

Political Connections, Competition, and Innovation: Quasi-Experimental Evidence from Chinese Firms

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I. Introduction

Innovation, an essential barometer of sustainable growth for firms and the economy as a whole (Solow 1957; Romer 1990), has received much attention in the literature. Abundant research has explored determinants of firms' innovation, but how the institutional environment affects innovation is still understudied. Given the risky and uncertain nature of innovative activities, firms often forge connections to political authorities to overcome institutional barriers that hinder innovation incentives (Haveman et al. 2019). Previous studies show that these political connections contribute to firm valuation (Fisman 2001; Faccio 2006; Fan, Rui, and Zhao 2008; Faccio and Parsley 2009; Acemoglu et al. 2016), but we know relatively less about how they affect firms' longer-term strategy, such as innovation performance. Investigating this question is especially relevant for developing countries given their deficient intellectual property rights protection and strong influence of political connections in business.

The debate on the relationship between political connections and innovation remains unsettled. Previous studies propose two competing hypotheses. Some maintain that political connections enhance a firm's innovative tendency because the connection to political power provides government-related favors that effectively reduce the risks of innovation, especially those related to expropriation or extortion (Brogaard, Denes, and Duchin 2015; Ovtchinnikov, Reza, and Wu 2020). In settings where the legal institution of intellectual properties is

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weak, in particular, political connections serve as an informal regime by enabling firms to circumvent bureaucratic rigidities.¹ Moreover, they also confer myriad privileges to firms, including protection against competitors and favorable credit from state-owned banks, which facilitate innovation (Allen, Qian, and Qian 2005; Claessens, Feijend, and Laeven 2008; Houston et al. 2014).

A competing hypothesis argues that these same economic benefits decrease firms' incentives to invent and thus impede innovation. Political connections inhibit market competition by imposing a barrier in the market to block potential rival firms (Huang and Yuan 2021). This market advantage afforded by political ties in turn incentivizes firms to engage in rent-seeking activities by establishing and maintaining political connections, which further depresses connected firms' drive to conduct risky innovation projects. This problem is especially acute in places with insufficient market-supporting regimes, such as China (Haveman et al. 2019).

To confront these competing hypotheses, this paper employs a unique data set of political connections and examines the causal effect of these connections on corporate innovation. Two culprits complicate the identification of causality and account for the conflicting evidence in empirical findings: the difficulty in measuring political connections and the endogenous nature of establishing those connections. For example, previous studies often define a firm as politically connected if a large shareholder or senior executive once worked or currently works for the government, a measure that is both coarse (e.g., lack of information on the strength of connections) and correlated with corporate governance. We overcome these challenges by isolating an exogenous shock from the sudden deaths of independent directors who were retired bureaucrats to measure a firm's loss of political connections, which not only captures political connections more cleanly but also gauges their strength based on the administration levels or jurisdictions of the retired officials. Given their plausible exogeneity, sudden death events have been used by researchers to analyze the effect of political connections on firm valuation (Faccio and Parsley 2009; Nguyen and Nielsen 2010); we employ these events in this paper as a natural experiment to study the impact on firms' innovation performance.

China presents an excellent setting to analyze the relationship between political connections and firm innovation. First, given the prevalence of government interventions in business in the country, private firms have incentives to

¹ It is argued that corruption can also play such a facilitating role in innovation (Leff 1964; Huntington 1968). In contrast to the covert nature of corruption, political connections are more ubiquitous and not necessarily illicit.

acquire political connections to circumvent weak market-supporting institutions (Firth, Rui, and Wu 2011; Lu, Pan, and Zhang 2015). Such informal regimes, as argued by some, facilitate China's economic growth (Allen, Qian, and Qian 2005; Haveman et al. 2019). To build ties to political power, private firms often hire retired government officials as independent board directors and leverage their social networks to obtain benefits from the government. This kind of independent director represents a scarce resource that, as we show, is hard to regain once lost, so losing these political ties will deliver a negative shock to firms. Second, the country experienced an acceleration in patent applications in recent years, which offers rich cross-sectional and temporal variation for researchers to exploit.

To proxy for an unanticipated loss of political connections, we manually collect a data set of sudden deaths of independent directors of the universe of listed firms from 2007 to 2015. We then merge these data with financial variables from the China Stock Market and Accounting Research database. Employing the difference-in-differences method that exploits exogenous variation of sudden deaths of politically connected independent directors across firms and time, we find that upon losing political connections a firm raises its patent applications by 34% (or 14 patents), on average. To validate our research design, we show that innovation dynamics did not diverge across firms that experienced a loss of a politically connected independent director and other firms until the sudden death event. This pattern corroborates the notion that the increase in innovation activities is driven by a loss of political connections. To provide additional evidence, we show that the innovation response to a loss of political connections is more pronounced when a firm's political connections are likely stronger—when the retired government official independent director held a higher-level position or when the firm operates within their geographical jurisdiction. Our findings are robust to various specifications such as alternative measures of innovation, different regression methods, alternative matching strategies, and different subsamples.

