The Innovation Cost of Short Political Horizons: Evidence from Local Leaders' Promotion in China*

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Abstract

I examine how politicians' time horizons affect the choices between policies that yield short- versus long-term growth. I digitize the career histories of Chinese city leaders and link them to economic policies and innovation outcomes. I exploit political connections formed through previous work ties to generate variation in leaders' promotion expectations. I find that when leaders are connected, they can expect an earlier promotion. Such expectations lead them to pursue a fast-over-slow strategy for growth: higher spending on infrastructure, lower spending on science and technology, and a lower effort in promoting innovation. As a result, the local economy has higher short-term growth but lower future patenting and long-term growth.

Keywords: Political Horizon, Innovation, Tenure Length, China Political Economy

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1 Introduction

Government policies are crucial for promoting innovation (Bloom et al., 2019). But, the yields from innovation policy often arise beyond politicians' horizons as they come and go. A recent example is the development of the various coronavirus disease-2019 vaccines, which built upon government investments in vaccine research made decades before the outbreak of the global pandemic (Frank et al., 2021).[1] Given politicians' short time horizons, there is a potential risk of public under-investment in innovation. Does the political horizon, in terms of how long politicians expect to stay in office, matter for innovation?

Whilst understanding innovation consequence of political short-termism is essential for designing institutions that promotes innovation and enable long-term prosperity (Aghion and Howitt, 2006), the empirical evidence is scarce. The existing literature on the organization of innovation has focused on the private under-investment in innovation inside firms (Porter, 1992; Aghion et al., 2013; Lerner and Wulf, 2007; González-Uribe and Groen-Xu, 2017). On the other hand, studies on political short-termism have examined issues such as fiscal sustainability (Besley and Case, 1995), corruption (Ferraz and Finan, 2011), and legislative output (Dal Bó and Rossi, 2011; Titiunik, 2016), but not innovation. This study aims to fill the gap by studying the innovation investments by the Chinese city government.

The Chinese city government is an ideal setting for examining the impact of political horizon on innovation. Local leaders in China, particularly city-level leaders, run the bulk of the economy (Xu, 2011) and have enormous economic resources at their disposal to advance policies with discretion.[2] However, their tenures are short and unpredictable - since 1992, the average tenure of city leaders has been about 3.5 years. Upon the end of the term, city leaders either move one level up or sideways in China's leadership hierarchy. The promotion decision is made by leaders one level up in this hierarchy, i.e., by those at the provincial level, and is closely associated with economic performance. However, as innovation policies may pay off after they leave, local leaders cannot

[1] (Popp, 2016) finds that the effect of government funding on research takes 12 years to peak.

[2] 87% of the total government budget is spent by local governments, who also own 47% of state-owned-enterprise assets are owned by local governments. Local governments also finance economic development through off-balance-sheet borrowing by using local government financing vehicles (LFVs).

fully internalize the gain of their policies. This tension is particularly relevant as China aims to transit towards "innovated in China" after four decades of growth (Naughton, 2017; Wei et al., 2017). Using this setting, I examine how leaders' tenure expectation affect economic policies for growth, particularly the choice regarding policies with rapid short-term effects (fast policies) versus those with slow long-term effects (slow policies).

The primary challenge in answering this question is endogenous tenure and I address this by exploiting political connection to generate exogenous variation. The observed tenure is subject to selection if innovation-prone leaders get promoted more quickly, and reverse causality if leaders with good performance get promoted sooner. To address this challenge, I draw on previous evidence showing that political connections accelerate promotions (Kou and Tsai, 2014; Pang et al., 2018) and use these connections to generate exogenous variation in expected tenure. Specifically, I exploit the turnovers of city leaders' superiors, i.e., provincial leaders, that switch connections on and off. I develop a new measure of connections based on a specific type of work ties: previously formed subordinate-superior relationships, i.e., whether the current superior was also a superior during any previous work spells. The advantage of such a measurement is twofold. First, the relationship of subordinate-superior is ubiquitous: each leader has to move up step-by-step, and there are always superiors.[3] Secondly, it is plausibly a matter of "luck" regarding whether former superiors still influence leaders' careers today, as the national leaders control the turnovers of the provincial leaders.

I build a novel dataset that links city leaders' careers to economic policies and innovation outcomes, covering all of China's 283 prefecture-level cities from 2000 to 2018.[4] It consists of four building blocks: leaders' CV profiles, local government spending, policy documents, and invention patent applications. Using leaders' CV profiles, I measure political connections and other background characteristics. Using the local government spending, I measure fast and slow economic policies. With local government policy documents, I create complementary measures of the areas on which leaders focus the most. Finally, using invention patent applications, I measure innovation output.

[3]Except for the national leader

[4]There are 333 prefecture units: 17 prefectures, 30 autonomous prefectures (ethnic minority regions), 3 leagues (in Inner Mongolia) and 283 prefecture-level cities. The data on local government spending and local government work report (GWRs) are available only for the prefecture-level cities.

In more detail, for the CV data, I compile the universe of local leaders' CV profiles from multiple sources.[5] In addition to manual collection and validation, I develop a novel method to structuralize the raw CVs using the named entity recognition (NER) method of natural language processing (NLP). This dataset contains 3214 city leaders and 318 provincial leaders. Next, for the economic policies, I collect data from multiple sources to account for both direct spending and indirect financing by the local government. For direct spending, I collect data from Global Economic Data, Indicators, Charts and Forecasts (CEIC) for budget spending on science and technology, and data from the Ministry of Housing and Urban-Rural Development (MHUD) for budget spending on local infrastructure. For indirect financing, I collect 4100 local government work reports (GWRs), which is an annual summary of the local government's policy agenda, and measure their policy postures on innovation using text analysis. Finally, for innovation outcomes, I collect data from the European Patent Office (EPO) and China National Intellectual Property Administration (CNIPA) and identify 8.73 million invention applications filed by Chinese residents since 1985. I then geo-code and aggregate patent applications at the city level to measure innovation outcomes.

Using the turnover of provincial leaders to generate exogenous variation in connections, I find that connected leaders can rationally expect earlier promotion but not more resources from their superiors. On average, a connected leader's tenure is 12% shorter than that of an unconnected leader, which is equivalent to 4 months, and their promotion likelihood is 20% higher. When cities have connected leaders, I observe a pursuit of fast policy over slow policy. On the one hand, government spending on infrastructure development is 6.8% higher, amounting to an annual increase of 26.8 million RMB. On the other hand, government spending on science and technology is 10% lower, equivalent to a reduction of 10.4 million RMB. Moreover, cities with connected leaders put roughly 0.07 standard deviation (SD) less emphasis on innovation, suggesting that a lower priority is given to promoting innovation.

The local economy's growth trajectory evidences the policy pursuit of fast-over-slow. The current effect of connections on gross domestic product (GDP) growth is 1 percentage point (pp), which is 8% relative to the average growth rate. The effect on GDP growth peaks in the second year,

[5] These include the China Stock Market and Accounting Research (CSMAR) and the Chinese Local Government Officials Database (CGOD) from the Chinese Research Data Services (CNRDS).

decays and disappears by the fifth year, and becomes negative (-1 pp) between the seventh year and the ninth year. Meanwhile, the reduction in patenting materializes immediately and persists beyond the seventh year. I interpret this as evidence that infrastructure development yields faster economic growth but is unlikely to drive long-term growth.

Both the horizons and promotion incentives of local leaders can affect the outcome and I am able to disentangle these by leveraging the heterogeneous effect of connections. Specifically, I compare the effect of the connections on young and old leaders. I find that connections help old and young leaders differently. Connections help old leaders attain promotion more quickly. However, for young leaders, only tenure is affected: the young leaders' tenures are shorter by six months, but they are not more likely to be promoted. The pursuit of fast-over-slow policies is primarily driven by young leaders and is less prominent among old leaders. I hence argue that leaders' promotion incentives mitigate the horizon effect and that the observed effect is most likely to be driven by the leader's short horizon.

This study contributes to the existing literature by firstly shifting the discussion on China's development from "made-in-China" to "innovated-in-China". Current literature shares a wide consensus that local leaders' career concerns are a double-edged sword in China's rise as a world factory: spectacular growth on the one hand, but serious economic problems on the other hand (Maskin et al., 2000; Blanchard and Shleifer, 2001; Li and Zhou, 2005; Xu, 2011; Jia et al., 2015; Naughton, 2017; Jia, 2017; Jia and Nie, 2017; Shi and Xi, 2018; Xiong, 2018). However, there is little discussion on the time aspect of local leaders' careers. I show that short tenures create tension between short-term growth and innovation-driven growth, leading to under-investment in innovation. These findings will therefore inform future studies on China's economic transition.

Secondly, this study adds to the literature on the short-horizons of politicians by providing evidence on innovation. Existing studies focus on democratic politicians and find that short horizons decrease fiscal sustainability (Besley and Case, 1995), macroeconomic stability (Rogoff, 1990; Lindbeck, 1976; Alesina, 1988; Alesina and Perotti, 1996), and legislative output (Dal Bó and Rossi, 2011; Titiunik, 2016), and increases corruption (Ferraz and Finan, 2011). The question of the extent to which politicians' short-termist behaviours matter for the innovation remains largely underexplored. This study examines China – a non democratic setting in which the national leaders have long horizons but the economic decisions are delegated to local leaders with short horizons. I find that local leaders prioritize fast growth in the short term at the cost of innovation. Further studies are needed to explore how does democratic leaders' political horizons affect innovation.

Thirdly, this study advances our understanding of the organization of innovation by examining the horizon constraints of governments. Existing studies focus on innovation problems within firms, such as risk-taking and short-termism (Porter, 1992; Lerner and Wulf, 2007; Aghion et al., 2013; González-Uribe and Groen-Xu, 2017). However, there are few studies on the innovation problems within governments, in which the incentive contract takes different forms than those inside firms (Dewatripont et al., 1999) and a long-term incentive contract is usually not viable for good reasons(Smart and Sturm, 2013; Aghion and Jackson, 2016). In this study, I show innovation policies could be under-provided in the presence of short-horizons. The issue of how innovation policies should be shielded from political short-termism requires future investigation.

Finally, this study contributes a novel method to the literature on political connections. Previous studies have focused on social ties such as having attended the same universities (Xu, 2018; Shih and Lee, 2020), being from the same hometown (Xu, 2018; Li, 2019; Fisman et al., 2020; Shih and Lee, 2020), group affiliation (Fisman, 2001) or even ancestry (Xu, 2018). The few studies exploiting work ties have focused either on high ranking politicians (Jia et al., 2015; Jia, 2017; Shih and Lee, 2020), or the most recently formed patron-client ties (Jiang, 2018). In this study I develop a novel method to measure political career networks using CV data and show that connections based on previously formed patronage ties are highly relevant for politicians' career progressions. This method is applicable to future studies on the role of career networks for which CV data are available.

The rest of this paper is organized as follows. The next section briefly introduces relevant institutional features of local leaders' promotion and innovation policies in China. Section 3 describes the data collection and variable construction methods. Section 4 presents the empirical strategy and explains the econometric specification. Section 5 reports on the main results and Section 6 discusses the mechanisms and implications. Section 7 concludes the paper.

2 Background

This section describes the institutional background of the political turnovers of local leaders and the innovation policies of local governments. For turnovers, I will focus on how the short tenure of local leaders is common and necessary, and how connections help the career progression of local leaders. For innovation policies, I will focus on the capacity and discretion of local governments.

2.1 Political turnovers and the role of political connections in China

To move up the political career ladder, fast turnover is necessary as many steps have to be taken to reach the top before hitting the age limit. Local Chinese leaders are political appointees and bureaucrats: they are appointed by their superiors, but their careers are governed by bureaucratic rules. These leaders progress through their careers by moving up the hierarchy ladder; decisions regarding their progression are made by their direct superiors, who are leaders at the level immediately above the local leaders. The progression has to be made step-by-step, and many steps have to be taken to reach the top. For example, to rise from an entry-level bureaucrat position to that of a city leader, there are six steps, and it takes an average of 30 years to reach that position. An additional four steps are required for a city leader to become a national leader. If a local leader has not reached the next level before she hits the corresponding age limit, then she retires. This practice dates back to the late 1980s and was formally institutionalized in the mid-1990s.[6][7] As a result of these rules, short tenures are necessary for career success, and fast promotions are widely observed (Kou and Tsai, 2014).[8] For example, all current politburo members, who run the highest decision-making organ of China, were on a fast track: along each step of the bureaucratic hierarchy, they arrived at a younger age, stayed at each position for a shorter period of time, and got

[6] *Notice about Revising the List of Cadres Positions Managed by the the Central Committee of the Chinese Communist Party (CCCPC).* issued by the organization department of the CCCPC in July 1984.

[7] *The Interim Regulations on Selecting and Appointing Leaders of Party and Government.* issued by the CCCPC in February 1995, *The Regulations on Selecting and Appointing Leaders of Party and Government.* issued by the CCCPC in July 2002, and *The Regulations on Selecting and Appointing Leaders of Party and Government (Revised Version).* issued by the CCCPC in 2013 and 2019. There are extensive discussions on the causes and implications of this unique combination of political appointees and the bureaucratic career path. In this article, I will focus on the time dimension of leaders' career paths.

[8] Kou and Tsai (2014) interpret fast promotion as a choice made to balance stability and rejuvenation.

promoted earlier.[9]

Both connections and economic performance help the career progression of local leaders. The CCCPC's guideline is "equal importance of competence and political integrity".[10] In practice, both economic performance and political connection are found to be associated with promotion (Li and Zhou, 2005; Shih et al., 2012; Jia et al., 2015; Wong and Zeng, 2018). Moreover, connections play a crucial role in putting leaders on the fast track. Pang et al. (2018) find a dual-track system of cadre management: some cadres are preferred, cultivated, and promoted along a fast track, while others have to earn their promotions alone the regular track[11].

2.2 Capacity, policy and innovation

Innovation policies in China, like any other kind of economic policy, follow a top-down approach in which the governments at the upper-level set the goals and guidelines and the governments at the lower level implement them.[12] Local governments have considerable economic resources at their disposal to advance such policies. For example, the subnational government's share of government spending in 2016 was 85.4%, of which the prefecture-level government's share was 58.2%.[13] For innovation, the subnational government share of government R&D spending was approximately 60%. The subnational government also controls a major share of the economic resource. In 2016, the subnational government's asset of state-owned-enterprise (SOE) was 59.5 trillion Yuan, which amounts to 47% of all SOE assets.[14] Using these resources, local governments can promote innovation in three ways. Firstly, they can coordinate the development of R&D projects. Examples include creating platforms for firms to collaborate, or building science parks for incubating high-tech start-ups. Next, they can finance innovation by offering fiscal subsidies

[9] For instance, the current president of China, Xi Jinping became the party secretary of Fuzhou, the capital city of Fujian province, at a recorded young age of 37.

[10] *The Interim Regulations on Selecting and Appointing Leaders of Party and Government*

[11] They argue that the Chinese Communist Party (CCP) is strongly ambivalent toward institutionalization: the CCP is fond of using institutional rules but is also afraid of being trapped by them. As a result, the regime applies its rules selectively to some cadres but not to others, leading to "sprinting with small steps" and thus a dual-track system of cadre promotion. The dual-track design illustrates how the regime employs the regular track to mobilize efforts and the fast track to cement loyalty.

