highest-ranking official who is responsible for city administration. This article focuses on turnover of the mayor because mayors are mainly responsible for economic policies and related affairs.

The dummy variable, Turnover, is assigned a value of one when a newly appointed official replaces the previous one, and zero otherwise. From an operational perspective, we follow Li & Zhou (2005) to determine the precise turnover year of newly appointed officials. If an official starts their term between January 1st and June 30th, the current year is considered the turnover year, and a value of one is assigned to Turnover. If an official begins their term between July 1st and December 31st, the

[2] This is because of our methodology, which involves counting all industries that existed between 1985 and 2018 before extending this count to our entire panel dataset. Industries that did not exist in earlier periods were therefore excluded from our analysis.

following year is designated as the turnover year, and Turnover is assigned a value of one.

**Control variables.** *Industry-specific control variables.* We compute the relative technological advantage (RTA) and the technological complexity index (TCI). RTA indicates whether a city has a comparative advantage in a technology, while TCI measures how complex specific technologies are across cities. A higher TCI signifies that the technology is more complex.

*City-specific* control *variables*. In line with prior literature, we introduce several commonly used indicators to control for variations in economic and social development across cities [14,15]. We use the logarithm of GDP per capita to reflect the availability of resources to support innovation. We introduce Manufacturing specialisation (work2) to account for the sectoral impact on innovation performance, as manufacturing tends to make it easier to generate new ideas and products compared to services. It is defined as the ratio of manufacturing employment to the total number of regional employment. Tertiary industries (ind3) denotes the proportion of added value from the service sector in the GDP. We control for this as transitioning the industrial structure towards the service sector is a crucial method for improving technological innovation capability. Population density (lnpopdens) is involved because it is expected to to have a positive correlation with economic and social development. We include the logarithm of the population density (population divided by land area in square kilometres) as a control variable to account for the effects of urbanisation.

### 3.3 Descriptive statistics

Panel A of Table 1 presents the annual distribution of the sample from 2002 to 2012. The years 2003 and 2008 had the highest percentages of mayor turnover, exceeding 40%. These years followed the national congresses of the Communist Party of China in 2002 and 2007. Panel B of Table 1 provides details on the distribution of government officials' tenure. Both party secretaries and mayors hold a majority tenure of 2–5 years, with percentages of 71.95% and 77.64% respectively.

**Table 1.** Summary statistics.

*Panel A: Distribution of the sample by year*

| Year | Cities | Industries | Secretary turnover (%) | Mayor turnover (%) |
|---|---|---|---|---|
| 2002 | 258 | 608 | 78 (30.23%) | 79 (30.62%) |
| 2003 | 256 | 615 | 99 (38.67%) | 118 (46.09%) |
| 2004 | 264 | 621 | 52 (19.70%) | 59 (22.35%) |
| 2005 | 258 | 621 | 55 (21.32%) | 56 (21.71%) |
| 2006 | 261 | 621 | 55 (21.07%) | 72 (27.59%) |
| 2007 | 262 | 623 | 79 (30.15%) | 103 (39.31%) |
| 2008 | 258 | 625 | 110 (42.64%) | 111 (43.02%) |
| 2009 | 260 | 628 | 28 (10.77%) | 33 (12.69%) |
| 2010 | 260 | 628 | 31 (11.92%) | 35 (13.46%) |

| | | | | |
|---|---|---|---|---|
| 2011 | 257 | 630 | 74 (28.79%) | 86 (33.46%) |
| 2012 | 260 | 629 | 91 (35.00%) | 103 (39.62%) |

*Panel B: Distribution of the Tenure*

| Tenure (No. of years) | No. of Secretary (%) | No. of Mayor (%) |
|---|---|---|
| 1 | 173 (14.27%) | 194 (14.75%) |
| 2 | 210 (17.33%) | 265 (20.15%) |
| 3 | 256 (21.12%) | 320 (24.33%) |
| 4 | 230 (18.98%) | 249 (18.94%) |
| 5 | 176 (14.52%) | 187 (14.22%) |
| 6 | 81 (6.68%) | 61 (4.64%) |
| 7 | 47 (3.88%) | 20 (1.52%) |
| 8 | 23 (1.90%) | 9 (0.68%) |
| 9 | 11 (0.91%) | 7 (0.53%) |
| 10 | 4 (0.33%) | 1 (0.08%) |
| 11 | 1 (0.08%) | 1 (0.08%) |
| 12 | | 1 (0.08%) |
| 2 ≤ Tenure ≤5 | 872 (71.95%) | 1021 (77.64%) |
| Total | 1212 (100%) | 1315 (100%) |