We then investigate the channel through which a loss of political connections spurs firm innovation: increased exposure to competition. We can think of rent seeking (i.e., investing in political connections) and innovation as a firm's substitute strategies to achieve a competitive edge: political connections provide a protected stream of rents, while innovation gives a first-mover advantage through patenting, while both insulate the firm from market competition (Allen, Qian, and Qian 2005; Claessens, Feijend, and Laeven 2008; Houston et al. 2014). When a firm loses a politically connected independent director and cannot regain political connections easily given their scarcity, it will lose its economic benefits afforded by those connections and confront higher

competitive pressure (Li and Cheng 2020). This will incentivize the firm to deploy resources away from rent seeking into innovation activities.

Delving into the competition channel further, we test two related mechanisms: competition (the external mechanism) and resource saving (the internal mechanism). Externally, when a firm loses political connections, its competitive advantage deteriorates and it faces stiffer competition, which drives it to innovate to recapture its market share. Internally, the once-connected firm will see an increase in financial resources saved from rent seeking, which become available for innovative investment. We find evidence supporting these hypotheses. Additionally, we show that a loss of political connections leads to an increase in not only innovation quantity but also its quality and transformability into profitability.

Our study is related to several strands of literature. First, we contribute to the literature that examines determinants of innovation. A growing list of papers investigates the interplay between corporate innovation and institutional features, such as intellectual property rights protection and ownership structure (Fang, Lerner, and Wu 2017; Helmers, Patnam, and Rau 2017; Haveman et al. 2019). More relatedly, Huang, Geng, and Wang (2017) and Xu and Yano (2017) show that the political environment—corruption, in particular—affects innovation: using data from the United States and China, respectively, these studies find that firms located in more corrupt regions file for fewer patent applications. We contribute to this line of research by focusing on political connections as another determinant, which, unlike corruption, are not necessarily illegal and covert.² Moreover, we use exogenous changes in political connections at the firm level—as opposed to more aggregate levels, such as regions—to relieve concerns about aggregate shocks, which strengthens the research design.

Second, we add to the large body of research studying the effect of political connections on firm behavior. A slew of literature has shown that firms' political connections affect their short-term valuation (Faccio and Parsley 2009; Nguyen and Nielsen 2010; Acemoglu et al. 2016). Recent research also examines real outcomes in terms of physical capital investment (Pan and Tian 2017; Li and Cheng 2020). Due to the difficulty of finding exogenous shocks to connections, however, previous studies commonly measure political connections by whether a corporate executive has worked in the government (Hou, Hu, and Yuan 2017; Pan and Tian 2017), which is prone to endogeneity issues: firms with connected executives may also be those with poor governance and hence low innovative proclivity. Most related to our paper is the work of

² Political connections can take various forms, e.g., hiring senior managers with political experience, lobbying, or donation to political campaigns.

Li and Cheng (2020), who apply a similar identification strategy to data from publicly traded firms in China and show a significant response in physical capital investment to a loss of political connections. Different from their paper, we study the impact on a longer-run corporate strategy in terms of intellectual capital investment or innovation, which, unlike physical capital investment, involves a large degree of risk and uncertainty.³ We also dissect a key mechanism—increased exposure to competition—that drives the substitution between political connections and innovation.

Third, this study is related to research on explaining China's economic growth based on its institutional features. Given the country's weak legal institutions (Acemoglu and Robinson 2012), some argue that the fast pace of China's economic development has been enabled by special characteristics of its economic and political systems, one of which is the competition between local governments to offer favorable deals to politically connected companies (Huang 2008; Chen and Kung 2019; Bai, Hsieh, and Song 2020). Our paper provides empirical evidence to confront this argument and speak to potential short-term versus long-term trade-offs of political connections as an informal regime to sidestep an inadequate market-supporting regime.

The remainder of the paper is structured as follows. Section II discusses the institutional background and hypothesis development. Section III describes the data and research design. Section IV presents the empirical results. Section V examines the mechanism. Section VI contains further discussions, and section VII concludes.

II. Institutional Background and Hypothesis Development

A. Firms' Political Connections in China

As the largest emerging economy with fast-growing innovation activities and an emphasis on political relationships in business and politics (Haveman et al. 2017; Fisman et al. 2020; Jiang and Zhang 2020), China offers an excellent setting for studying corporate strategies in response to a loss of political connections. Given the country's weak legal institutions (Acemoglu and Robinson 2012), it has been argued that informal regimes help drive its economic growth (Allen, Qian, and Qian 2005; Haveman et al. 2019). One of the unique features of the Chinese economy is the race between local governments via "special deals" to private companies with political ties (Huang 2008; Chen and Kung 2019), which some have viewed to be growth enhancing (Bai,

³ Our data also cover a more extended period (2007–15) than those used in Li and Cheng (2020), which studies a shorter-term outcome of (quarterly) physical capital investment between 2003 and 2012.