[12] For a detailed review, see Ding and Li (2015). China started promoting innovation systematically in 1999 and launched the Medium-and-Long-term National Plan for Science and Technology Development (2006-2020) in 2020.

[13] http://www.gov.cn/xinwen/2017-03/06/content_5173807.htm.

[14] With financial firms excluded. http://www.gov.cn/xinwen/2016-09/13/content_5107843.htm.

and financial investment funds. Last but not the least, they can also implement complementary measures such as tax refund, credit support, and preferred public procurements.

The decentralized implementation of innovation policies leaves local governments with considerable discretionary powers. The local government can, for example, decide which firms should enter science parks and receive a tax refunds or other kinds of policy support, and which universities to get funding for research. They can also decide to offer none of these forms of support. I now illustrate how local governments are involved in innovation using the example of the city of Dongguan.[15] Between 2006 and 2010, Dongguan initiated the "Technology Dongguan" program and spent 5 billion Yuan, which is 1.8% of its fiscal budget, to promote innovation. This program subsidizes firms' technology upgrades, the credit supply to small and medium-sized enterprises, projects granted with upper-level government funds, and innovation services. Besides directly financing innovation, Dongguan also built the Songshan Lake Science (DGSSL) and Technology Industrial Park at where used to be hard-to-reach rural areas.[16] The construction of DGSSL involved massive infrastructure investment on public facilities, including a new highway linking it to the main traffic artery of Dongguan. On top of public facilities, DGSSL prioritizes entrance for high-tech firms with a set of supportive policies. Formally opened in 2010, by 2019 this technology park had attracted more than 800 IT firms, 400 firms that manufacture intelligent robots, and 300 biotech firms, and had filed 4869 patent applications.[17] However, not all science parks in China are as successful as DGSSL. For xample, researchers find aggregate level evidence on R&D funds misallocation in China (König et al., 2020).

Last but not the least, the government's innovation policies matter to a different extent for innovation by firms compared to universities. While firms' R&D activities are mostly self-financed, their innovation activities are dependent on continued support to the government policies For example, a survey conducted by the National Bureau of Statistics (NBS) on firm innovation activities during the period of 2002-2006 reports that close to 50% of the firms with innovation activities find the following policies to be helpful: tax discounts, credit support, government procurements, intellec-

[15]Dongguan is famous for its nickname of the "world factory" and as the R&D headquarters of the company Huawei.
[16]http://ssl.dg.gov.cn.
[17]http://ssl.dg.gov.cn/zjyq/yqgk/cyfz/index.html

tual property protection, industrial policies, trade policies, and talent recruitment.[18] In the most recent survey, more than 70% of the firms confirm the usefulness of these policy interventions.[19] Universities and government-affiliated research institutes, in contrast, rely heavily on direct government funding. For example, a survey on universities' innovation activities in 2014 reports that universities receive 60% of their R&D funding from the government and spend around 30% of their R&D funding on basic research and 50% on applied research.[20]

In short, the incentives of innovation policies can vary significantly across regions and sectors, and the factors that drive these differences are unclear. The reason behind the varying levels of innovation success in different parts of China is precisely what this study attempts to uncover.

3 Data and Measurements

I study innovation for all of China's 283 prefecture-level cities from 2000 to 2018. This sample is chosen primarily due to its relevance and data availability. I focus on the city-level governments as they are significant players in economic policies, both in terms of responsibilities and discretionary powers over economic resources (Xu, 2011). I restrict my analysis to the period of 2000-2018 due to data availability constraints. For the period before 2000, I lack leader features for about 15% of the cities. From 2018 onwards, there is data truncation due to the time lag in reporting patent applications.

My dataset consists of leaders' CV profiles, local government spending and GWRs, and invention patent applications. Aside from these four main components, I collect data on city yearbook statistics for local economy outcomes; the variables include GDP, investment, industry revenue, population, and others. I now describe the collection of CVs, government spending and GWRs, and patent data in detail.

[18]http://www.stats.gov.cn/ztjc/ztsj/2006gysj/200802/t20080222_61480.html.
[19]http://www.stats.gov.cn/tjzs/tjsj/tjcb/dysj/201704/t20170421_1487052.html.
[20]Tables 4-2 from http://www.most.gov.cn/zxgz/cxdc/cxdcjcbg/201710/P020171027326121716670.pdf.

3.1 Data collection

3.1.1 Leaders' CVs

First, I construct a database of the Chinese local leaders' demographic characteristics and career trajectories using their CVs. There are two public sources of local leaders' career backgrounds in China: the local leader database from China Stock Market & Accounting Research (CSMAR) and the Chinese Local Government Officials Database (CGOD) from the Chinese Research Data Services (CNRDS). However, even a combination of these two sources is incomplete, and it is common to miss data on leaders' early careers, which is particularly problematic for this study. To approximate the universe of the Chinese local leaders' CVs as closely as possible, a significant amount of effort is spent on collecting and validating data.

I then use the CV data to construct a panel data set that contains the time series of the positions of each leader. For this step, I characterize each position by its location, office and title, all parsed using the NLP-NER method. For example, for the deputy mayor of Wuhan, the office is "government", the title is "vice head", and the location is "Wuhan". So far, my database contains complete CV information for 3443 leaders, which includes 318 provincial leaders and 3,214 city leaders.[21] This step is crucial for measuring a leader's political connections, as explained later on. For all prefectures in the period of 2000-2018, the universe of city leaders contains 3,325 individuals and I have CV characteristics for 92.15% of these individuals.

Using the structured CV data, I also measure aspects other than the political connections, such as career background and the promotion outcome. For career background, the variables are age, education background in STEM, work experience in STEM, seniority (accumulated working time in government sectors), and progression along the fast track by being promoted within every 3.5 year period. I define the promotion outcome as a dummy variable capturing if a leader's next position in the subsequent 3 years has either a higher nominal rank or the same nominal rank but higher de-facto rank and is not a "retirement" position.[22] Positions with "a higher nominal

[21] Eighty-nine of them became provincial leaders later on.

[22] It is common that at the end of the current term, a city leader first gets flat move first but shortly afterwards obtains a one-level-up move. Using a forward window of 3 years can rule out such transitory moves.

rank" than that of city-level leaders are sub-provincial level positions. Examples include standing committee members of provincial-level party committees or the mayors of sub-provincial cities. I also consider a move to a position with "the same nominal rank but higher de-facto rank" as a promotion.[23] "Retirement position" refers to a position at the People's Congress (PC) or the Committee of People's Political Consultative Conference (PPCC) at the city level or the province level, as positions in these two organizations are likely indicators of (early) retirement.

3.1.2 Local government spending and work reports

It's impossible to fully account for local government's various economic policies that affect innovation directly or indirectly. I instead focus on policies measurements that reflect local government's engagement in promoting innovation by combining both government spending data and policy texts. Specifically, I focus on the governments' policies on infrastructure development, which immediately stimulates growth, and on science and technology, which affects growth slowly.

I collect government spending data from two sources. For spending on science and technology, I use the China Premium Database provided by the CEIC. The sample covers all Chinese prefecture-level cities from 2003 onwards.[24] For spending on infrastructure, I use the China Urban-Rural Development Database provided by EPS Data, for which the source data comes from MHUD The sample period for Chinese prefecture-level cities is 2006-2016.

I also collect local government work reports (GWR) to account for complementary policies on innovation. I collect 4100 GWRs from city governments during the period of 2006-2018 from People Data, a database owned by the newspaper *People's Daily* in China.[25] I then measure local governments' policy engagement in promoting innovation at the city-year level using text analysis.

[23] The set of such positions includes heads of departments within the provincial party organization or the provincial government who are responsible for personnel decisions and economic decisions. A more detailed description is provided in the appendix.

[24] These data have been available from 2003 onwards, after the budget management reform. Before 2003 the spending on science and technology was contained in the category of government spending on science, education, culture, and health.

[25] Before 2006, digital versions of work reports were not available for the majority of the local governments.

3.1.3 Invention patent application data

I combine patent application data from the Patstat database of the European Patent Office (EPO) and the PatViewer database, which is indirectly owned by the China National Intellectual Property Administration (CNIPA). Both databases have used data from CNIPA since 1985. From Patstat, I collect information on the patent attributes, such as authorization, International Patent Classification (IPC) code, citations, and technical fields. From PatViewer, I collect data on patent applicants' attributes, such as name and address. I focus on invention patents by Chinese applicants. There are a total of 10.11 million CNIPA invention patent applications documented by Patstat. Among these, I identify 8.73 million applications with a Chinese address.

3.2 Measuring connections using previous subordinate-superior ties in CVs

I define a connection as a dummy indicator of the existence of any previous subordinate-superior ties between a city leader and the provincial leaders. "Previous" refers to the past career paths taken before an individual becomes a city leader. "Subordinate-superior" refers to whether the person as a subordinate works with another person as the superior. For such ties the superior, as the one-level-up leader, is responsible for the appointment, evaluation and promotion of the subordinate.

I define a subordinate-superior tie as a pair of individuals simultaneously positioned at two vertically adjacent nodes in the Chinese bureaucratic hierarchy, with the person at the higher-ranked node arriving before the person at the lower-ranked node. Due to the M-shape of the Chinese bureaucratic system (Qian et al., 2006), there exist three types of subordinate-superior ties. The first is within-location-within-organization, such as the head of the anti-corruption bureau and the division head within the anti-corruption bureau in the same region. The second is within-region-between-organization, for which two scenarios are possible. In the first scenario, a department-affiliated organization is supervised by the department to which it is affiliated. For example, the procuratorate in the same region oversees the anti-corruption bureau. In the second scenario, a department within the local government/party is supervised by the local government heads (vice-heads) and the local party committee. For example, the head of government (mayor) is the direct superior for all of the department heads in the local government. The third is between-region-within-organization. For example, the anti-corruption bureau of the province of Hunan oversees the anti-corruption bureau of Changsha, which is its provincial capital city.[26]

This definition of the subordinate-superior tie is highly restrictive in two aspects. First of all, it only accounts for a relationship between two individuals without any intermediaries, by restricting it to “vertically adjacent nodes simultaneously”. Secondly, it only accounts for a tie formed by the superior appointing the subordinate, and not by the superior inheriting the subordinate, by restricting it to the superior arriving before the subordinate. These two restrictions allow for an accurate depiction of a direct patronage relationship.

The implementation of this measurement involves three steps.[27] The first step is to characterize each CV as a sequence of job events using the NLP-NER method.Each job is characterized as a combination of location (where the job is), organization (which section of the bureaucratic system), and title (the level of the position). This characterization is crucial for identifying the hierarchical relationship between jobs. The second step is to create the matrix of position hierarchies based on administrative rules. With these two steps of preparation, I can then search for subordinate-superior ties based on whether two individuals work at the same organization, in which one person holding a job oversees that of another person. I implement this step by developing a speedy search method using matrix representation. By construction, the on and off status of a leader's connection status is driven by the turnovers of provincial leaders. Thus, when the central party committee changes provincial leaders, a city leader's connection status will either stay the same, or switch off or on, depending on whether previously formed subordinate-superior ties exist between her and the provincial leaders.

[26]Since 1984, the management of cadres has followed two rules: appointments are made by the party committee one level up, and they are subject to the leadership both of the local authority (in local government or local party committee) and of the same department at the upper level.

[27]Appendix A and B show the details.

3.3 Measuring policy posture using local GWRs

I use each local government's annual government work report (GWR) to measure its policy posture on innovation-related and other issues. I define the policy posture as the share of sentences that belong to a specific topic in each report.

This differs from the bag of words (BOW) approach used by existing studies. From the rudimentary word counts to more sophisticated methods such as topic modeling, there have been substantial developments in the study of local government's policy agendas using GWR (Jiang, 2018; Campante et al., 2019). One thing these studies have in common is to treat each document as a BOW. The difference, depending on the exact method used, arises from how to count the relevant words. The BOW approach is appropriate for documents with a single theme, such as user reviews, US congressmen's speeches and news articles (Gentzkow et al., 2019). The Chinese GWR falls outside this scope, as they have a highly homogeneous structure and have multiple themes, which results in either low cross-sectional variation or an *ad-hoc* interpretations of the topic model results. By exploiting the structural features of GWR, this study proposes a bag of sentences (BOS) model of GWR representation and uses sentence as the basic semantic unit.

I use text analysis to determine whether a sentence refers to innovation. I then aggregate the lengths of sentences on innovation. Finally, I compute policy posture by dividing the total lengths of sentences on innovation by the length of the document. The comparison with BOW based machine learning methods and the validation based on correlation with conventional statistics are provided in the appendix.

3.4 Measuring innovation using invention patent applications

Innovation is intangible and hard to measure (Bloom et al., 2019). Patent count, however, is closely related to other measures of innovative activities (Shambaugh et al., 2017; Fang et al., 2020) and technology progress (Kelly et al., 2018), and is one of most commonly used proxies for innovation (Kogan et al., 2017).

I use invention patent applications instead of the granted invention patents for two reasons. The first is that this addresses the data truncation problem for recent patent applications as it usually takes 3-5 years for an invention patent to be granted. The second is that being granted is not the only measure for patent quality. To measure quality without truncating the data, I use the within-application-year citation ranking percentile to measure the quality of a patent. Specifically, for all invention patents applied from the same year from all around the world, I rank each patent based on the total number of citing simple DOCDB families it received.[28] A patent is labelled as high-impact if its within-application-year citation ranking is above the 90th percentile and low-impact otherwise.

I aggregate the patents at the city-year level to measure the quantity and quality of innovation. I first assign each applicant's address to the city in which the application was filed.[29] I then aggregate the total number of applications at the city level over alternative forward windows. The experiment of varying time windows is to account for the slow-to-yield nature of innovation activities (Aghion et al., 2018). In particular, I compare patents filed by firms with those filed by universities to study the heterogeneous effects.

3.5 Descriptive statistics

Table 1 summarizes the basic statistics of key variables . From panels A to C the observation is at the city-year level.[30] For panel D the observation is at the city-leader spell level.[31]

An average city in China files nearly 960 invention patents per year from 2000 to 2018. However, the geographic distribution of patents applications is highly skewed, with patent applications by cities in the top 95th percentile being almost 1000 times that of cities in the bottom 5th percentile.

[28] The simple DOCDB family is a technical concept defined by the European Patent Office to represent patents that belong to the same set of technology range. For details, please go to https://www.epo.org/searching-for-patents/helpful-resources/first-time-here/patent-families/docdb.html. The number of forward citing DOCDB simple families, representing number of distinct future inventions citing the current invention, is widely used in existing literature to capture the quality of patents (Martinez, 2010)

[29] A small share of observations has city names and boundaries that have changed over time. I assign these observations to the original cities.