# 4 Main results

## 4.1 Political turnover and breakthrough inventions

The baseline model for estimating the effect of political turnover on breakthrough inventions is specified as follows in equation (1).

$$BK_{i,j,t+1} = \alpha_0 + \alpha_1 Turnover_{j,t} + \sum_m \alpha_m Controls_{i,j,t} + \theta + \gamma + \delta + \mu + f(t) + \varepsilon_{i,j,t} \quad (1)$$

where the subscripts represent industry $i$, city $j$, and year $t$. We use the number of breakthrough inventions (BK) in the following year as our dependent variables. This accounts for the time typically required for innovation processes. $\alpha_1$ is the main parameter of interest. Controls refers to a vector of control variables. The symbols $\theta$, $\gamma$, $\delta$ and $\mu$ correspond to the fixed effects of time, city, industry, and official, respectively. The term $f(t)$ stands for two distinct region-specific time trends: (1) an interaction between the province-level fixed effect and the year fixed effect, accounting for economic shocks at the province-year level; and (2) an interaction between the prefecture-level fixed effect and the linear time trend, adjusting for variations in breakthrough invention trends across cities. $\varepsilon_{i,j,t}$ is the error term. Standard errors are clustered at the industry-region pairs level in all specifications.

Our study recognizes two possible issues with endogeneity: the omission of variables and reverse causality. In the case of reverse causality, breakthrough inventions could be seen as political achievements by local officials, which are then considered by higher party committees when deciding whether to reorganize these officials. To address the potential endogeneity problem, we employ a two-stage least squares

(2SLS) regression. We use the age and tenure of officials in identical positions prior to the year of turnover ($Age_{t-1}$ and $Tenure_{t-1}$) as instruments for political turnover.

The validity of our instrumental variables (IVs) can be justified for three reasons [13]. First, according to the Decision on Establishing a Retirement System for Veteran Cadres, municipal leaders retire at the age of 60. As per the Interim Provisions on Tenure of Office for Party and Government Leaders, each term of office for Party and government leadership positions at or above the county level is five years. Individuals who have served in the same position for two consecutive terms cannot be reappointed to that position. Hence, political turnover is related to both the age and tenure of officials in identical positions prior to their year of turnover. Second, after controlling for a series of variables and applying various stringent fixed effects, it becomes nearly impossible for unobserved heterogeneity to influence political turnover. Third, projections of official tenure are based solely on past information and are not influenced by current factors. The last two points contribute to explain the orthogonality between our IVs and the error term.

Table 2 presents the baseline estimates for breakthrough inventions. Column (1) incorporates time, city, and industry fixed effects, along with industrial and economic controls. The coefficient for Turnover Mayor is -0.004, which is statistically significant at the 1% level. Column (2) provides further information by including the personal characteristics of officials as additional control variables.[3] The coefficient of Turnover Mayor switches from negative to positive, remaining statistically significant at the 1% level. A potential constraint of the specification in column (2) is that it may not fully capture all aspects of the individual competence and governance traits of local leaders by relying solely on the controlled individual characteristics of officials. Nonetheless, it is possible to control for individual fixed effects, considering that an official may serve as mayor in multiple locations. In this context, we present the results in column (3) after substituting individual characteristics with individual fixed effects. The increase in $R^2$ indicates that column (3) has higher level of explanatory power. The coefficient is 0.028 and it is statistically significant at the 1% level.

**Table 2.** Baseline results**.** Standard errors clustered at the city-industry level are in parentheses. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

| | OLS | | | | | 2SLS | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Turnover Mayor | -0.004** | 0.005** | 0.028** | 0.010** | 0.004** | | 0.008** |
| | (0.001) | (0.001) | (0.002) | (0.001) | (0.001) | | (0.001) |
| Age Last Mayor | | | | | | 0.003*** | |
| | | | | | | (0.000) | |
| Tenure Last Mayor | | | | | | 0.211*** | |
| | | | | | | (0.000) | |
| Constant | -0.577* | 2.218** | -0.013 | -1.517* | -0.672* | | |