Hsieh, and Song 2020). Building political connections with the government has long been deemed a quick and efficient strategy for private firms in China to reduce costs associated with market and legal failures.

To build political connections, private firms often hire retired government cadres as independent directors.⁴ Although incumbent government officials in China are prohibited from working in firms, retired ones are allowed to do so 3 years after retirement (the so-called cooling-off period). Despite no longer being in office, these outside directors' social networks accumulated before retirement still exist, which private firms leverage to establish ties with the government to reap economic privileges, such as bank loans, tax preference, and government subsidies. We make use of this institutional feature to measure political connections. We gather detailed information about when retired government officials were hired as independent directors and the administrative levels of the positions they held before retirement, which allows us to gauge the strength of firms' political connections. To resolve endogenous bias, we employ sudden death events of these politically connected independent directors as a natural experiment to measure an exogenous loss of political connections.

Despite not being the focus of our study, private firms can establish political connections in other ways. After Deng Xiaoping's Southern Tour in 1992, China's private sector expanded dramatically, leading many government employees to quit their positions to work in business. This exodus from the government to private companies has been vividly dubbed a "plunge into the sea" (*xiahai* in Chinese). Connections with the Communist Party and the government afford the *xiahai* entrepreneurs certain advantages over other private entrepreneurs without such connections. A firm can therefore be viewed as politically connected if one of its large shareholders or senior executives once worked (or currently works) for the government (Faccio 2006; Fan, Wong, and Zhang 2007; Boubakri, Cosset, and Saffar 2008; Ferguson and Voth 2008). However, measuring political connection this way is rough and imprecise in China's context. For example, it does not consider when the CEO or senior executives worked for the government. If it happened a long time ago, their political linkages might have faded. As noted by Faccio (2006), connections with politicians who served further back in time are less likely to have a major impact on firm activities. Moreover, the measure does not provide information about the type

⁴ The term "government officials" can be ambiguous in the Chinese context, as it can mean government cadres who work in government agencies, state-owned enterprises, or public institutions. In this paper, we define government officials as those who once worked in government agencies, because cadres from SOEs or public institutions in general do not have political power and hence their sudden deaths have little to do with the loss of political connections (though they usually hold administrative positions). We show in unreported results (available on request) that the sudden loss of these two types of independent directors hardly affects corporate innovation.

or administrative level of government positions they held and thus cannot capture the strength of political connections.

A firm could also gain political connections by obtaining political status for CEOs or senior executives through becoming members of the People's Congress (PC), China's legislature and the highest organ of state power, and the Chinese People's Political Consultative Conference (CPPCC), an advisory body to the party and government. Membership in the PC or the CPPCC is advantageous to private entrepreneurs because it not only gives them some political power but also makes it easier to cultivate formal and informal links with key bureaucrats. This option is infeasible for most private entrepreneurs, however, because most PC and CPPCC members are reserved for those from governments and the army, and only a small quota is allocated to entrepreneurs from state-owned enterprises (SOEs) or private firms. For example, among the 2,987 PC and 2,237 CPPCC members elected in 2012, only 597 PC and 151 CPPCC members are from business circles, or more specifically, from SOEs (<http://www.npc.gov.cn>). Consequently, using the political status of CEOs or senior executives to define firms' political connections may lead to small sample bias.

It is worth noting that the existence of these other types of political connections is not a concern for our baseline results for two reasons. First, our use of the difference-in-differences methodology will eliminate the average differences in other types of political connections across firms. Second, the baseline results change little when we explicitly control for these other types of political connections.

After the unexpected loss of political connections due to the sudden death of a politically connected independent director, a firm could in principle regain its political ties by hiring another retired government official to replace the deceased one. However, regaining lost political connections is infeasible for most private firms. Table 1 reports the number of firms that succeeded in finding a replacement over the next 3 and 6 years after losing a politically connected independent director. Only 13 firms (or 10.8%) successfully hired another retired government official 3 years after the sudden death of a previous one. Even if we extend the period to 6 years, this ratio rises to only 35%. Retired government officials in China, especially those with strong political networks, are a scarce resource, so it is impractical, if not impossible, for a firm to hire another one in a short time.⁵ Even if a firm succeeded in doing so, it would take time to rebuild

⁵ Some firms might refill the positions with unconnected independent directors. Since these directors do not have a political background, however, hiring them should not affect firms' innovation performance. We test this argument in app. D, which shows that the sudden death of a nonpolitically independent director does not have a statistically significant effect. Moreover, to eliminate potential

TABLE 1
NUMBERS OF SUDDEN DEATHS AND REPLACEMENTS OF POLITICALLY CONNECTED INDEPENDENT DIRECTORS

Year	Number of Sudden Deaths	Number of Firms That Successfully Hired another Retired Government Official after Loss of Former One	
		Over Next 3 Years	Over Next 6 Years
2007	7	1	3
2008	13	1	5
2009	10	1	4
2010	14	2	8
2011	12	3	7
2012	18	3	9
2013	15	1	3
2014	15	0	1
2015	16	1	2
Total number (ratio)	120	13 (10.8%)	42 (35%)

ties with the government. These observations show that when a firm loses its political connections, it cannot regain them easily.⁶ It is in this context that we investigate the actions (in terms of innovation) that the firm takes to respond.