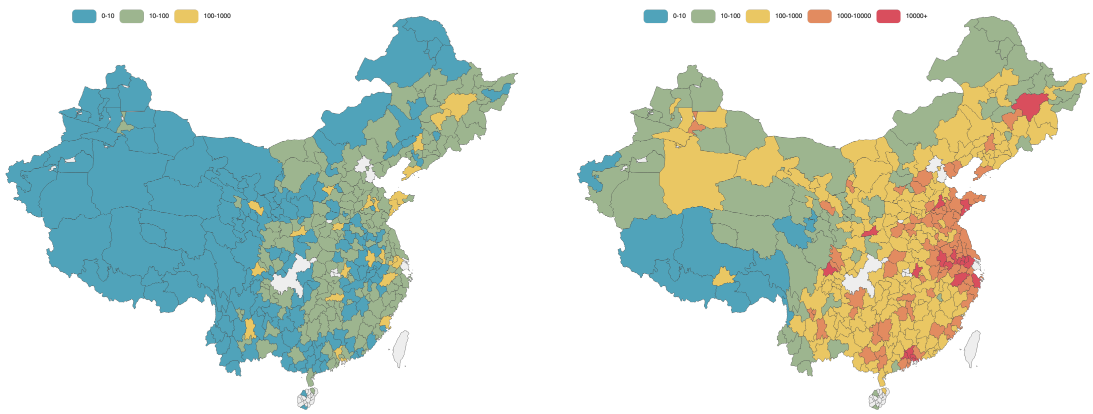
[30] The data on budget spending on science and technology starts in 2003, and the data on budget spending on infrastructure is available for 20006-2016.

[31] Each spell is the time period during which the city-leader is in office.

Table 1: Summary Statistics

Variables	Statistic					Share of Variation	
	Count	Mean	Std	5th Percentile	95th Percentile	Within	Between
A: Innovation and Growth (city-year panel)							
Patent Count	6015	989.80	3664.48	4.00	4453.00	0.56	0.44
Firm-Patent Count	6015	589.58	2664.50	0.00	2415.00	0.54	0.46
University-Patent Count	6015	154.14	701.09	0.00	719.00	0.54	0.46
GDP Growth Rate(%)	5171	13.09	8.85	0.60	26.55	0.94	0.06
B: Policy Outcome (city-year panel)							
Budget Spending (million)							
Infrastucture	2575	1097.01	2320.50	50.49	4541.80	0.39	0.61
Sci &Tech	3658	533.27	1751.03	11.98	2064.90	0.47	0.53
Innovation Posture (%)	3824	12.28	6.49	3.62	24.61	0.74	0.26
C: Leader Features (city-year panel)							
$Connected^{start}$	6209	0.80	0.40	0.00	1.00	0.78	0.22
$Connected^{startpsecretary}$	6090	0.62	0.49	0.00	1.00	0.76	0.24
$Connected^{startmayor}$	5935	0.57	0.50	0.00	1.00	0.75	0.25
$Connected$	6211	0.68	0.47	0.00	1.00	0.81	0.19
$Connected^{psecretary}$	6086	0.47	0.50	0.00	1.00	0.82	0.18
$Connected^{mayor}$	5959	0.50	0.50	0.00	1.00	0.80	0.20
$STEM^{psecretary}$	6269	0.37	0.48	0.00	1.00	0.77	0.23
$STEM^{mayor}$	6269	0.35	0.48	0.00	1.00	0.77	0.23
$FastTrack^{psecretary}$	6229	0.32	0.47	0.00	1.00	0.79	0.21
$FastTrack^{mayor}$	6133	0.29	0.46	0.00	1.00	0.79	0.21
$Age^{psecretary}$	6086	52.20	3.79	45.00	58.00	0.77	0.23
Age^{mayor}	5986	50.31	4.01	43.00	56.00	0.75	0.25
D: Turonver Outcome (finished city-leader spells)							
$TermLen^{psecretary}$	1935	3.69	1.77	1.08	6.92	0.81	0.19
$TermLen^{mayor}$	2078	3.42	1.66	1.08	6.25	0.74	0.26
$Promoted^{psecretary}$	1953	0.39	0.49	0.00	1.00	0.76	0.24
$Promoted^{mayor}$	1978	0.33	0.47	0.00	1.00	0.82	0.18

Another feature of patent data is that between-city variation explains around 40% of the variation, indicating a permanent gap in innovation across cities (as shown in Figure 1). To resolve the skewness of patent applications, all of these outcome variables are log-transformed for regression analysis.



(a) # of application in 2000 (b) # of application in 2015

Figure 1: Patent applications across Chinese Cities: 2000 v.s. 2015 [32]

Figure 1 compares the geographic distribution of patent applications across Chinese cities for the year of 2000 and the year of 2015. In 2000, there were only 24 cities (7.3% of the prefectures) that file more than 100 applications. By 2015, there are 262 cities (78.4% of the prefectures) that file more than 100 applications, among which there are 97 cities that file more than 1000 applications. This pattern of widespead patenting is described as the "democratization of patenting" (Hu et al., 2017) and is closely associated with the surge of Chinese patenting at the aggregate level (Li, 2012; Wei et al., 2017; Hu et al., 2017).

City governments spend nearly twice as much on infrastructure as on science and technology. The average annual budget spending on science and technology is around 533 million RMB or 3% of the total budget spending. Moreover, the average policy posture value on innovation is around 12.2, i.e. 12.2% of the GWR content is related to innovation. In comparison, local governments' average spending on infrastructure development is 1,076 million RMB, which is approximately 6% of the budget. These exact numbers are likely to underestimate the actual expenditure by

[32]The empty area on the map are the four provincial prefectures (Beijing, Tianjin, Shanghai and Chongqin), and several county-level cities which are out of our sample.

local governments as they can use off-balance-sheet financial tools. However, as long as the actual spending is proportional to the on-budget spending, the issue of under-measuring should not affect the main conclusions of this study.

Next, we look at the leaders' backgrounds (panel C). First, political connections, measured as former subordinate-superior ties that are currently active, exists widely among local leaders, with close to half of the mayors and party secretaries being connected. Second, there is a relatively high representation of leaders with STEM backgrounds (around 40%) and leaders on a fast track (one-third). Finally, the average age of city leaders is 50-52, which is a safe distance from retirement.

The tenure length for city leaders is relatively short, and the promotion probability is around one-third. For example, the average tenure length for city party secretaries is 3.5 years, with 95% leaving within six years. In the regressions on turnover outcomes I pool both but control for the office fixed effects.

4 Empirical Design

I aim for a causal estimate of leaders' tenure expectations on local innovation outcomes. The identifying variation comes from political turnovers at the provincial level that either turns on or off previously formed superior-subordinate ties between the city leaders and the provincial leaders. This section discusses the identifying variation and the specification in detail.

4.1 Identifying Variation

Political connections can put leaders on a fast track (Kou and Tsai, 2014; Pang et al., 2018) and improve their promotion prospects (Jia et al., 2015; Shih et al., 2012). Thus, when leaders are connected, they might expect faster promotion.

l use the exit of patrons for exogenous variations in connection, similar to Xu (2018). The identification is driven by leaders who change their connections during their respective terms. In accordance with the definition of the connection measurement (section 3.2), a person is connected to her/his provincial leaders if they ever previously worked as subordinate-superior. From the perspective of a city leader, the turnover of provincial leaders generates within-person variation in connection: when the provincial leaders change due to decisions made by the central government, that city leader's connection status changes accordingly. At the spell level, 33.6% of all leaders are never connected, 34.3% are always connected, and 32% are switchers.[33]

A natural concern is that leaders are selected into being connected. If innovation-prone leaders are more likely to be connected, the estimated effect of the horizon will be biased downward. Conversely, if less innovation-prone candidates become city leaders because of connection, the estimated effect of horizon will be biased upwards. Either way, leaders who begin as connected could systematically differ from those who do not. I examine the characteristics of leaders and cities based on whether the spell begins with connection. I find that leaders who begin as connected are similar to the remaining, except that they have more upward connections (Appendix C.1) and are more likely to have worked as a city leader before. Thus, this concern of leaders being selected needs to be addressed.

Conditioning on whether leaders begin as connected removes this selection effect.[34] After controlling for selection upon the appointment, those who are connected should not differ from those who are not. The average effect of the current connection the becomes a weighted average of two comparisons. The first comparison is between (currently) connected and unconnected leaders among those who begin as connected (59% of the spells). The second comparison is between (currently) connected and unconnected leaders among those who do not begin as connected (41% spells). Figure 2 illustrates the sample composition at the spell level based on how connection switches within each spell. Depending on whether a leader starts as connected, and whether the leader is currently connected, a city-leader spell can experience one of the following four types of transitions: *NN*, if

[33] If a leader ever gets a connection (66% of the spells), then it is most likely to happen at the beginning of the spell upon appointment (59% of the spells). Furthermore, for those who begin with as connects, half of them will lose the connection over their years in term due to the turnovers of provincial leaders.

[34] The direct solution is to control for leader fixed effects, which is not feasible in the setting of this study for two reasons. The first is that most leaders work as mayor or party secretary at the city level only once. In the sample period, only 7.2% of the mayors used to be mayors in another city, and 20% of the party secretaries used to be party secretaries in another city. Given that only around one-third of the spells are switchers, what remains is a small sample that is particularly problematic for studying the effect of connection on tenure length. The second reason is that each city is always co-governed by a mayor and party secretary at the same time. Controlling for leader fixed effects also comes at the cost of removing the majority of the sample, which creates missing data problems when studying dynamic effects.

the leader begins as unconnected and stays unconnected; *NC*, if the leader begins as unconnected but is currently connected. *CN*, if the leader begins as connected but is currently unconnected; *CC*, if the leader begins as connected and is currently connected. If the issue of selection exists, the comparison between CC and CN captures the treatment effect of political connections on the selected by holding the selection effect constant. Similarly, the comparison between NN and NC captures the treatment effect of political connections on the unselected.

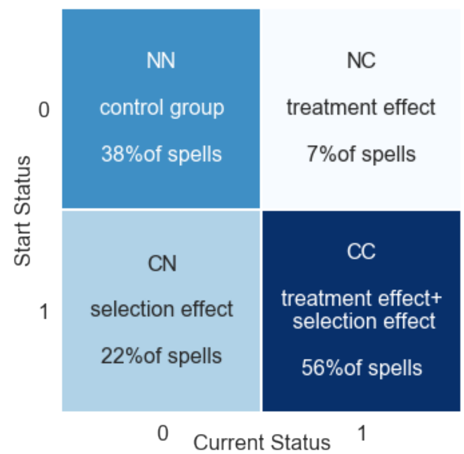


Figure 2: Sample composition by the switch of connections at spell level

The unit of observation is city-year spell for spells that start during the period of 1997-2017. The row represents the connection status at the beginning of the spell and the column represents the current connection status during the spell. Note that if a spell starts as unconnected, it can experience both a NC and NN transition at different time within the spell. By analogy, for spells beginning as connected,, the transition of CC and CN are not mutually exclusive. For spells that ever experiences CC transitions (56%), 34.3% experiences only CC transition, i.e., always connected, and the remaining 22% experiences both CC and CN transitions.

Conditional on selection, the variation is then driven by the turnovers of provincial leaders, which switches city leaders' connections on and off. Therefore, a causal estimate of the effect of connection crucially relies on the following assumption: conditional on selection, the timing of switching connections is exogenous to outcomes. This assumption relies on the validity of the following two conditions. The first is that initial selection is uncorrelated with potential outcomes. The second is that the switching of connection is uncorrelated with potential outcomes. I test the first condition by examining whether a city's initial economic conditions are correlated with its probability of being assigned with leaders beginning as connected. For the validity of the second condition, I examine whether a city's initial economic conditions are correlated with its probability of having leaders' connections status switched on or off after the appointment (Appendix C.2). In addition, I also test whether there exists differential trends in economic growth and patenting for cities with connected leaders (Appendix C.3). Overall, I do not find evidence that suggests cities with connected leaders differ from those without in terms of innovation potential.

4.2 Reduced-form specification

I examine whether connections affect the tenure and the promotion expectations of the leaders. Regressing turnover outcomes at the spell level on the current connection status faces an issue of mechanical bias: the longer a leader stays, the more likely the provincial leaders changes and hence the connection status switches. One solution is to estimate the effect of connection on tenure and promotion by comparing leaders with at least the same duration year by year.[35] The intuition is that for leaders who stay for at least the same duration, the likelihood of them experiencing a change in provincial leaders is comparable. In addition, this comparison allows me to link the results on leader turnovers to the results on city outcomes directly, as the latter are estimated at city-year level. For tractability, I estimate a linear model of the hazard rate of leaders' tenure durations, specified as follows.

$$\begin{aligned}\pi_{i,c,t} =& \gamma_s * 1\{S_{i,c,t} = s\} + \gamma * Connected_{i,c,t} + \gamma^{start} * Connected_{i,c}^{start} \\ &+ X_{i,c,t}\Gamma + \delta_c + \delta_t + u_{i,c,t} \end{aligned} \tag{1}$$

where i, c, and t are indexes for the leader, city and year, respectively. $\pi_{i,c,t}$ is an indicator of the turnover outcome. Regarding the outcome of exiting, $\pi_{i,c,t} = 1$ if the leader of the city c at year t ends his term.[36] Regarding the outcome of promotion, $\pi_{i,c,t} = 1$ if the leader of the city c at year t ends his term and gets promoted. $S_{i,c,t}$ denotes the duration of city leader since arrival in years, and $S_{i,c,t} = s$ if the leader has stayed for s years since being appointed. $X_{i,c,t}$ is a set of control variables that contains the initial value of the outcome variable and the local economic conditions

[35] Another alternative is to estimate the effects of connection at spell level by controlling for how long the provincial leaders lasts after the appointment, as shown in Appendix D.1.

[36] When a prefecture leader ends her/his term, she/he will either be reposted to a new position (but not necessarily promoted), or in rare cases, retire due to reaching the age limit.

before the leaders were appointed in terms of GDP, population, and revenue of the manufacturing sector, and indicators for the term year of the provincial leaders.[37] δ_c and δ_t captures city fixed effects (FE) and year FE, respectively.

The parameter of interest is γ. By construction, the coefficient γ measures the average difference in the probability of exiting (promotion) due to being connected, conditional on having stayed s years and after accounting for the fact that those selected with connections initially ($Connected^{start}$) might be different. The higher the probability of exiting, the shorter the tenure.[38]

I then investigate whether political connections affect a city's resource transfer, economic policies, growth, and innovation. The main equation takes the form:

$$y_{c,t} = \theta * Connected_{c,t} + \theta^{start} * Connected^{start}_{c,t} + X_{c,t}\Theta + \delta_c + \tau_t + \epsilon_{c,t} \tag{2}$$

where the subscripts c and t are indexes for city and year, respectively. $Connected_{c,t}$ represents connection at the team level, i.e., whether either the party secretary or the mayor is connected.[39] Similarly, $Connected^{start}_{c,t}$ denotes whether the leader team begins as connected, i.e. at least one of two leaders begins as connected. The control variables $X_{c,t}$ contain the initial value of the outcome variable and the local economic conditions preceding the appointment of the leadership team in terms of GDP, population, the revenue of the manufacturing sector, and indicators for the term year of the provincial leaders.

Using the specification above, I explore the effects of connections on policy outcomes and innovation outcomes. I first examine the effects on economic policy and in particular, quick-to-yield versus slow-to-yield policies. The outcome variables include annual growth in GDP, government spending

[37] At city level, a leader team is newly appointed if either the mayor or the party secretary is replaced by a new one.