[3] Following Deng et al. (2019), we control for individual characteristics using officials' age (Age), the quadratic term for age (Age2), and their educational background (Education).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | ** | * | | ** | ** | | |
| | (0.072) | (0.285) | (0.100) | (0.174) | (0.121) | | |
| Individual Controls | | Yes | | | | | |
| Controls | | Yes | Yes | Yes | Yes | | Yes |
| Year FEs | Yes | Yes | Yes | Yes | Yes | | Yes |
| City FEs | Yes | Yes | Yes | Yes | Yes | | Yes |
| Industry FEs | Yes | Yes | Yes | Yes | Yes | | Yes |
| Individual FEs | | | Yes | Yes | Yes | | Yes |
| Year × Province FEs | | | | Yes | | | |
| Time Trend × City FEs | | | | | Yes | | Yes |
| Observations | 1777033 | 1602512 | 1777033 | 1777033 | 1777033 | 1705244 | 1705244 |
| $R^2$ | 0.100 | 0.102 | 0.123 | 0.132 | 0.130 | | 0.003 |
| Underidentification test | | | | | | 1.26e+05 | |
| Kleibergen-Paap Wald rk F-statistics | | | | | | 4.92e+05 | |
| P-value of Hansen J statistic | | | | | | 0.258 | |

The estimates in columns (4) and (5) introduce more strict settings for time fixed effects. Column (4) incorporates province-year fixed effects to control for shocks at the province-year level, while column (5) integrates city-time trend fixed effects to capture any underlying trends specific to each city over time. Across both specifications, the sign of the coefficient remains consistent and statistically significant at the 1% level. In column (5), the coefficient of Turnover Mayor is 0.004, implying that a turnover of mayor leads to a 0.4% increase in breakthrough inventions. Considering that the average number of breakthrough inventions is 0.05, this result suggests that a change in mayorship triggers an increase in breakthrough inventions by an 8% standard deviation.

Columns (6) and (7) report the 2SLS regression results. The first-stage regression result, as shown in column (6), indicates a significant relationship between our IVs and political turnover. In column (7), the coefficient of the predicted variable is 0.008 and is significant at the 1% level. This suggests that a change in mayorship leads to a 16% standard deviation increase in breakthrough inventions. This estimate exceeds the results from column (5), implying that potential endogeneity issues might lead to an underestimation of the actual coefficients. The underidentification tests yield p-values less than 1%, demonstrating the relevance of the IVs. The values of the Kleibergen-Paap rk Wald F-statistic exceed the critical values of the Stock-Yogo weak ID test at the 10% level. This further suggests that our IVs are not weak. In addition, the p-value of the Hansen J statistic rejects the null hypothesis, implying that the IVs are exogenous. Overall, the 2SLS regression results enhance our confidence in the results of columns (2)-(5). Unless stated otherwise, we will employ the specification in column (5) as our baseline model for subsequent analyses.

### 4.2 Dynamic patterns

A prevalent concern about our analysis is that new leaders are simply appointed to regions where breakthrough inventions are more likely to occur [16]. Implementing a placebo test on the dynamic trends of breakthrough inventions following political turnover could help mitigate this endogeneity concern. The proposed model is defined as follows in equation (2):

$$BK_{i,j,t+1} = \sum_{\tau=1}^{d_1} \beta_{-\tau} Turnover_{j,t-\tau} + \beta Turnover_{j,t} \sum_{\tau=1}^{d_2} \beta_{+\tau} Turnover_{j,t+\tau}$$

$$+ \sum_m \beta_m Controls_{i,j,t} + \theta + \gamma + \delta + \mu + f(t) + \varepsilon_{i,j,t} \quad (2)$$

where the subscript $\tau$ indicates the year before or after $t$. Hereby $Turnover_{j,t+\tau}$ denotes a set of binary indicators determining whether political turnover occurs in city $j$ at time $t+\tau$. According to these definitions, $\beta_{-\tau}$ and $\beta_{+\tau}$ capture the pre-trends and post-trends of the impact of political turnover on breakthrough inventions, respectively. Considering that the average tenure of mayors in our sample is 3.26 years, and assuming that each individual experiences turnover only once within the time window $[t-d_1, t+d_2]$, it would be prudent to set $\tau$ to 2.