B. Trends of Political Connections and Corporate Innovation in China

Political connections have become harder to build for Chinese firms in recent years. After becoming the president and general secretary of the Communist Party of China (CPC) in 2012, Xi Jinping launched a large-scale anticorruption campaign. Hundreds of high-ranking officers were arrested because of corruption scandals. As a landmark measure, the Organization Department of the Central Committee of the CPC issued a rule on October 19, 2013 (hereafter, “rule 2013”) regulating government cadres working in corporations. The stated purpose of rule 2013 is to “enforce strict requirements with the Party and government cadres,” which includes three key stipulations.⁷ First, government officials are not allowed to work in firms for more than two terms (6 years), work past age 70, or hold two or more posts concurrently. Second, incumbent government officials are prohibited from working in firms. Third, government officials qualified to work in firms are not permitted to receive any kind of

confounding effects of rehiring another politically connected director, we drop observations after the replacement took place.

⁶ As pointed out earlier, obtaining political status for CEOs or senior executives through PC or CPPCC membership is infeasible for private firms. Indeed, as shown in app. A, only nine private firms in our sample (or 7.5%) had their senior executives successfully elected as PC or CPPCC members over the next 6 years after the sudden death of an independent director. Our baseline results are little changed if we drop from our sample those firms that reestablished political connection by having their senior executives elected as PC or CPPCC members.

⁷ Details (in Chinese) can be found at <http://renshi.people.com.cn/n/2013/1030/c139617-23380219.html>.

compensation or, more importantly, use their political influence to benefit the firms or themselves.

This rule triggered a wave of involuntary resignations of politically connected independent directors. In a highly publicized case, rule 2013 caused the mandatory resignation of Li Guoguang, who once served as vice president of the People's Supreme Court, from the position of an independent director for Ya Ge Er, one of the largest privately owned textile companies in China (Hu et al. 2020). Under these circumstances, the establishment and maintenance of political connections have become costlier, and many firms have since experienced a loss of political connections (Xu and Yano 2017). As shown in figure 1A, the proportion of politically connected (listed) firms sharply declined after 2013. Moreover, as China's market economy has advanced significantly in recent years, favorable benefits enjoyed by politically connected firms have diminished (Li et al. 2008; Zhang, Marquis, and Qiao 2016). Consequently, entry barriers imposed by political connections have weakened, and market competition has intensified. To respond to these changes, previously connected firms may turn to boosting their internal capacity via innovation to reclaim their competitive edge.⁸ As shown in figure 1B, the total number of patent applications filed by these firms accelerated after 2012. Given the country's weak protection of intellectual property rights, this rise in innovative activities may appear somewhat puzzling. We use exogenous variation in a loss of political connections at the firm level to delve into the causal link between a reduction in the prevalence of political connections and a rise in patent applications.

C. Hypothesis Development

Political connections can influence firm innovation through several channels, and the overall effect is indeterminate *ex ante*. On the one hand, political connections may improve a firm's innovation performance. First, previous studies have shown that ties to political power afford firms with various economic benefits, such as subsidized loans from state-owned banks, and these otherwise unobtainable resources may promote R&D investment and innovation (Allen, Qian, and Qian 2005; Claessens, Feijend, and Laeven 2008; Houston et al. 2014).

⁸ Furthermore, China has introduced various policies in recent years to encourage firms to invest in innovation, which have reduced the up-front cost of innovation significantly (Bryce Campodonico, Bonfatti, and Pisano 2016; Mukherjee, Singh, and Žaldokas 2017). For example, the Super Tax Deduction Policy was implemented in 2015, providing firms with a 150% deduction of their qualified R&D expenditures from taxable revenues. Further details (in Chinese) can be found at http://www.sohu.com/a/332966557_267316.