[38] The following formula computes the difference between always connected and never connected leaders in tenure:

$$\begin{aligned}\alpha^T &= E(T|Connected = 1) - E(T|Connected = 0)\\ &= \sum_{s=\tau_{min}}^{s=\tau_{max}} s(\gamma_s + \gamma) \prod_{s'|s' \leq s-1} (1 - \gamma_{s'} - \gamma) - \sum_{s=\tau_{min}}^{s=\tau_{max}} s\gamma_s \prod_{s'|s' \leq s-1} (1 - \gamma_{s'})\end{aligned}$$

[39] A city is always co-governed by a party secretary and a mayor, and it is unclear who the de facto decision-maker is. Thus, running the regression at the person level by examining the impact of only one individual leads to omitting the other individual. It is possible to run regressions at the individual leader level by examining the effects of one leader's connection and the teammate's connections, but this generates the issue of self-reflection. For these two reasons, a reduced form estimated at the city level is the preferred specification.

on infrastructure, science & technology, and the local governments' policy postures on innovation. I then investigate how connections affect growth and innovation outcomes dynamically. In all of these regressions, the interest is θ, which measures the annual effect of connections.

5 Results

This section reports the baseline results on tenure, promotion, economic policy, growth, and innovation. Overall, connected leaders get promoted earlier, pursue fast investments over innovation policies, and bring about a persistent decline in future innovation.

5.1 Tenure, promotion and resource

I compare the average differences in tenure length and promotion rate that arise due to connections. To address the concern of the mechanical bias caused by the fact that leaders who serve for longer are more likely to lose their connections, I use the year-by-year specification following equation (1). In this specification, *Connected* captures the average difference in exiting (promotion) between always connected leaders and never connected leaders, conditional on beginning as connected ($Connected^{start}$). Table 2 presents the results. I use columns (4) and (7) for interpretation.

First of all, I find that being connected significantly shortens leaders' tenure lengths. A connected leader has a significantly higher likelihood of exiting her current position at any time during the term (row (1), columns (1) to (4)). On average, a connected leader's exiting rate is 3.06% higher (row (1), column(4)), which is equivalent to a 12.4% higher likelihood than the average, or a reduction of 5 months (or 0.42 years). Moreover, this result is robust to alternative specifications. It is similar to the result obtained using binomial regression (column (1), whether controlling for city and year FE (column (2) v.s. column (3)) and control variables (column (3) v.s. column (4)).

Secondly, I also find that being connected significantly increases leaders' ex-ante promotion probabilities (row (1), columns (5) to column (7)). During any year of her/his term, a connected leader's promotion probability is 2% higher (row (1), column (7)), i.e., she/he has a 20.8% higher promotion

Table 2: Estimates of the effects of connections on tenure and promotion

	Exited				Promoted		
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Connected	0.0278***	0.0388***	0.0467***	0.0306***	0.0213***	0.0270***	0.0203**
	(0.009)	(0.011)	(0.011)	(0.011)	(0.007)	(0.008)	(0.008)
$Connected^{start}$	-0.0209***	-0.0342***	-0.0531***	-0.0449***	-0.0266***	-0.0350***	-0.0335***
	(0.008)	(0.010)	(0.011)	(0.011)	(0.007)	(0.008)	(0.008)
Old			0.0397***	0.0449***		-0.0377***	-0.0314***
			(0.007)	(0.007)		(0.005)	(0.006)
$FastTrack$			0.0398***	0.0423***		0.0233***	0.0267***
			(0.008)	(0.009)		(0.006)	(0.007)
Observations	14,647	14,720	14,720	12,139	14,712	14,712	12,134
R-squared		0.197	0.267	0.275	0.051	0.103	0.112
Mean	0.244	0.248	0.248	0.246	0.096	0.096	0.096
City and year FE			X	X		X	X
Controls				X			X
SE Cluster	City	City	City	City	City	City	City

The unit of observation is leader by year. The sample is a pooled sample of leaders, namely city mayors and party secretaries, who were appointed during the period of 2000-2017[a]. The dependent variable is an indicator of whether the leader leaves office (columns (1)-(4)) or is promoted (columns (5)-(7)) in a given year. The variable *Old* is a dummy and equals to 1 if the leader's age upon appointment is older than the median age of all leaders appointed in the same year. The variable $FastTrack$ is a dummy that equals 1 if the leader's accumulated average tenure length across all her/his previous jobs is less than 3.5 years. All of the regressions include a fully non-parametric baseline hazard for the number of years in office (job-tenure fixed effects (FE)). Column 1 shows results from a binomial regression with a complementary log-log model (marginal effects). The other columns show estimates using a linear probability model. Controls include the logs of GDP, population and industry revenue for year before the local leader was appointed, and FEs for the term year of the provincial governor and party secretary. Standard errors (SE) are clustered by city, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

[a]2018 is skipped due to data truncation issues, as around 20% of the leaders appointed in 2018 still hold office.

likelihood relative to the average. This result is also robust to alternative specifications (columns (5)-(6)). However, as compared with Jia et al. (2015), the effect of political connection in this study has a smaller magnitude: Jia et al. (2015) find that connections, when measured as sharing the work place with politburo members, increases provincial leaders' promotion probabilities by 70%.[40] As I examine city leaders, the difference between this study and that found by Jia et al. (2015) might be driven by the heterogeneous effect of connections by political rank.

Thirdly, I find suggestive evidence on adverse selection due to connections (row (2)). Compared with leaders who are never connected, leaders who begin as connected but later lose their connections serve for 6.8 months more (row (2), column (4)) and have a 34% lower likelihood of being promoted (row (2), column (7)). One possible explanation is that these leaders are less competent but nonetheless become city leaders due to their connections. However, once the connections are lost, these leaders can no longer expect fast promotions and have to earn future promotions. Another explanation is that the lack of loyalty hinders their career progression, as connections to previous provincial leaders signal disloyalty. In either case, selection issues exist and should be controlled for when examining the impacts of connections on economic policies.

I interpret the effects of connections on turnover outcomes as the realization of the turnover expectation. However, connections can affect other aspects that change leaders' behaviors. For example, connected leaders might receive more support from provincial governments in the explicit fiscal transfers or implicit transfers such as credit expansion. Table 3 presents the effects of connections on resources following equation 2. Overall, I find that the connections affect neither explicit nor implicit resource transfers. Cities with connected leaders do not receive more fiscal transfers (columns (1)-(2)), do not accrue more debt to finance local infrastructure development (columns (3)-(4)), and do not rely more on the provincial government's transfer for fiscal spending on infrastructure development (columns (6)-(7)).[41]

[40] Jia et al. (2015), Table 2, row (1), column (1)-(3).

[41] The city government can issue off-balance-sheet debt through the local financing vehicle (LFV) companies. LFVs are owned by local governments and borrow and spend on behalf of local governments. For a detailed institutional context on the LFVs and how the local governments uses them for off-balance-sheet financing, see Huang et al. (2020).

Table 3: Estimates of the effects of connections on resources

	log(Total Fiscal Transfer)		Depdency on Debt Total Infra.Dev		Depdency on Pro.Gov Fiscal Infra.Dev	
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Connected	0.0026	0.0193	0.0149	0.0109	0.0042	0.0075
	(0.016)	(0.019)	(0.009)	(0.010)	(0.007)	(0.007)
$Connected^{start}$	-0.0290	-0.0421	-0.0025	-0.0021	0.0065	0.0024
	(0.023)	(0.026)	(0.012)	(0.013)	(0.010)	(0.010)
Observations	5,239	4,826	4,948	4,453	1,521	1,394
R-squared	0.929	0.926	0.355	0.375	0.453	0.469
Mean	8.413	8.440	0.212	0.216	0.057	0.055
City and year FE	X	X	X	X	X	X
Controls		X		X		X
SE Cluster	City	City	City	City	City	City

"The unit of observation is city by year.The dependent variable is log values of fiscal transfer (columns (1)-(2)), debt dependency of infrastrure development (columns (3)-(4)), and fiscal dependendecy on provincial government for infrastrure development [a] (columns (6)-(7)). Due to data avaiability constraint, the sample period for fiscal transfer is 2000-2018, for debt ratio of infrastrure development it is 2002-2018 and for fiscal dependendecy on provincial government for infrastrure development it is 2006-2016. Controls include the logs of GDP, population and industry revenue for the year before the local leader was appointed, and fixed effects FE for the term year of the provincial governor and party secretary. Standard errors (SE), clustered by city, in parentheses: *** p<0.01, ** p<0.05, * p<0.1. Infra. Dev.: infrastructure development; Pro. Gov.: provincial government.

[a] included both on-budget spending and off-budget spending.

5.2 Economic policies: fast v.s slow

Next, I examine how connections matter for economic policies that differ in the horizons required to yield policy impacts. Table 4 summarizes the results of the estimates on the impacts of political connections on the choice of fast v.s slow economic policies based on equation (2). In this specification, *Connected* captures the difference in policies when leaders are connected, conditional on initial selection ($Connected^{start}$). For the purpose, of precision, I use columns (1), (3), and (5) for interpretation.

Table 4: Estimates of the effects of connections on economic policies by the government

	log(Infrastructure)		log(Sci&Tech)		Innovation Posture (SD)	
Variables	(1)	(2)	(3)	(4)	(5)	(6
Connected	0.0687*	0.0762	-0.0997***	-0.0923**	-0.0739**	-0.0717
	(0.041)	(0.060)	(0.032)	(0.046)	(0.037)	(0.052)
$Connected^{start}$	-0.0721	-0.1466*	0.0370	0.1005*	-0.0133	0.0175
	(0.049)	(0.082)	(0.041)	(0.060)	(0.049)	(0.070)
Observations	2,391	1,126	4,262	1,858	3,311	1,961
R-squared	0.865	0.895	0.935	0.918	0.707	0.683
Mean	6.103	6.402	4.581	5.713	-0.019	0.386
City and year FE	X	X	X	X	X	X
Controls	X	X	X	X	X	X
Init.Cond.Depvar		X		X		X
SE Cluster	City	City	City	City	City	City

The unit of observation is city by year and the sample period various by outcome variable due to data avaiability constraints. The dependent variable is log value of budget spending on infrastructure development (columns (1)-(2)), science and technology (columns (3)-(4)), and government's policy posture on innovation (columns (5)-(6)). The sample period for budget spending on infrastrure development is 2006-2016, for budget spending on science and technology it is 2003-2018, and for government's policy posture on innovation it is 2006-2018. All of the regressions include city and year fixed effects (FE). Control variables include the logs of GDP, population and industry revenue the year before the local leader was appointed, and FEs for the term year of the provincial governor and party secretary. Initial conditions of dependent variable includes the log value and the growth rate in the 5 years preceding the appointment of the local leaders. Standard errors (SE) are clustered by city, in parentheses: *** p<0.01, ** p<0.05, * p<0.1. Sci & Tech: science and technology; SD: standard deviation.

I find that connected leaders spend more on infrastructure development (row (1), columns (1)-(2)). The local governments' budget spending on infrastructure is 6.87% higher , which is equivalent to a

26.8 million RMB increase.[42] Although this effect is not very precisely estimated (row (1), column (1)), it is robust to adding initial values and the initial trend of budget spending on infrastructure before leaders' arrival (row (1), column (2)).

However, I find that connected leaders are less engaged in promoting science and technology and innovation (row (1), columns (3)-(6)). When leaders are connected, the local governments' budget spending on science and technology is lower by 10% (row(1), column (3)), which is equivalent to a reduction of 10.4 million RMB.[43] Moreover, local governments mention innovation less frequently in their GWRs by 0.074 SD(row (1), column (5)). The reduction in spending and policy posture could have different implications for firms and universities. As explained in section 2, direct financing from governments is crucial for innovation by universities due to their heavy financial dependence on government funding. For firms, both reductions can be consequential, as firm's innovation activities are sensitive to both direct financing and indirect policy support. In the next section I will explore the heterogeneous response in innovation by firms and universities in detail.

The contrast between higher infrastructure spending on the one hand, and lower spending on science and lower policy posture on innovation on the other hand implies a clear priority of fast over slow. Local governments' spending on infrastructure primarily goes to public infrastructures, such as water, gas, electricity, internet, telecommunication, and transportation. Aside from broad spillover effects in the future, however, infrastructure spending can also immediately stimulate investment, employment, and thus GDP growth.[44] However, the local governments' spending on science and technology primarily supports R&D activities through research grants and subsidies. And the yields from these investments arise much slower, and are unlikely to immediately contribute to GDP growth.

I argue that the observed priority given to fast over slow policies is likely to be driven by leaders' turnover expectations. One natural concern is that connections can affect the policy choices through other channels. For example, connected leaders generally receive more support from the provincial government to coordinate local development. However, I find that connections do not affect resource

[42]The average annual budget spending on infrastructure by the city government is approximately 391 million RMB.
[43]The average budget spending on science and technology by the city government is approximately 105 million.
[44]20% of physical investment goes toward infrastructure development. 45% of infrastructure development is public infrastructure development which is mainly financed by the government.

transfer, neither explicitly nor implicitly. Another possibility is that connected leaders are more likely to seek rent through infrastructure development. However, I show that connections sharpen leaders' career concerns by enhancing their promotion prospects. In other words, connected leaders are less likely to be corrupted by trading future political careers for short term economic benefit.[45]

5.3 Growth and innovation

I next examine the effects of political connection on growth and innovation based on equation (2). To relate this to the results on fast and slow policies on growth, I examine the impulse response of growth and innovation to connection. Table 5 presents the results on current growth (innovation) and future growth (innovation). Here the focus is on how connections affect the dynamics of growth and innovation.

Connected leaders deliver higher GDP growth in the short run but lower growth in the long run (row (1) in Panel A). The current effect of connection on GDP growth is 1 pp (row (1), column (1), Panel A), which is equivalent to an 8% increase relative to the average growth rate, or approximately 320 RMB in GDP per capita. The effect on GDP growth peaks in the following year (year t+1) (row(1), column (2), Panel A)), i.e., leaders are connected today, the GDP growth rate is higher by 1.9 pp in the next year. However, from the third year onwards, the effects of connections first decay, with the positive effects only lasting until the fourth year (year t+3) (row (1), column (4)), become negligible from then till the sixth year (row (1) column (5)-(6), and flipped as negative for the seventh year and the eighth year (row (1), column (7)-(8), with the GDP growth rate lower by 1 pp. The short-term effect on economic growth is similar to those reported in previous studies, which show that connections sharpen leaders' incentives in economic work (Jia et al., 2015; Jiang, 2018). However, given the effect of connections on future growth, it is clear that connection only sharpens leaders' incentives for short-term economic growth.

[45] Although I cannot entirely rule out the possibility of connected leaders pursuing rent-seeking activities, I present on suggestive piece of evidence on its minimal impact. The corruption rate among city leaders is relatively low, and the connection rate is quite well-balanced between connected ones and unconnected ones. From 1994 to 2020, only approximately 4% of the city leaders were ever demoted or suspended due to corruption (calculated using the author's data). Moreover, among those who were later demoted/suspended, I do not find the leaders to have more connections than average. Therefore, I infer that rent-seeking driven by economic incentive is very limited among city leaders.