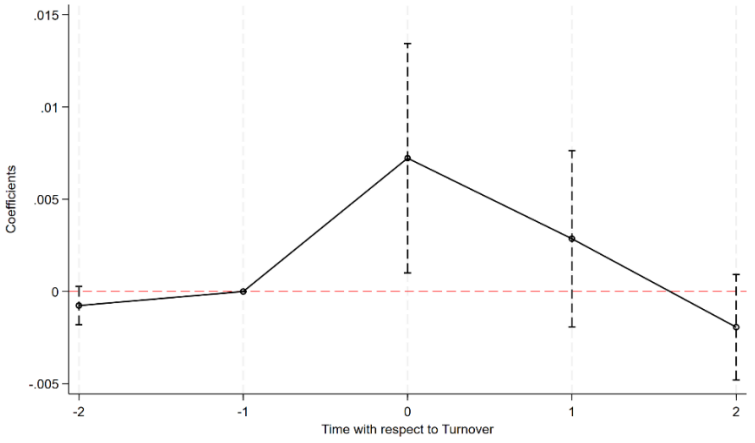


**Fig. 1.** The dynamic effects of political turnover on breakthrough inventions. The horizontal axis represents the hypothetical years of turnover, both before and after the actual year of turnover. Time 0 corresponds to the first year of the new mayor's tenure. The coefficient of the year before the new leader's coming $t=-1$ is normalized to 0. The vertical axis denotes the estimated dynamic effects of the political turnover. Each dot on the graph represents an estimate of the coefficient, while the vertical bars depict the 95% confidence intervals.

Figure 1 presents the dynamic effects of political turnover on breakthrough inventions. We normalize the effect at $t=1$. The figure clearly shows that the estimated pre-trend differences are negative and insignificant prior to the turnover. At the same time, the initial difference between the treated and control groups at $t=0$ is

positive and statistically significant. However, this difference quickly diminishes and becomes insignificant after the turnover. This suggests that the surge in incentives for filing breakthrough inventions, triggered by political turnover, is temporary and reverts back once the associated uncertainty is resolved. Concurrently, the dynamic pattern offers reassuring evidence that cities experiencing political turnover do not have significantly difference of breakthrough inventions compared to the rest of the cities during the pre-turnover period. Taken together, the dynamic pattern supports the idea that political turnover per se, rather than other factors, has played a major role in promoting breakthrough inventions.

### 4.3 Heterogeneity analysis

Considering place-based endowments, we divide our sample into two categories based on RTA: industries with a relative technological advantage and industries without. The results are presented in column (1) of Table 3. The interaction term between political turnover and RTA has a sig- nificant negative coefficient. Therefore, political turnover is associated with a greater increase of breakthrough inventions in industries without RTA. This implies that incumbent officials may not fully adopt the policies of their predecessors. Instead, they often redirect their focus to different industries and seek advancements in new sectors.

We further divide our sample into four groups based on TCI. The interaction coefficients, as shown in column (2) of Table 3, indicate a significant positive relationship between industries at medium-high and highest TCI levels. It is evident that officials are actively working to promote the transformation and upgrading of local industries in order to move towards more complex sectors. This is particularly noticeable when comparing industries with the lowest TCI. This partially explains China's swift transition from "Made in China" to "Innovated in China".

**Table 3.** Different endowment and industries**.** Standard errors clustered at the city-industry level are in parentheses. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

| | (1) | (2) |
|---|---|---|
| Turnover Mayor | 0.009*** | -0.002 |
| | (0.001) | (0.002) |
| RTA | 0.099*** | |
| | (0.007) | |
| Turnover Mayor ×RTA | -0.030*** | |
| | (0.005) | |
| Medium Low TCI | | 0.045*** |
| | | (0.004) |
| Medium High TCI | | 0.055*** |
| | | (0.004) |
| Highest TCI | | 0.070*** |
| | | (0.005) |
| Turnover Mayor ×Medium Low TCI | | 0.004 |

| | | |
|---|---|---|
| | | (0.003) |
| Turnover Mayor × Medium High TCI | | 0.012*** |
| | | (0.002) |
| Turnover Mayor ×Highest TCI | | 0.010*** |
| | | (0.002) |
| Constant | -0.664*** | -0.680*** |
| | (0.120) | (0.121) |
| Controls | Yes | Yes |
| Year FEs | Yes | Yes |
| City FEs | Yes | Yes |
| Industry FEs | Yes | Yes |
| Individual FEs | Yes | Yes |
| Time Trend × City FEs | Yes | Yes |
| Observations | 1777033 | 1777033 |
| $R^2$ | 0.150 | 0.066 |

### 4.4 Robust Check

**Alternative measures of breakthrough inventions**. To evaluate the robustness of our results, we perform a series of supplementary tests. First, we use alternative measures of breakthrough inventions. In column (1) of Table 4, an invention is classified as a breakthrough if it ranks in the top 10 percent of citations and represents the first combination of any two unrelated technologies (10% BK). The conditions are separated in columns (2) and (3), where a breakthrough invention is defined as an invention that receives the top 5% of citations (5% Cit) or represents the first instance of combining two technologies (NewCombo). Columns (1) and (2) continue to exhibit robust main results, whereas the result in column (3) is negative and non-significant. The divergence in findings might stem from the broad conceptualization of radical inventions. A radically new invention could be either a significant breakthrough or just a flash in the pan. Consequently, entrepreneurs might choose not to file patents for such highly uncertain inventions during that period to mitigate the risks associated with political uncertainty.