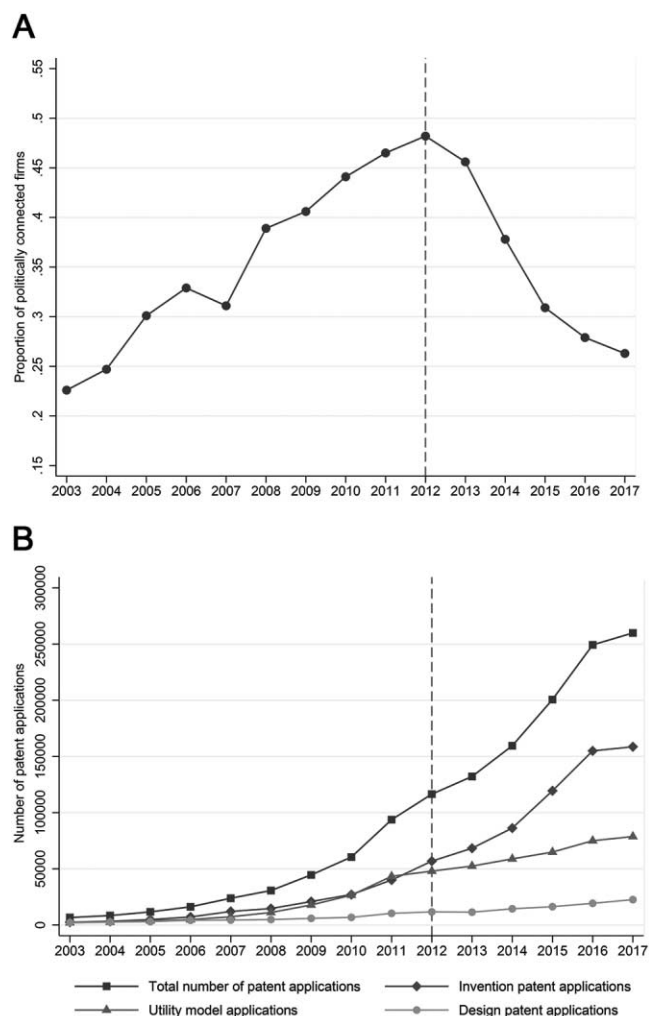


Figure 1. Trends of political connections (A) and patent applications (B) in China. Graphed are the proportions of politically connected firms and the number of patent applications among listed firms in China. A firm is defined as politically connected if it has hired a retired government official as an independent director. A color version of this figure is available online.

Second, political connections offer protection against government expropriation or extortion, increasing the incentive for firms to take on inventive projects, which generally take a long time and entail high tail risk (Brogaard, Denes, and Duchin 2015; Ovtchinnikov, Reza, and Wu 2020). Furthermore, these connections act as an informal mechanism that enables firms to circumvent bureaucratic red tapes and fastens the provision of public goods and services, such as the granting of licenses and permits, which is particularly important in contexts where formal protection of intellectual properties is lacking. Connected firms

are consequently able to enhance their investment efficiency and expedite the innovative process. This view suggests a complementary relationship between political connections and innovation.

On the other hand, political connections may hinder a firm's innovation performance. First, political connections deter market competition by imposing an arbitrarily high entry barrier for rival firms (Li and Cheng 2020; Huang and Yuan 2021). This deterrence to new entrants protects connected firms against potential competitors and reduces their motivation to compete through innovation. Further, such a market advantage granted through ties to political authorities induces firms to engage in rent-seeking activities by exchanging favors with or even paying bribes to political contacts, instead of engaging in innovative projects (Murphy, Shleifer, and Vishny 1993). Research has shown that firms overspend on entertainment and travel expenses as grease payments to establish and maintain political connections (Cai, Fang, and Xu 2011). This shrinks the room for investment in research and development. This view holds that political connections and innovation are substitutes.

Under this hypothesis, rent seeking (i.e., investing in political connections) and innovation act as a firm's strategic substitutes to maintain a competitive edge in the market, although they do so via different means. Political connections grant a protected series of economic benefits, while innovation grants a first-mover advantage through patenting, both of which shield connected firms from market competition. When a firm loses political connections unexpectedly—the context we examine in this study—it cannot regain them easily given the scarcity of politically connected independent directors, especially after China's government-led anticorruption movement began in earnest in 2012. Facing increased exposure to competition, the firm will choose to innovate its way back to profitability.

Taken together, the net impact of political connections on innovation is theoretically ambiguous. Whether the role political connections play is complementary or substitutable in firms' innovation decision is largely an empirical question, to which we seek to provide an answer in the context of China in this study.

III. Data and Key Variables

A. Data

This paper uses data from A-share privately owned firms listed on the Shenzhen Stock Exchange and Shanghai Stock Exchange from 2007 to 2015.⁹

⁹ Types of firm ownership in China include public (i.e., SOEs), private, and foreign, as well as Hong Kong, Macao, and Taiwan ownership. Because political connections are pervasive and entrenched in

Unlike state-owned firms, private firms are not under direct government control and thus have strong incentives to establish political connections, often by hiring retired government officials as independent directors, to gain access to economic benefits such as bank loans, tax benefits, and subsidies. We search major financial websites and annual company reports to collect information on sudden death events of politically connected independent directors. All other variables at the firm level, including measures of innovation, come from the China Stock Market and Accounting Research (CSMAR) database.¹⁰ We eliminate firms in financial and insurance industries due to their special accounting rules, as well as firms that are marked with Special Treatment (*ST) or suspended during the sample period. We conduct our analysis at an annual frequency. Our final sample is an unbalanced panel containing 1,560 firms with 11,257 firm-year observations.¹¹ This sample represents about 70% of all listed private firms in China. This data set, to our knowledge, is the most recent time series relative to previous studies, with the advantage of covering periods before and after the 2012 anticorruption movement for us to exploit the time variation in political connections.