Table 5: Estimates of the effects of connections on growth and innovation

Variables	t (1)	t+1 (2)	t+2 (3)	t+3 (4)	t+4 (5)	t+5 (6)	t+6 (7)	t+7 (8)	t+8 (9)	t+9 (10)	t+10 (11)
Panel A: Grow Rate in GDP											
Connected	0.0102***	0.0189***	0.0159***	0.0101***	0.0042	-0.0002	-0.0096**	-0.0107***	-0.0064	0.0017	0.0041
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)
$Connected^{start}$	-0.0025	-0.0125***	-0.0129***	-0.0056	-0.0059	0.0011	0.0153***	0.0121***	0.0073	0.0015	-0.0076
	(0.004)	(0.004)	(0.004)	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)
Observations	4,419	4,156	3,885	3,618	3,340	3,062	2,814	2,539	2,267	2,004	1,731
R-squared	0.488	0.506	0.512	0.521	0.529	0.542	0.573	0.582	0.580	0.569	0.562
Mean	0.127	0.126	0.124	0.122	0.119	0.116	0.110	0.105	0.098	0.092	0.086
Panel B: log(# of invention patents applications)											
Connected	-0.1190***	-0.0972***	-0.0685**	-0.0481	-0.0614*	-0.0743**	-0.0798**	-0.0331	-0.0429	-0.0164	-0.0121
	(0.028)	(0.030)	(0.032)	(0.033)	(0.034)	(0.034)	(0.033)	(0.030)	(0.030)	(0.031)	(0.030)
$Connected^{start}$	0.0224	-0.0119	-0.0524	-0.0736*	-0.0637	-0.0484	-0.0247	-0.0103	-0.0148	-0.0135	0.0024
	(0.039)	(0.040)	(0.042)	(0.044)	(0.044)	(0.045)	(0.040)	(0.036)	(0.034)	(0.033)	(0.034)
Observations	4,874	4,590	4,326	4,056	3,782	3,502	3,252	2,973	2,696	2,420	2,141
R-squared	0.941	0.937	0.936	0.935	0.936	0.940	0.942	0.947	0.950	0.954	0.959
Mean	5.079	5.192	5.320	5.445	5.571	5.707	5.850	5.978	6.112	6.246	6.377
City and Year FE	X	X	X	X	X	X	X	X	X	X	X
Controls	X	X	X	X	X	X	X	X	X	X	X
Trend.init.Dep	X	X	X	X	X	X	X	X	X	X	X
SE Cluster	City	City	City	City	City	City	City	City	City	City	City

The unit of observation is city by year and the sample period is 2000-2018. The dependent variable in panel A is annual GDP growth and in panel B it is the log value of total number of invention patent application. Each column indicates the period of the corresponding outcome variable. All regressions include city and year fixed effects (FE). Control variables include the logs of GDP, population and industry revenue for the year before the local leader was appointed, and FEs for the term year of the provincial governor and party secretary. Standard errors (SE) are clustered by city, in parentheses: *** p<0.01, ** p<0.05, * p<0.1. Trend.init.Dep: initial value of the outcome variable before the leader was appointed and trend in the outcome variable 5 years before the leader was appointed.

In contrast, connected leaders reduce innovation in the future (row (1) in Panel B). I observe an immediate drop of 11.9% in the invention patent applications(row (1), column (1), Panel B), which is equivalent to 19 fewer patents in the current year. This effect persists over time and lasts at least until the seventh year (year t+6), with a magnitude of around 16-17 fewer patents in each corresponding year.

If innovation is slow-to-yield, why is there an immediate drop in innovation ? What drives the persistent reduction? I first exclude the possibility of connected leaders being appointed to cities with lower potential in innovation, as discussed in section 4. Essentially, I exploit a shock in politicians' career concerns, which directly affects innovation policies and indirectly reshapes the market environment through affecting other polices. Studies show that patent applications respond immediately to a direct policy shock but much more slowly to a market shock.[46] Thus, I infer my findings to reflect a combination of both direct change in innovation policy and an indirect change in the market environment. The immediate drop is likely to be primarily driven by a reduction in funding support that discourages the filing of patent applications. From the second year (year t+1) onwards, the persistent reduction is likely to be driven by both factors. A full analysis that disentangles these two mechanisms is beyond the scope of this study. Nevertheless, in the next section, I will discuss the relative magnitudes by comparing innovation by firms and universities. Overall, the dynamic effects highlight the slow-to-yield nature of innovation activities and their vulnerability to short-termism policies.

In summary, when leaders are connected, the local economy follows a trajectory wherein growth rises at the cost of innovation but falls when the fall in innovation persists. This pattern is closely associated with the policy pursuit of fast-over-slow. Fast policies such as infrastructure development can immediately boost investment and employment, have broad spillover effects on the local economy and facilitate innovation over time. However, local leaders pursue fast policies at the cost of innovation by spending less and working less on innovation. When the effect of underinvestment

[46]From the perspective of a direct policy shock, a close comparison is Aghion et al. (2019), a study that exploits the state composition of the US Senate Appropriation Committee as the instrumental variable for innovation. They observe a sharp rise in patents applied by universities immediately after a one-member increase in state representation on the Appropriation Committee and a rise in patent applications by all sectors 3 years later. From the perspective of change in the market environment, a close comparison is Aghion et al. (2018), a study that quantifies the impact of a demand shock on firm innovation in France and finds that a patent response arises 3-5 years later.

in innovation materializes, it supersedes the spillover effects of infrastructure and reduces growth.

6 Interpretation and Extension

The previous section shows that leaders' connections affect their turnover, policy choices, and innovation outcomes. I also show that cities with connected leaders are not significantly different from those with unconnected leaders and that connections do not affect resource transfer from the provincial government. However, as connections affect both tenure and promotion, it remains unclear how the interplay between these mechanisms affects the policy and innovation outcome.

I leverage the heterogeneous effects of connections by leaders' heterogeneity on innovation by different sectors to isolate the horizon effect from the promotion effect. Specifically, I study the heterogeneous effects of connections by leaders' age category and compare sub-samples of leaders whose tenure alone is affected with sub-samples of leaders whose tenure and promotion are both affected. I also examine the heterogeneous effects of connections on innovations by firms and universities, as the former are affected by both innovation policies and other policies whereas the latter are primarily affected only by innovation policies.

6.1 Horizon effect v.s. promotion incentive

I first study the heterogeneous effect by age group and report the results in Table 6. A leader is considered young if her age upon appointment is below the median age of the appointment cohort. The coefficient of $Connected$ represents the effect of connections for young leaders, and the sum of $Connected$ and $Connected * Old$ represents the effect of connections for old leaders.

I find that although the effect of connection on shortening tenure does not differ across age categories (rows (1)-(2), column (1)), the effect of connections on enhancing the promotion likelihood is only observed for old leaders (rows (1)-(2), column (2)). In other words, connections help young leaders move faster but assist old leaders in moving *up* faster.

This differential effect across age groups offers a unique opportunity to examine the relative magnitude of horizon and promotion incentives on outcome variables. First of all, conditional on connection, this approach can address the concerns of exclusion restriction due to connection affecting other unobservable factors that affect a leader's behaviors. Secondly, by leveraging the heterogeneous effect on the connections for old and young leaders, I can isolate the effect of promotion incentives.

I next examine whether the effect on economic policies also differs across age groups. I find that the policy pursuit of fast-over-slow is primarily driven by young leaders. When cities have young connected leaders, the local governments' spending on infrastructure is 21% higher (row (1) column (3)), which amounts to a 126 million RMB raise, but the local government's spending on science and technology is 14.8% lower, which is equivalent to cuts of 12.6 million RMB. Similarly, cities with connected young leaders have lower policy postures on innovation by 0.09 SD (insignificant) (row (1), column(5)).

The pursuit of fast policy over slow policy is much less prominent among old connected leaders (row(1)+row(2)). One possible explanation is that promotion incentives mitigate the problem of short-horizons as old connected leaders also have a higher likelihood of promotion. Alternatively, it implies that the short horizons tend to undo the promotion incentives.

6.2 Firms v.s. universities

I examine the effects of political connections on innovation by firms and universities, out of which the former contributes 60% of the patent applications and the latter contributes 15% of the patent applications.[47] Using the same specification as in Table 5 but interacting the connection dummy with the age dummy, I compare how the patent responses of firms and universities differ over time. The estimated coefficients of *Connected* are plotted in Figure 3.

I find that the patent response differs between firms and universities. I observe an immediate and persistent reduction in the patent applications filed by firms, with the effect decaying over time. In

[47] The remaining categories are by individuals (19%) and government's affiliated research institutes (6%). The categories of individuals are relatively noisy as they could be either individuals or small firms (Sun et al., 2021), and it is unclear how market forces affect them. I also exclude the category of government's affiliated research institutes as it is relatively small and, in practice, its orientation is between for-profit and not-for-profit.

Table 6: Estimates of the effects of connections by age group

	Turnover Outcome		log(Gov Spending)		Policy Posture (SD)
	Exited	Promoted	Infrastructure	Sci&Tech	Innovation
Variables	(1)	(2)	(3)	(4)	(5)
Connected	0.0467***	0.0124	0.2107***	-0.1480***	-0.0918
	(0.015)	(0.011)	(0.077)	(0.052)	(0.063)
*Connected*Old*	-0.0173	0.0392***	-0.1988**	0.0891	0.0236
	(0.020)	(0.015)	(0.100)	(0.061)	(0.071)
$Connected^{start}$	-0.0385**	-0.0182	-0.4254***	0.0811	0.1078
	(0.016)	(0.011)	(0.119)	(0.090)	(0.093)
$Connected^{start}*Old$	-0.0201	-0.0447***	0.3829***	-0.0696	-0.1543
	(0.021)	(0.016)	(0.142)	(0.104)	(0.105)
Old	0.0607***	-0.0338***	-0.1706	-0.0197	0.0911
	(0.013)	(0.009)	(0.121)	(0.083)	(0.092)
Observations	11,727	11,727	1,126	4,262	3,034
R-squared	0.285	0.123	0.896	0.935	0.712
Mean	0.245	0.098	6.402	4.581	-0.010
City and year FE	X	X	X	X	X
Controls	X	X	X	X	X
Init.Cond.Depvar			X	X	X
SE Cluster	City	City	City	City	City

For columns (1)-(2), the unit of observation is leader by year and the sample period is for leaders who are appointed during the period of 1997-2017, including the mayor and the party secretary. For columns (2)-(5), the unit of observation is city by year and the sample period varies based on data availability. The dependent variables are an indicator for whether the leader leaves office in the given year (column (1)), whether she/he is promoted in the given year (column (2)), log value of budget spending on infrastructure development (column (3)), log value of budget spending on science and technology (column (4)), and government's policy posture on innovation (column (5)). The sample period for budget spending on infrastructure development is 2006-2016, for budget spending on science and technology it is 2003-2018, and for the government's policy posture on innovation it is 2006-2018. In columns (1) and column (2), term year fixed fixed effects are controled for. In columns (3)-(5),initial conditions of the outcome variable before the leader arrives are controled for (Init.Cond.Depvar). All of the regressions include city fixed effects, year fixed effects. Control variables include the logs of GDP, population and industry revenue for the year before the local leader was appointed, and fixed effects for the term year of the provincial governor and party secretary. Initial conditions of dependent variable includes the log value and the growth rate in the 5 years preceding the appointment of the local leader. Standard errors (SE) are clustered by city, in parentheses: *** p<0.01, ** p<0.05, * p<0.1. Gov.: government; Sci & Tech: science and technology contrast, universities' responses materializes later but lasts longer.

I infer that the persistent reduction in universities' innovation is likely to be directly driven by innovation policies. First, universities' innovation activities respond less to the market environment and more to direct policy shocks than do firms' innovation activities. Moreover, universities are also more likely to conduct slow research and rely more on direct funding support from the government.[48]

Both innovation policies and the market environment changed by other policies can affect firms. On the one hand, firms rely little on the government's direct financing: at the aggregate level, only 4% of the R&D expenditure comes from the government (at all levels). On the other hand, firms' innovation activities are highly responsive to indirect government financing, such as tax incentives, credit assistance, talent recruitment, patent services, and collaborations with research institutes. Disentangling these mechanisms is an important topic for further research.

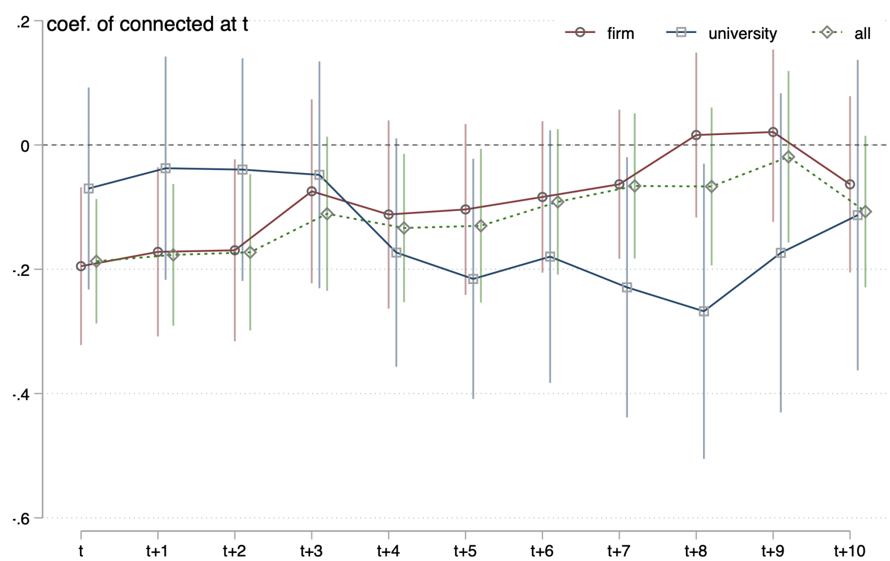


Figure 3: Dynamic effects of connection on innovation: firm v.s. university

6.3 Quantifying the horizon effect on innovation

What is the effect on innovation if a leader's expected tenure is shorter by 1 year? I examine the effect of connection on patent applications by firms and universities from now until 5 years hence.

[48]According to the survey by NBS in 2010, universities receive 56% of their R&D funding from government.

Table 7: Estimates of the effect of connection on accumulated number of patents (from t to t+5)

	Firm			University		
	All	L-impact	H-impact	All	L-impact	H-impact
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Connected	-0.1235*	-0.1278*	-0.1695**	-0.2474**	-0.2172**	-0.2354**
	(0.066)	(0.067)	(0.081)	(0.097)	(0.096)	(0.101)
Connected∗Old	0.0436	0.0484	0.0710	0.1091	0.0811	0.0932
	(0.070)	(0.070)	(0.082)	(0.111)	(0.110)	(0.115)
$Connected^{start}$	-0.0765	-0.0794	-0.0296	0.1114	0.0944	0.1198
	(0.093)	(0.094)	(0.096)	(0.137)	(0.136)	(0.140)
$Connected^{start}*Old$	0.0302	0.0291	0.0152	-0.1415	-0.1243	-0.1360
	(0.101)	(0.101)	(0.101)	(0.152)	(0.151)	(0.153)
Old	-0.0565	-0.0577	-0.0669	0.0930	0.0986	0.0579
	(0.082)	(0.082)	(0.082)	(0.128)	(0.126)	(0.137)
Observations	3,478	3,478	3,478	3,478	3,478	3,478
R-squared	0.961	0.959	0.960	0.944	0.942	0.919
Mean	4.398	4.281	2.174	1.931	1.823	0.452
City and year FE	X	X	X	X	X	X
Controls	X	X	X	X	X	X
Init.Cond.Depvar	X	X	X	X	X	X
SE Cluster	City	City	City	City	City	City

The unit of observation is city by year and the sample period is from 2000-2018. The dependent variable is log value of invention patent application by firms from years t to t+5 (columns (1)-(3)), and invention patent applications by universities from years t to t+5 (columns (4)-(6)). All of the regressions include city and year fixed effects (FE). Control variables include the logs of GDP, population and industry revenue for the year before the local leader was appointed, and FEs for the term year of the provincial governor and party secretary. Initial conditions of dependent variable (Init.Cond.Depvar) includes the log value and the growth rate in the 5 years preceding the appointment of the local leader. Standard errors (SE) are clustered by city, in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 7 reports the results, and I draw from columns (2) and column (4) for interpretation. In all of the regressions, *Connected* represents the semi-elasticity of innovation with regard to having young connected leaders.