**Remove higher-level cities**. The results also could be driven by some sub-samples. In China, there are four centrally administered cities - Beijing, Shanghai, Tianjin, and Chongqing - that hold the same status as a province. As a result, we exclude observations from these municipalities from our analysis. The robustness of our results to this sample restriction is confirmed in column (4) of Table 4.

**Remove predictable turnovers**. We further eliminate predictable turnovers after excluding higher-level cities[17]. Our sample period includes three national elections (2002, 2007, and 2012) . To mitigate concerns about firms potentially adjusting their patent filing strategies in anticipation of these elections and subsequent political turnover, we exclude observations from these three years. Additionally, turnover becomes predictable when an official nears the age of 60 or when their term of office is due to expire in 5 or 10 years, we also remove these observations. The results,

presented in column (5) of Table 4, align consistently with the findings discussed thus far in this paper.

**Table 4.** Robustness checks**.** This table reports estimation results for robust checks. The alternative measures of breakthrough inventions and sub-samples are listed in the first row. Standard errors clustered at the city-industry level are in parentheses. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

| | 10% BK | 5% Cit | NewCombo | Remove higher level cities | Drop predictable turnovers |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Turnover Mayor | 0.009*** | 0.012*** | -0.011 | 0.002** | 0.006*** |
| | (0.002) | (0.002) | (0.009) | (0.001) | (0.001) |
| Constant | -1.572*** | 0.678* | -2.413** | 0.832*** | 0.480*** |
| | (0.235) | (0.373) | (0.996) | (0.158) | (0.151) |
| Controls | Yes | Yes | Yes | Yes | Yes |
| Year FEs | Yes | Yes | Yes | Yes | Yes |
| City FEs | Yes | Yes | Yes | Yes | Yes |
| Industry FEs | Yes | Yes | Yes | Yes | Yes |
| Individual FEs | Yes | Yes | Yes | Yes | Yes |
| Time Trend × City FEs | Yes | Yes | Yes | Yes | Yes |
| Observations | 1777033 | 1777033 | 1777033 | 1749637 | 1191146 |
| $R^2$ | 0.150 | 0.066 | 0.139 | 0.107 | 0.105 |

## 5 Conclusion

Leveraging comprehensive data on patents and government officials, we establish a correlation between political turnover and breakthrough inventions in Chinese cities from 2002 to 2012. Our research shows that when a new mayor takes office, there is a significant increase in the number of breakthrough inventions in the following year. These findings remain robust under alternative measures of breakthrough inventions and diverse sample selections.

This research contributes to the existing literature in three ways. First, we contribute to disentangle the debate on whether the inherent uncertainty in political turnover suppresses or stimulates regional innovation. Our empirical findings support the notion that uncertainty can be advantageous for a short-term surge in breakthrough inventions. Second, we provide a new and dynamic point of view when looking at the industry-region pairs to evaluate the effect of political turnover on regional innovation. Finally, to the best of our knowledge, we are the first to demonstrate that political turnover plays a significant role in promoting breakthrough inventions. Previous research on this topic has focussed on R&D inputs or invention outputs. We aspire that this paper marks an initial stride towards exploring this aspect.

Our study still has a few limitations. First, our results do not consider the influence of turnover in municipal secretaries and its interaction with turnover in mayors on breakthrough inventions. As a result, we fail to provide a detailed analysis of the effects of official turnover on breakthrough inventions. Second, since the 18th Party Congress, China has decisively implemented an innovation- driven development strategy. The performance of innovation now serves as a crucial benchmark for official evaluations, with regional innovative development and breakthroughs increasingly becoming key promotional incentives for officials under the "Political Promotion Tournament" system. However, our dataset only includes data up until 2012. As a result, we are unable to observe how the changing competitive landscape affects the motivations and actions of officials. Therefore, future work could involve updating the patent and official data to further validate the findings.

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