B. Measurement of an Unexpected Loss of Political Connections

As a key independent variable, a firm's loss of political connections is measured by the sudden death of an independent director who was a retired government official (i.e., politically connected independent director). We follow earlier studies to define sudden death based on the medical literature as an unexpected and nontraumatic death that happens instantly or within several hours of an abrupt change in an individual's clinical status (Faccio and Parsley 2009; Nguyen and Nielsen 2010). We also include accidental and traumatic deaths unlikely to be expected by firms. Because most annual reports of listed firms do not contain obituaries, we searched major financial websites for reports of such events for the firms in our sample; our sources include Baidu, Google, Sina, Sohu, and NetEase (primarily their financial sections). We use annual company reports as auxiliary materials to ascertain the causes of the deaths. Appendix B details

SOEs, we focus on privately owned firms in this paper to purge potential confounders in the management of the other types of firms. For a study on the performance of SOEs, see Cheng, Li, and Li (2021). Chinese listed firms were not required to disclose the R&D expenditure separately until 2007, so we exclude data before 2007.

¹⁰ The CSMAR database is maintained by GTA, a leading provider of China financial market data, and has gained wide recognition from more than 1,000 universities and financial institutions worldwide. It is accessible at <http://www.gtarsc.com>.

¹¹ A reason our sample is an unbalanced panel is due to the different timing when firms went public. Moreover, we delete missing and abnormal observations, which accounts for 0.2% of the full sample.

TABLE 2
CHARACTERISTICS OF POLITICALLY CONNECTED INDEPENDENT DIRECTORS (PCIDs)

Characteristics of PCIDs	Sample with PCIDs		Sample with Non-PCIDs (3)	p-Value of Difference (4)
	Full Sample (1)	Sudden Death Sample (2)		
Gender (= 1 if male)	.814	.825	.763	.7615
Education level (= 1 if bachelor's degree)	.426	.433	.906	.8792
Government administrative level (= 1 if above bureau level)	.496	.508	.006	.7969
Age when hired (= 1 if above 65)	.670	.667	.140	.9454
Had work experience in the firm's main industry before being hired? (= 1 if yes)	.419	.408	.875	.8109
Once worked in government agency in province where firm is located? (= 1 if yes)	.618	.625		.8772
Was absent from at least 50% of board meetings during tenure as director? (= 1 if yes)	.363	.358	.078	.9112
Number of PCIDs	2,752	120	11,764	

Note. Values in cols. 1–3 represent the proportion of directors with related characteristics. For example, .426 in col. 1 means that 42.6% of PCIDs hold a bachelor's degree. China's government administrative levels are divided into central, provincial and ministerial, bureau, county, and township levels (from the highest to the lowest). Column 4 shows p-values of the differences between values in cols. 1 and 2.

the process of the data collection of sudden death events, along with their characteristics (causes, timing, and regions).¹²

As shown in table 1, we collected 120 sudden death events from 2007 to 2015 according to our definition among 2,752 politically connected independent directors. Table 2 reports the characteristics of these independent directors in both full and sudden death samples of firms with politically connected independent directors. In firms with politically connected independent directors (shown in cols. 1 and 2), we notice that these independent directors tended to be older, did not attend college, and did not have relevant work experience before being hired.¹³ Moreover, more than one-third were absent from half of the board meetings during their tenure. These features indicate that politically connected independent directors are probably unable to offer substantive suggestions on firms' management or innovation decisions.

The primary reason for hiring them is to leverage their political network and obtain favorable treatment from the government. The strength of a firm's

¹² One may be concerned that some firms chose not to reveal death information for some unknown reasons, but we think this is unlikely considering that government officials hired by private firms are often politically important (e.g., about half of them held high-level positions, as we show in table 2); their sudden deaths are likely to be sensational events, which are hard to hide. Besides, the sudden death sample excludes suicides, which may be correlated with firm performance. We therefore do not need to worry much about sample selection caused by firms' underreporting or anticipatory strategies.

¹³ It is worth noting that many of the government officials in our sample had no chance to attend college in their 20s because it was the 1970s when China underwent the Cultural Revolution.

political connections may differ based on the administrative levels of the government position that connected independent directors previously held. These are divided into state, provincial and ministerial, bureau, county, and township levels (from the highest to the lowest). It is no surprise that about 50% of the politically connected independent directors once had above-bureau-level experience. Firms are also inclined to hire retired government officials who once worked in the province where the firms are located because these officials' political connections are likely stronger within their geographical jurisdictions. Indeed, more than 60% of deceased government officials once worked in agencies in the same province as the firms that hired them.

As a comparison, we also identified sudden deaths of independent directors from academic circles (e.g., university professors and senior researchers from research institutes) or business circles (e.g., CEO or senior executives of other firms, accountants, and lawyers). Because most of them do not have a political background, they are regarded as nonpolitically connected. As shown in column 3 of table 2, relative to those who are politically connected, these independent directors were younger, more educated, had relevant work experience, and attended board meetings more often. The chief reason for hiring academic or business elites, unlike retired government officials, is to take advantage of their expertise to improve firm operation. Because the sudden deaths of these nonpolitically connected independent directors should not represent a loss of political capital, we use them in the empirical analysis as a placebo test.