The horizon semi-elasticity of innovation is sizable. When leaders expect a tenure shorter by 6 months (Table 6, row (1), column (1)), the annual innovation by local firms will be lower by 12.35% from now until five years later (row (1), column (2)). Following a simple back-of-the-envelope calculation, a one year reduction in tenure implies a 27% drop in firms' innovation. For an average city, this is equivalent to 9 fewer patents. per year. This effect is likely driven by both the direct and indirect effects of the fast-over-slow policy choice. By analogy, the effect on innovation by local universities is lower by 24.7% from now until 5 years later (row (1) column (3)). It implies that a 1 year reduction in tenure can lead to a 55.4% reduction in universities' innovation. For an average city, this is equivalent to 3.4 fewer patents by the university annually. Furthermore, the horizon effect is similar between low impact patents (row (1), column (2) and column (5)) and high impact patents (row (1), column (3) and column (6)), thus excluding the possibility of quality-over-quantity in innovation policies.

7 Conclusions

Innovation is constantly exposed to the risk of short-termism policies as politicians come and go. Understanding this risk is essential for designing institutions that promote innovation. However, there is little existing evidence on how this risk matters for long-term development.

This study fills the gap by exploiting the unique institutional setting of Chinese city leaders. I build a novel dataset that links leaders' careers to policies and innovation outcomes for all Chinese prefecture-level cities during the period of 2000-2018. I draw on evidence that political connections put leaders on a fast track and use political connections to generate exogenous variation in expected tenures. I digitize leaders' career histories from their CVs and measure connections based on whether a previously formed subordinate-superior relationship exists between the city and provincial leaders. I find that connected leaders can rationally expect short tenure, spend more on infrastructure but less on innovation and put less emphasis on innovation. Such prioritization is reflected in the local economy's growth trajectory: higher short-term growth but lower future innovation and growth.

This study contributes to four strands of literature. Firstly, it adds the time dimension of local leaders' career concerns to the discussion on China's transition from "made-in-China" to "innovated-in-China". Secondly, it provides empirical evidence on short-termism in innovation policies driven by political turnovers. Thirdly, it advances our understanding of innovation policy-making by showing that the government's horizon is a crucial constraint. Lastly, this study contributes methodologically to the literature on political connections.

Future extensions are necessary for a further understanding on the political economy of innovation. First, the political horizons of local leaders matters for the future trajectory of China's development. I show that when leaders expect shorter tenure, they tend to sacrifice innovation for fast growth in the short term. Does short-termism also exist in other policies that are slow to pay off? Do leaders promote innovation when they expect longer tenures? These questions require further study. Given that short tenures are necessary for political career success in China, the effect of tenure is likely to be asymmetric. However, further investigations are needed to understand China's trade-off between political stability and economic prosperity. Second, this study finds that short political horizons lead to under-investment in innovation and lower future growth. However, the context of China is very different from the rest of the world. Does the effect of short-termism on promoting innovation also exist in democracies? Does short-termism in promoting innovation matter in democracies? The answers are likely to vary due to differences in political and market institutions. Extending this study to other settings is necessary to design institutions that promote innovation and shield innovation from political short-termism.

.1 Data collection for leaders' CVs

Many previous studies had collected data on Chinese leader's career background for top leaders. The interest has recently expanded to prefecture level leaders and country level leaders. But the external usage of these data collections is limited by the lack of consistency and compatibility. One exception is a recent work by Yang et al. (2020) in which their research team collects CV:s for major leaders who ever served at a position at prefecture level or above during 1994-2017. The coverage rate of their sample is around 99% after 2002. They also developed a set of coding rules for parsing the CV:s data manually.

My work differs from Yang et al. (2020) in two ways. Firstly, the CV:s in the CCER data covers only records above county level position, while my work covers CV:s dating back to at least county level position, which enables an exhaustive search for superior-subordinate ties in more deepth. Secondly, the parsing of CV:s data is fully automated and facilitated with NLP methods in this study. This could provide more granularity, flexibility, as well as consistency for future exploration.

Appendix A Encoding CV trajectories based on the bureaucratic hierarchy

The raw documents contain rich but unstructured information that cannot be analyzed directly. Each raw CV is a chronological account of events, in which each event, represented as a string, refers to a person working at one or several jobs for a certain period[49].

I structure CV trajectories by encoding positions contained in CVs based on the existing Chinese bureaucratic hierarchy. I first parse each event string as a sets of job vectors using the NLP-NER method. Next, I convert each person's CV into a year-job panel, with job defined in step one.

A.1 Definitions of position

For each job string (contained in an event string), I apply the NER method to parse it as a set of positions, with each position defined as a tuple of locality, organization, and job title. This encoding approach creates 16, 182 unique positions.

$$Position = (Locaility, Organization, JobTitle)$$

- The universe of *Locality* contains 3,360 elements, with each element referring to either the whole nation (if it is a national level position) (1 element), a province (31 elements), a prefecture (334 elements), or a county (2,933 elements).
- The universe of $Organization$ contains 129 elements, with each element referring to either military, regional-level party committee, government, local people's congress, local people's political consultative conference committee, or a division under any of the above organizations such as the department of propaganda within the party committee, or the committee of development and reform within the government.
- The universe of $JobTitle$ contains 9 elements, with each element referring to either the head (vice-head), division head (vice-division-head), section head (vice-section head), or section

[49]for example, http://ldzl.people.com.cn/dfzlk/front/personPage15093.htm

member.

- Each position also has a rank that is jointly determined by the locality, organization and job title[50]. There are 11 levels of rank in the bureaucratic hierarchy, with section members who are grass-root level bureaucrats as the bottom layer and the national head as the top layer.

For example, the vice chairman of the Standing Committee of the People's Congress of Xiamen Prefecture is a position with the following three attributes: $Locality$ =Xiamen, $Organization$ =local people's congress, $JobTitle$ = vice-head. Based on the ranking rules, this position is ranked as a deputy bureau director.

A.2 Definition of superior-subordinate relationship between positions

I denote the hierarchy of position or position features (location, organization or job title) as a graph $G = (N, E)$, in which N represents the set of nodes and E represents the set of directed edges in which each edge points from a superior to a subordinate. For any $n \in N$, its superior nodes ($sup(n)$ and weak superior ($wsup(n)$) nodes are defined as

$$sup(n) = \{n' \in N | (n', n) \in E\} \tag{A.1}$$

$$wsup(n) = \{n' \in N | (n', n) \in E\} \cup \{n\} \tag{A.2}$$

By this definition, superior nodes of a node refers only to direct superiors, whereas weak superiors refers to not only direct superiors but also to the node itself.

There exists three different types of superior-subordinate relationship in the bureaucratic system in China. The first is within-location-within-organization, such as the head of the anti-corruption bureau and the division head within the anti-corruption bureau of the same region. The second is within-region-between-ogranization, such as the anti-corruption bureau being supervised by the procuratorate of the same region. The third is between-region-within-organization, such as the anti-corruption bureau of the province of Hunan overseeing the anti-corruption bureau of its provincial

[50]for reference, https://en.wikipedia.org/wiki/Civil_Service_of_the_People%27s_Republic_of_China.

capital city [51].

It is worth emphasizing that the superior-subordinate relationship between organizations is restricted to only the following two situations:

- departments within a local government/party supervised by the local government head(vice-head) and local party committee. For example, the head of government (mayor) is the direct superior of all the department heads in the local government.
- department-affiliated organizations supervised by the department to which they are affiliated to. For example, the anti-corruption bureau is supervised by the procuratorate in the same region.

Under this institutional set up, a position m is a direct superior of another position n if there exists a weak superior-subordinate relationship in location and organization, and a superior-subordinate relationship in job title between m and n.

$$\begin{aligned} 1\{Position_m \in sup(Position_n)\} =& (1\{Locaility_m \in wsup_{loc}(Locaility_n)\} \\ & * 1\{Organization_m \in wsup_{org}(Organization_n)\} \\ & * 1\{JobTitle_m \in sup_{title}(JobTitle_n)\}) \end{aligned} \tag{A.3}$$

This definition of superior-subordinate relationship allows for the following scenarios in which n has a title rank that is one or two levels above m

- m and n are from the same location and same organization. For example, the head of the anti-corruption bureau and the division head within the anti-corruption bureau.
- m and n are from the same location and different organizations, but the organization of n supervises the organization of m. For example, the anti-corruption bureau is supervised by the procuratorate in the same region.

[51] Since 1984, the management of cadres has followed two rules: appointment made by the party committee one level up, and they are subject to the leadership both of the local authority (in local government or in local party committee) and the same department at an upper level.

- m and n are from different locations, but the same organizations, and n's organization supervise m's organization due to the hierarchical relationship between their locations. For example, the anti-corruption bureau of a province oversees that of its provincial capital city.

A.3 Algorithms to create the hierarchy of positions

I denote the total number of positions as N. The superior-subordinate relationship between positions is the Hadamard product of three $N \times N$ matrices, defined as follows

$$H = S_{location} \odot S_{org} \odot S_{rank} \tag{A.4}$$

- H is a $N \times N$ matrix that represents the superior-subordinate relationship between the row and the column positions, with each element being either 0 or 1.
- $S_{location}$ is a $N \times N$ matrix that represents the superior-subordinate relationship between the row and column positions' localities, with each element being either 0 or 1.
- S_{org} is a $N \times N$ matrix that represents the superior-subordinate relationship between the row position's organization and the column position's organization, with each element as either 0 or 1.
- S_{rank} is a $N \times N$ matrix that represents the superior-subordinate relationship between the row and the column positions' job titles (rank), with each element being either 0 or 1.
- $\odot$ represents the Hadamard product (element-wise product) between the matrix on the left and the matrix on the right of this operator symbol.

The derivation of the matrix of S_{loc} requires the matrix that represents the geographic location of position and the matrix that represents the hierarchical relationship between locations. I denote the total number of localities as N_{loc}, and the matrix of S_{loc} as:

$$S_{loc} = L \cdot H_{loc} \cdot (L)' \tag{A.5}$$

- L is a $N \times N_{loc}$ matrix that represents the geographic location relationship between the row position and the column location, with each element being either 0 or 1.

- H_{loc} is a $N_{loc} \times N_{loc}$ matrix that represents the superior-subordinate relationship between the row and the column positions, with each element being either 0 or 1 and all of the elements on the diagonal being 1.

The derivation of the matrix of S_{org} requires the matrix that represents the organization of position and the matrix that represents the hierarchical relationship between organizations. I denote the total number of organizations as N_{org} and the matrix of S_{org} as:

$$S_{org} = G \cdot H_{org} \cdot (G)' \tag{A.6}$$

- G is a $N \times N_{org}$ matrix that represents the organizational relationship between the row position and the column organization, with each element being either 0 or 1.

- H_{org} is a $N_{org} \times N_{org}$ matrix that represents the superior-subordinate relationship between the row and the column positions, with each element being either 0 or 1 and all of the elements on the diagonal being 1.

The derivation of the matrix of S_{rank} requires the matrix that represents the rank of position and the matrix that represents the hierarchical relationship between ranks. I denote the total number of ranks as N_{rank} and the matrix of S_{rank} as:

$$S_{rank} = K \cdot H_{rank} \cdot (K)' \tag{A.7}$$

- K is a $N \times N_{rank}$ matrix that represents the rank relationship between the row position and the column rank, with each element being either 0 or 1.

- H_{rank} is a $N_{rank} \times N_{rank}$ matrix that represents the superior-subordinate relationship in rank between the row and the column positions, with each element being either 0 or 1 and all of elements on the diagonal being 0.

Appendix B Measuring connection based on career trajectory

B.1 Algorithms to create superior-subordinate links

To further restrict the superior-subordinate relationship to representing patron-client ties, I first impose the superior-before-subordinate relationship between superior and subordinate.

$$\xi(t) = D(t) \cdot B \cdot (D(t))' \tag{B.1}$$

- $\xi(t)$ is a $N_{psn} \times N_{psn}$ matrix and N_{psn} represents the total number of persons. An element equals to 1 if the row(person) starts her/his current position before the column (person), and 0 otherwise.
- $D(t)$ is a $N_{psn} \times N_{dn}$ matrix that represents the person-duration relationship between the row person and the column duration (measured in years) at time t, with each element being either 0 or 1 and $N_{dn} = 10$. For example, $D(t)[i, 2] = 1$ if at time t the individual i is in the second year of her/his current position.
- B is a $N_{dn} \times N_{dn}$ matrix that represents the before-after relationship between the row and the column duration (years). If the row duration is not smaller than the column duration, then the corresponding element equals to 1, and 0 otherwise.

I then use a square matrix $S(t)$ to denote the superior-subordinate relationship between individuals at time t. The derivation of $S(t)$ relies on a matrix that represents the relationship between person and position, a matrix that represents the hierarchy of positions and the matrix $\xi(t)$ defined as above

$$S(t) = ((Position(t)) \cdot H \cdot (Position(t))') \odot \xi(t) \tag{B.2}$$

- $S(t)$ is a $N_{psn} \times N_{psn}$ matrix and N_{psn} represents the total number of persons. An element equals to 1 if the row(person) supervises the column (person), and 0 otherwise.

- $Position(t)$ is a $N_{psn} \times N$ matrix that represents the person-position relationship between the row person and the column position at time t, with each element being either 0 or 1.

- H is a $N \times N$ matrix that represents the superior-subordinate relationship between the row and the column positions, with each element being either 0 or 1, and is derived from equation A.4.

This algorithm enables a speedy and comprehensive search through the career trajectory network for subordinate-superior links. For individual i at time t, her/his direct superiors are defined as individuals who were holding a position that supervises person i's position at time t, which is equivalent to the i-th column of the matrix $S(t)$

$$sup(i,t) = \{j \in I : Position_{j,t} \in sup(Position_{i,t})\} := S(t)[:, i] \tag{B.3}$$

For individual i at time t, her/his previous superiors are defined as individuals who were holding a position that supervises person i's position before or at time t, denoted as $\bigcup_{s<t} sup(i,s)$.

B.2 Evaluating connection between politicians

For any superior $j \in \bigcup_{s<t} sup(i,s)$, the value of i connected to j via previous subordinate-superior links depends on two factors: the intensity of the link, and the current political rank of j. I denote the intensity as $w_{i,j,t}$, and the political power of j as $\kappa_{j,t}$, and model the value of i connected to j, denoted as $v_{i,j,t}$, as follows:

$$v_{i,j,t} = \omega_{i,j,t}\kappa_{j,t} \tag{B.4}$$

I infer the value of $\omega_{i,j,t}$ from the time composition of the links. I let $T_{i,j,t}$ denote the set of periods prior to t when j was the direct superior of i

$$T_{i,j,t} = \{s < t | Position_{j,s} \in sup(Position_{i,s})\} \tag{B.5}$$

I impose the following three monotonicity constraints on $\omega_{i,j,t}$:

- $\omega_{i,j,t}$ is non-decreasing in τ_{min} conditional on $||T_{i,j,t}||$: the more recently the links are formed, the higher the connection intensity
- $\omega_{i,j,t}$ is non-decreasing in τ_{max} conditional on τ_{min}: the longer the links last between i and j, the higher the connection intensity
- $\omega_{i,j,t}$ is non-increasing in τ_{min} conditional on τ_{max}: the earlier the links start between i and j,the higher the connection intensity

Among the eligible function forms, I consider the following choices:

- time-discounted (with a discount constant δ)
  - sum: $\omega_{i,j,t} = \left(\sum_{\tau \in T_{i,j,t}} \delta^{t-\tau} \right)$
  - maximum :$\omega_{i,j,t} = \max_{\tau \in T_{i,j,t}} ||T_{i,j,t}|| \times \delta^{t-\tau}$
- time-constant
  - count :$\omega_{i,j,t} = ||T_{i,j,t}||$
  - binary :$\omega_{i,j,t} = 1\{||T_{i,j,t}|| >= 1\}$

I take the maximum value of connection at person level in the presence of multiple previous superiors. I let $v_{i,t}$ denote the value of the political connection person i has at time t,

$$v_{i,t} = \max_{j \in \bigcup_{s<t} sup(i,s)} v_{i,j,t} \tag{B.6}$$

B.3 Evaluating connection between city leaders and provincial leaders

For the main specification of this study, I choose the binary measure of link intensity and restrict the links to be formed before the latest appointment of the city leader and the provincial leaders.

Specifically, for city leader i and provincial leader j, the periods of links are defined as follows:

$$T_{i,j,t_0} = \{s < t_0 | Position_{j,s} \in sup(Position_{i,s})\} \tag{B.7}$$

where t_0 indicate the time when i and j encounter each other as city leader and provincial leader for the first time. The connection dummy is defined as whether i ever worked with j as subordinate-superior before t_0

$$v_{i,j,t} = 1\{||T_{i,j,t_0}|| >= 1\} \tag{B.8}$$

For each individual i, she/he is connected to her/his provincial leaders if she/he is connected to at least one of them:

$$v_{i,t} = 1\{v_{i,gr(i),t} + v_{i,ps(i),t} >= 1\} \tag{B.9}$$

where $gr(i)$ indexes the provincial governor of i and $ps(i)$ indexes the provincial party secretary.

Appendix C Validating the empirical design

C.1 Whether leaders select into connection

I test whether career background affects a leader's probability of beginning as connected or later turning connected, using the following specification:

$$ConnEvent_{i,c} = X_i\Omega + \tau_{t_{i,c}} + \delta_c + \epsilon_{i,c} \tag{C.1}$$

where X_i is a set of dummies that characterize a leader's career background, including whether the starting age is above the median of the same appointment cohort., whether have studied STEM at university or worked in a STEM related department in the government, whether on a fast-track, whether connected to any other leaders at the provincial level, and whether have worked as a city leader before. $\tau_{i,t_{i,c}}$ indexes the start year fixed effect (FE) for the spell. δ_c indexes the city FE.

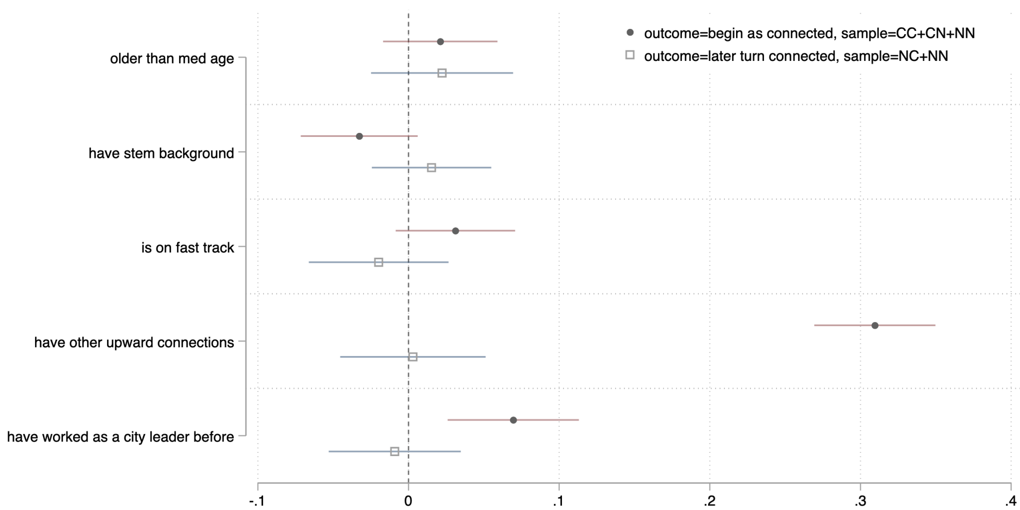


Figure C.1: Coefficients of leaders' background features on becoming connected

The unit of observation is city-year spell for spells that start during the period of 1997-2017. All of the regressions include FEs for the position (mayor or party secretary), and FEs for the term year of the provincial governor and party secretary

C.2 Whether cities select into having connected leaders

I test whether the initial social-economic conditions affects a city's probability of having a leader starting as connected or gradually becoming connected, using the following specification:

$$ConnEvent_{c,s} = \eta_1' X_{c,s}^0 + \eta_2' \Delta y_{c,s}^0 + CityFE + TrendFE + unobservable \quad \text{(C.2)}$$

c index city and s index a tenure spell. $ConnEvent_{c,s} = 1$ if the leader either started as connected due to previous links or gradually become connected under the same provincial incumbents. $X_{c,s}^0$ is a set of variables to represent local conditions, including GDP, population, industry revenue (size of the manufacturing sector). $\Delta y_{c,s}^0$ is the 2-year-accumulated-change (or 5-year-accumulated-change) in these variables preceding the appointment of the leaders to measure pre-trends. $TrendFE$ includes both year fixed effects in terms the year the spell started, and provincial leader's term year fixed effects. Standard errors are clustered by the city.

Figure C.2 displays the results of the correlation between $X_{c,s}^0$ and connection events. Overall, cities' initial economic conditions are not correlated with the occurrence of various types of connection event, except for that cities with smaller populations have a higher likelihood of being assigned with leaders who begin as connected.

Figure D.3 displays the results of the correlation between $\Delta y_{c,s}^0$ and connection events for each outcome variable, conditional on $X_{c,s}^0$.

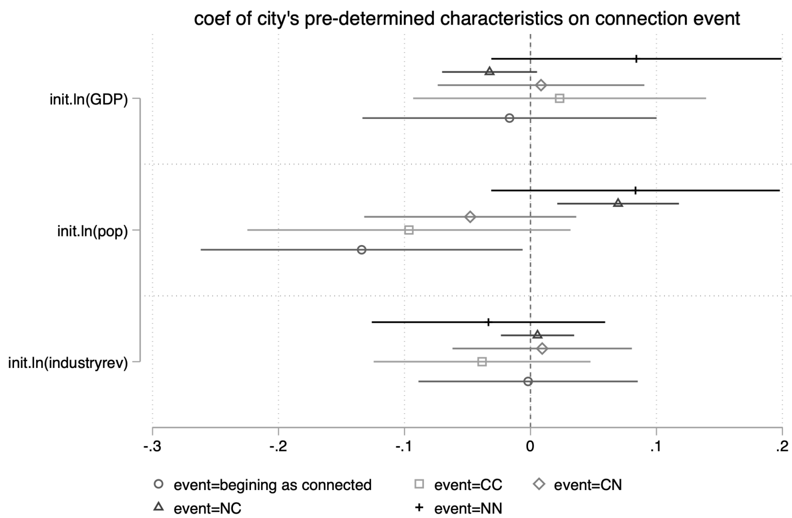
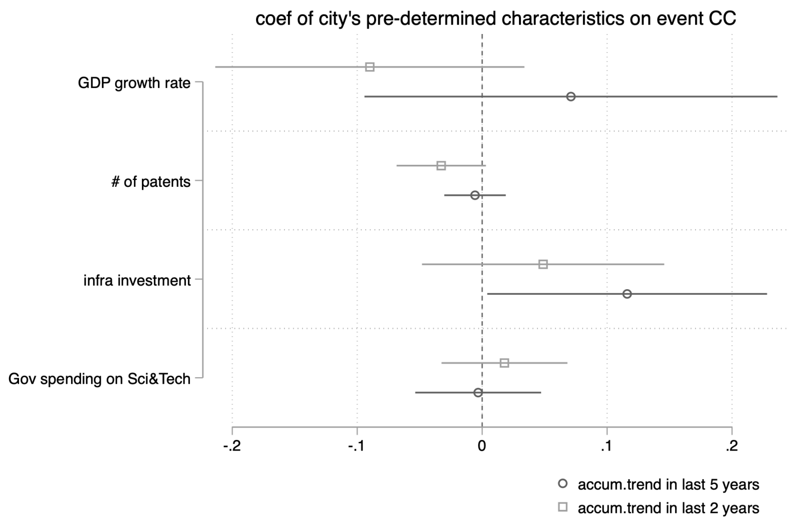
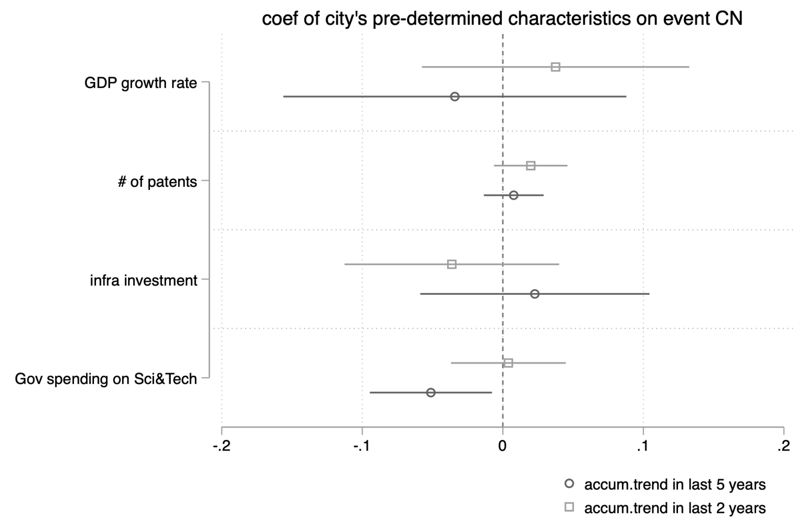


Figure C.2: Coefficients of city's initial economic condition on connection events

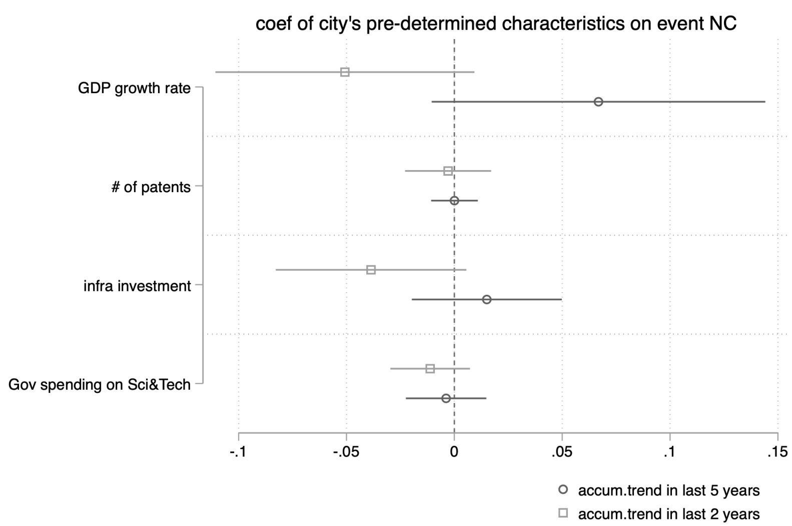
The unit of observation is city-year spell for spells that start during the period of 1997-2017. All of the regressions include FEs for the position (mayor or party secretary), FEs for the term year of the provincial governor and party secretary, and City FEs. Standard errors are clustered by the city.



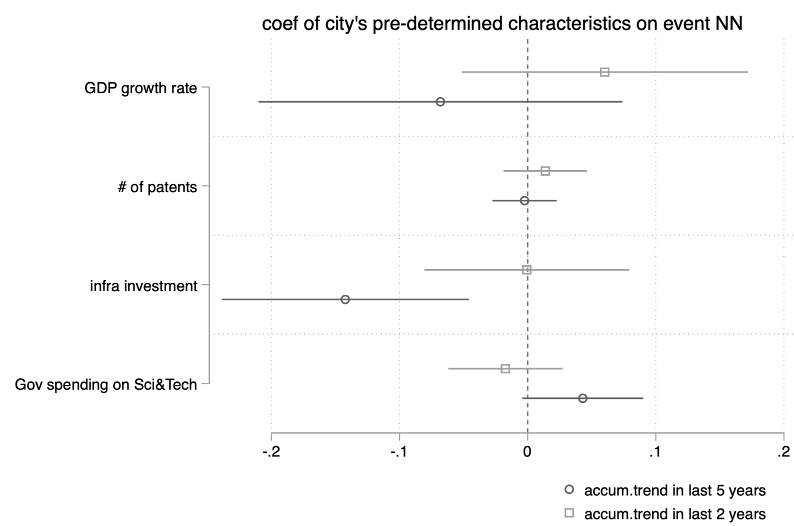
(a) event=CC



(b) event=CN



(c) event=NC



(d) event=NN

Figure C.3: Coefficients of city's initial economic condition on connection events: outcomes

The unit of observation is city-year spell for spells that start during the period of 1997-2017. All of the regressions include FEs for the position (mayor or party secretary), FEs for the term year of the provincial governor and party secretary, and City FEs. Standard errors are clustered by the city.

C.3 Pre-trends of patents and growth

To test whether there exists pre-trends in innovation and growth for cities with connected leaders, I run the following regression:

$$y_{t-k} = \theta_k * Connected_{c,t} + \theta_k^{start} * Connected_{c,t}^{start} + X_{c,t-k}\Theta_k + \delta_c + \tau_{t-k} + \epsilon_{c,t-k} \tag{C.3}$$

where k indicates the lag, ranging from 1 year to 5 years. For each lagged outcome, the control variables $X_{c,t-k}$ include GDP, population and manufacturing sector size 5 years before (and hence $t-k-5$) , and indicator of provincial leader's term year at $t-k$. The fixed effects include city fixed effect δ_c and year fixed effect τ_{t-k}.

Table C.1 reports the results.