Columns 1 and 2 of table 2 compare the full and sudden death samples of firms with politically connected independent directors. The characteristics across the two samples are highly similar both quantitatively and statistically, which attests to the randomness of the sudden death events.¹⁴ In section IV, we denote the unexpected loss of political connections by *Polcon loss*, which is a dummy variable taking a value of one if a firm has experienced a sudden death of its politically connected independent director (i.e., the treatment).

C. Measurement of Innovation

Following previous studies on corporate innovation (Ovtchinnikov, Reza, and Wu 2020), we measure a firm's innovation performance using the number of patent applications filed by a firm (*Total patent*). The CSMAR database provides us with the total number of patent applications, which we use in our baseline

¹⁴ One may worry that the fact that the full sample in col. 1 includes the sudden death sample in col. 2 potentially underestimates their differences in col. 4. We recalculate the *p*-values using a subsample excluding the sudden deaths and find that results are nearly unchanged. This suggests that underestimation is not serious due to the relatively small size of the sudden death sample.

analysis. As auxiliary measures, we use patent applications per employee, invention patent applications (*Invention patent*), the ratio of R&D expenditures to sales revenue (*RD ratio*), and the ratio of high-skilled workers (Aghion, Van, and Zingales 2013; Adhikari and Agrawal 2016; Chen, Leung, and Evans 2016; Mukherjee, Singh, and Žaldokas 2017). We also use other patent types (utility model and design) and patent citations when examining the impact on patent quality.

D. Control Variables

Following previous studies (Brogaard, Denes, and Duchin 2015; Ovtchinnikov, Reza, and Wu 2020), we control for characteristics that may affect a firm's innovation: firm size (*Size*), asset-liability ratio (*Leverage*), the number of years since the firm went public (*Age*), cash flow (*Cash*), return on assets (*ROA*), Tobin's Q (*TobinQ*), CEO duality (*Duality*), shares held by the chairman and CEO (*CEO shareholding*), and the proportion of independent directors in the board of directors (*ID ratio*). The definitions of a full list of key variables are shown in appendix C.

Panel A of table 3 reports the descriptive statistics of key variables. The average number of patent applications in the sample is 42, with a minimum value of zero and a maximum value of 2,742. The mean R&D expenditure accounts for 3.4% of a firm's sales revenue (*RD ratio*).

IV. Empirical Strategy and Results: The Impact of Losing Political Connections on Corporate Innovation

A. Empirical Strategy: Difference-in-Differences Estimation

We use a difference-in-differences estimation for the empirical analysis. Since the treatment—the sudden death of an independent director who was a retired government official—took place at different times for treated firms, we first define the year when their politically connected independent director suddenly died as time 0. We then represent the years before and after the event using negative and positive integers; for example, -2 and 2 represent 2 years before and 2 years after, respectively. We focus our period of analysis to be from 3 years before to 6 years after the treatment.¹⁵ We allow the posttreatment period to

¹⁵ Because the time period of analysis was $(-3, 6)$, each firm can have up to 10 observations. In reality, many firms have fewer than this number. As shown in table 1, 35% of treated firms hired another retired government official to replace the deceased one within the 6 years. To purge potentially confounding effects of regaining political connections, we keep observations only before any replacement took place. For example, if a treated firm regained political connections by hiring another retired government official at time t ($1 \leq t \leq 6$), its period of analysis becomes $(-3, t - 1)$ and it has only $t + 3$ observations. Our results (available on request) are quantitatively similar if we do not truncate the observations.

TABLE 3
SUMMARY STATISTICS OF KEY VARIABLES

A. Summary Statistics of Key Variables					
	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
<i>Total patent</i>	8,331	42.184	146.296	0	2,742
<i>Invention patent</i>	8,331	24.192	82.796	0	1,465
<i>RD ratio</i>	8,331	.034	.038	0	.485
<i>Size</i>	8,331	21.756	1.088	14.108	26.761
<i>Leverage</i>	8,331	.429	.232	.161	4.166
<i>Age</i>	8,331	8.614	5.905	0	27
<i>Cash</i>	8,331	.133	.127	-.762	.670
<i>ROA</i>	8,331	.090	.079	-.427	.863
<i>TobinQ</i>	8,331	2.539	1.559	.065	8.394
<i>Duality</i>	8,331	.318	.466	0	1
<i>CEO shareholding</i>	8,331	.100	.154	0	.705
<i>ID ratio</i>	8,331	.374	.053	.333	.8
<i>Loan rate</i>	8,331	.165	.137	0	.859
<i>Tax rate</i>	8,331	.158	.096	0	.504
<i>Subsidy</i>	8,331	.119	.171	-.236	.861
<i>Overinvest</i>	7,283	.368	.482	0	1
<i>Overemploy</i>	8,331	.489	.500	0	1
<i>Entertainment</i>	8,331	11.874	1.283	2.766	17.953
<i>Profitability</i>	8,331	.154	.111	-.102	.690
<i>ROE</i>	8,331	.119	.129	-1.146	1.426