Table C.1: Estimates of the pre-trend of connection on growth and innovation

Variables	t-1 (1)	t-2 (2)	t-3 (3)	t-4 (4)	t-5 (5)
Panel A: Grow Rate in GDP					
Connected	-0.0023	-0.0075***	-0.0048	-0.0008	0.0015
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
$Connected^{start}$	0.0137***	0.0082*	-0.0009	-0.0045	-0.0017
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
Observations	3,748	3,700	3,602	3,488	3,335
R-squared	0.547	0.539	0.521	0.468	0.429
Mean	0.133	0.138	0.143	0.152	0.159
Panel B: log(# of invention patents application)					
Connected	-0.0054	0.0093	0.0215	0.0092	0.0185
	(0.030)	(0.029)	(0.030)	(0.029)	(0.029)
$Connected^{start}$	-0.0383	-0.0056	-0.0111	0.0381	-0.0028
	(0.046)	(0.042)	(0.042)	(0.042)	(0.043)
Observations	3,753	3,704	3,608	3,501	3,349
R-squared	0.934	0.929	0.928	0.928	0.928
Mean	5.357	5.142	4.943	4.749	4.576
City and Year FE	X	X	X	X	X
Controls	X	X	X	X	X
SE Cluster	City	City	City	City	City

The unit of observation is city by year and the sample period is 2000-2018. The dependent variable in panel A is anual GDP growth and in panel B is the log value of the total number of invention patent applications. Each column indicates the period of the corresponding outcome variable. All regressions include city fixed effects and year fixed effects. Control variables include the logs of GDP, population and industry revenue 5 years prior to t-k, and fixed effects for the term year of the provincial governor and party secretary at t-k. Standard errors all clustered by city, in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Appendix D Robustness checks

D.1 Regression on tenure at spell level

There exists a mechanical bias in linking tenure length to connection status directly. The longer a leader stays, the more likely that the provincial leaders change, which would decrease the probability for those beginning as connected to stay connected while increase the probability for those beginning as connected to gain connection. Figure D.1 illustrates the mechanical bias. Regressing tenure lengths on connection status directly will be biased by these two types of mechanical bias. One solution is to control for how long has leaders stay and run a year-by-year regression, as that in Section 4.2.

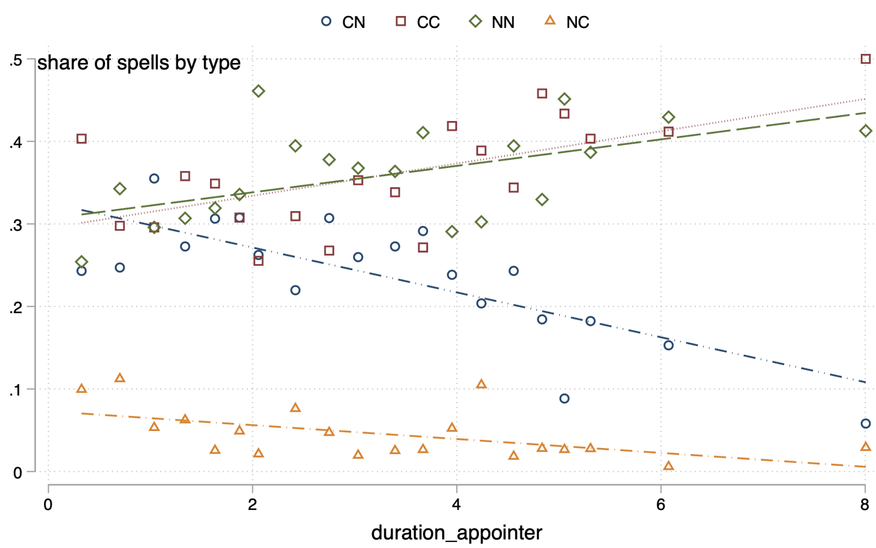


Figure D.1: Type composition of spell by superior's duration after the appointment

Another solution is to control for how long the provincial leaders stay after the appointment and run regression at the spell level. Specifically, I implement the following specification:

$$\ln(T_{i,c}) = \delta * T^{sup}_{i,c} + (\delta * Connected^{end}_{i,c} + \eta * Connected^{start}_{i,c}) * T^{sup}_{i,c} + FEs + \nu_{i,c} \qquad \text{(D.1)}$$

Conditional on the superiors' duration after appointing city leader i to city c (denoted as $T_{i,c}^{sup}$), the tenure for leader who is CC is then $(\delta + \eta) * \overline{T^{sup}}$., for leader who is NC is then $\delta * \overline{T^{sup}}$, for leader who is CN is then $\eta * \overline{T^{sup}}$, and the benchmark is leader who is NN. The intuition is that conditional on superiors' duration, the difference in tenure length is then driven by whether leaders are endogenously selected ($Connected_{i,c}^{end}$) and whether leaders are exposed to connection ($Connected_{i,c}^{start}$). For instance, for each additional year that the superiors stay after appointing a city leader, the difference between CC and CN is δ.

Table D.1 reports the results using the above specification. Overall, the results are similar with those using year-by-year estimation of the exiting rate.

Table D.1: Estimates of the effects of connection on tenure and promotion at spell level

	$ln(Tenure)$			Promoted		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
T^{sup}	0.0344***	0.0207***	0.0201***	0.0001	0.0023	0.0014
	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)
$T^{sup}$$*$$Connected^{end}$	-0.0814***	-0.0455***	-0.0453***	0.0088	0.0044	0.0056
	(0.007)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)
$T^{sup}$$*$$Connected^{start}$	0.0586***	0.0310***	0.0315***	-0.0141**	-0.0099	-0.0107
	(0.007)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)
Old			-0.0330**			-0.2080***
			(0.016)			(0.019)
$FastTrack$			-0.0363*			0.0443**
			(0.019)			(0.021)
Observations	3,493	2,855	2,855	3,491	2,854	2,854
R-squared	0.257	0.490	0.491	0.179	0.198	0.239
Mean	1.092	1.074	1.074	0.391	0.393	0.393
City and year FE	X	X	X	X	X	X
Controls	.	X	X	.	X	X
SE Cluster	City	City	City	City	City	City

The unit of observation is leader-city spell. The sample is a pooled sample of leaders, namely city mayors and party secretaries, who was appointed during 2000-2017[a]. log value of term length (in years) (columns 1-3) or is promoted (columns 4-6). Controls include the logs of GDP, population and industry revenue the year before the local leader was appointed, and fixed effects for the term year of the provincial governor and party secretary. Standard errors (SE), clustered by city, in parentheses: *** p<0.01, ** p<0.05, * p<0.1..

[a]2018 is skipped due to data truncation issue, as around 20% of leaders are still in term

D.2 Event study

At any time, a city is between the arrival of the current superiors and the arrival of the next superiors. Within each spell, for each superior leadership, the connection status is constant as it is pre-determined. The turnover of superiors hence creates a setting for event study. Figure D.2 illustrates this idea. For example, suppose a province and is governed by provincial leader team A for the period of 2003-2008 and leader team B for the period of 2009-2012. For a city leader a in year 2005, it is two years after A being in office and 3 years before B being in office. If a is connected to A but not connected to B, in 2005 a will have been connected to A for two years. If a is not connected to A but connected to B, in 2005 a is three years before becoming connected.

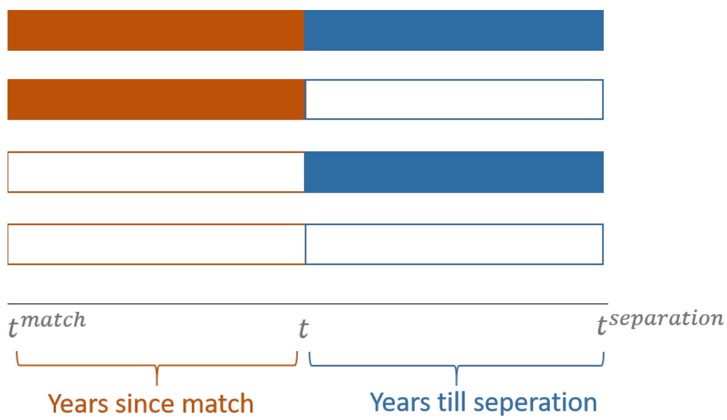
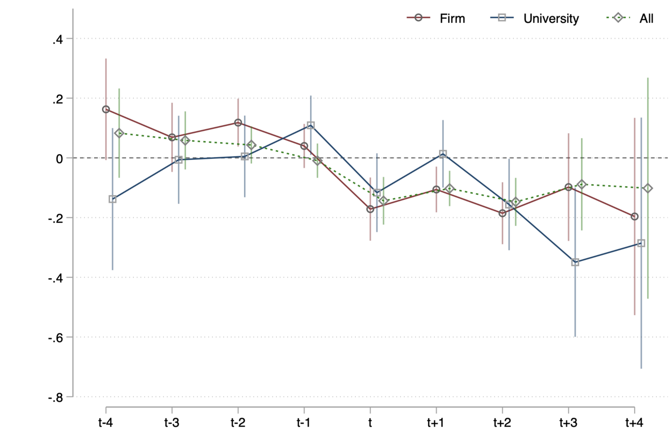


Figure D.2: Illustration of event study

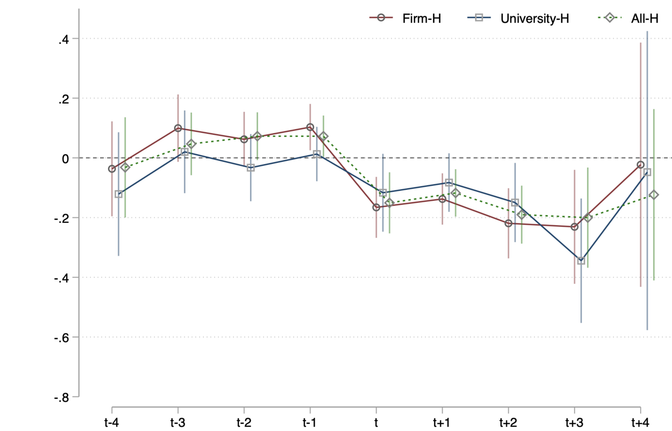
I examine the before-after change of city's innovation outcome within each provincial leader spell

$$
\begin{aligned}
y_{c,t} = & \sum_{k=1}^{k=5} \theta_{-k} 1\{\text{k Yrs before } SupArrival^{next}\} * Connected_{c,t}^{next} \\
& + \sum_{k=1}^{k=5} \theta_{k} 1\{\text{k Yrs after } SupArrival\} * Connected_{c,t} + Controls + FEs + u_{c,t}
\end{aligned}
\tag{D.2}
$$

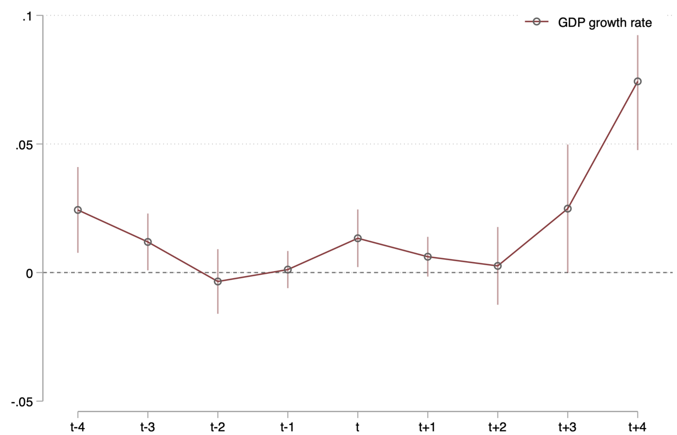
Where $SupArrival$ indicates the year when the current provincial leadership arrives, and $SupArrival^{next}$ indicates the year when the current provincial leadership leaves. $Controls$ include the interaction terms between the after/till year dummies with $Connected^{started}$, and the control sets used in equation 2. FEs include city, term year and year fixed effects.



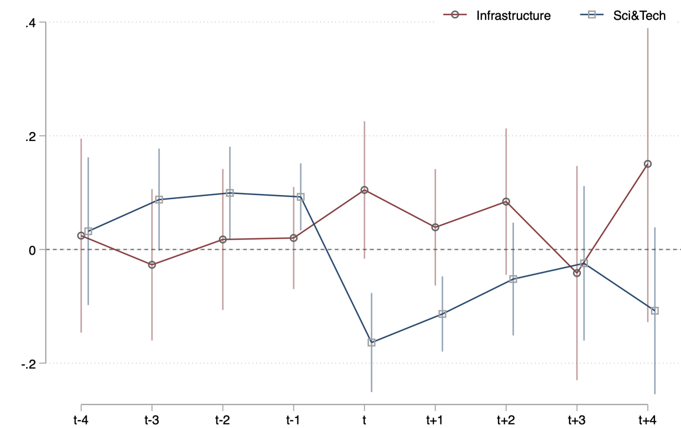
(a) log(# patents)



(b) log(# H- patents)



(c) GDP growth rate



(d) log(Gov.spending)

Figure D.3: Coefficients of *Connected* for event study

The unit of observation is city-year. For (a), (b) and (c) the sample period is 2000-2018 and all of the regressions control for the initial trend of the outcome variable preceding the appointment of city leaders. For (d), the sample period for government spending on science& technology is 2003-2018, and for government spending on infrastructure development it is 2006-2016[a].

[a]Initial trend of outcome variables are not controlled for the purpose of precision, as the point estimates are similar

D.3 Other type of connections

I examine whether connections formed through attending the same university or being from the same home town affect outcomes. Such types of connections are relatively sparse: at the spell level, 2.7% of city leaders are connected through university and 4% are connected through home town, and 6.5% of the spells are connected through either. Table D.2 presents the results following equation (1). Overall, I do not find these types of connections to be influential on leader's tenures.

Table D.2: Estimates of the effects of other type of connections on tenure and promotion

	Exited			Promoted		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
$SameUniversity$	-0.0193			0.0209		
	(0.022)			(0.019)		
$SameHometown$		0.0025			0.0239	
		(0.019)			(0.017)	
$SameEither$			-0.0104			0.0159
			(0.015)			(0.013)
$STEM$	-0.0037	-0.0038	-0.0036	0.0087	0.0103*	0.0086
	(0.008)	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
Old	0.0408***	0.0411***	0.0408***	-0.0317***	-0.0302***	-0.0318***
	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)
Observations	12,397	12,242	12,397	12,335	12,180	12,335
R-squared	0.274	0.252	0.273	0.107	0.106	0.107
Mean	0.094	0.092	0.094	0.094	0.092	0.094
City and year FE	X	X	X	X	X	X
Controls	X	X	X	X	X	X
SE Cluster	City	City	City	City	City	City

The unit of observation is leader by year. The sample is a pooled sample of leaders, namely city mayors and party secretaries, who were appointed during the period of 2000-2017[a]. The dependent variable is an indicator of whether the leader leaves office (columns (1)-(4)) or is promoted (columns (5)-(7)) in a given year. The variable $SameUniversity$ is a dummy and equals to 1 if the leader had attended the same university that the provincial leaders attended. The variable $SameHometown$ is a dummy and equals to 1 if the leader is from the same city where the povincial leaders are from. The variable $SameEither$ is a dummy and equals to 1 if either $SameUniversity$ or $SameHometown$ equals to 1. The variable Old is a dummy and equals to 1 if the leader's age upon appointment is older than the median age of all leaders appointed in the same year. The variable $STEM$ is a dummy that equals 1 if the leader has worked at a STEM related department in her/his previous jobs or has studied STEM at university. All of the regressions include a fully non-parametric baseline hazard for the number of years in office (job-tenure fixed effects (FE)). Column 1 shows results from a binomial regression with a complementary log-log model (marginal effects). The other columns show estimates using a linear probability model. Controls include the logs of GDP, population and industry revenue for year before the local leader was appointed, and FEs for the term year of the provincial governor and party secretary. Standard errors (SE) are clustered by city, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

[a] 2018 is skipped due to data truncation issues, as around 20% of the leaders appointed in 2018 still hold office.

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