B. Comparison of Control Variables of Treatment and Control Groups during Pretreatment Period					
	Treatment (N = 275)		Control (N = 2153)		p-Value of Difference
	Mean	SD	Mean	SD	
<i>Size</i>	21.509	1.000	21.414	.994	.1360
<i>Leverage</i>	.457	.200	.439	.237	.2392
<i>Age</i>	7.276	5.365	6.610	5.559	.0605*
<i>Cash</i>	.109	.138	.119	.130	.2337
<i>ROA</i>	.122	.087	.127	.090	.3376
<i>TobinQ</i>	2.329	1.560	2.375	1.480	.6245
<i>Duality</i>	.309	.463	.304	.460	.8566
<i>CEO shareholding</i>	.101	.158	.105	.162	.7148
<i>ID ratio</i>	.370	.055	.372	.052	.6233

Note. Panel A shows summary statistics of key variables. Panel B shows a comparison of firm characteristics across treated and control groups during the pretreatment period ($-3, -1$), where the last column shows p-values of testing the null hypothesis that the variables of the treatment and control groups are equal to each other. See app. C for detailed definitions of the variables.

* Significant at the 10% level.

be longer because it takes time for firms to adapt their innovative behavior following a loss of political connections. We do not extend the posttreatment period too long, however, because the effect may dilute over time, leading to lower power for the estimation.

We start by constructing a control group to match with each treated firm. Since a treated firm is one whose politically connected independent director

experienced a sudden death event at time 0, the ideal control unit is identical to the treated one in every respect except that its politically connected independent director did not yet die at time 0. Following previous studies (Faccio, Ronald, and McConnell 2006; Fan, Rui, and Zhao 2008; Pan and Tian 2017), we select a potential control firm to be one that operates in the same industry (two-digit Standard Industrial Classification code) and geographical region as the treated firm.¹⁶ Conditioning on industry affiliation and geographical region ensures that treated and control firms face similar economic conditions. To ease the matching process, we focus on firms with only one politically connected independent director.¹⁷

Using the criteria above, we identified 928 control firms to match with 120 treated ones. Each treated firm has about eight control firms. We assigned a simple weight that is equal to the inverse of the total number of control firms to form a composite control group for the treated firm. For example, if a treated firm has eight control firms, a weight of one-eighth is assigned to each control firm.¹⁸ We obtain a sample of 8,331 observations to use in the main analysis.¹⁹ We first check whether the treated and control groups are balanced in our sample. Panel B of table 3 reports mean values of key variables in the two groups during the pretreatment period; no statistically significant differences are found in most firm characteristics, which indicates that the matching criteria worked well in balancing observable features across treated and control firms.²⁰

¹⁶ China is usually divided into seven regions according to their geographic characteristics. They are north China (Beijing, Tianjin, Hebei, Shanxi, and Inner Mongolia), northeast China (Liaoning, Jilin, and Heilongjiang), eastern China (Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, and Shandong), central China (Henan, Hubei, and Hunan), southern China (Guangdong, Hainan, and Guangxi), southwest China (Chongqing, Sichuan, Guizhou, Yunnan, and Tibet), and northwest China (Shaanxi, Gansu, Ningxia, Qinghai, and Xinjiang).

¹⁷ It is in fact rare for firms to hire more than one politically connected independent director, probably because of the high search cost; all but 72 firms (4.6%) out of 1,560 do so in our sample.

¹⁸ This weighting scheme is adopted for ease of implementation. Our results are robust to alternative matching methods, e.g., nearest-neighbor matching (see sec. IV.D). Note also that our baseline regressions control for firm characteristics.

¹⁹ Because the time period of analysis was $(-3, 6)$, each firm can have up to 10 observations. In reality, many firms have fewer than this number. For example, if a treated firm regained political connections because it hired another retired government official at time 1 ($1 \leq t \leq 6$), its time period of analysis becomes $(-3, t - 1)$ and it has only $t + 3$ observations. For a control firm, if it hired a retired government official at time t_1 ($-3 \leq t_1 \leq -1$) who died at time t_2 ($1 \leq t_2 \leq 6$), this firm's time period of analysis is $(t_1 + 1, t_2 - 1)$.

²⁰ We note that the difference in firm age (*Age*) is marginally significant with a p -value of .06. This is not a concern, however, for two reasons. First, this significance occurs in only one out of the nine firm observable variables we examine. Second, we control for firm characteristics (including firm age) in our regressions and find robust results.

We now examine how a firm responds to a loss of political connections in terms of corporate innovation by applying the difference-in-differences regression framework:

$$Innovation_{i,t} = \alpha + \beta Polcon\ loss_{i,t-1} + \gamma X_{i,t-1} + \mu_i + \eta_t + \varepsilon_{i,t}, \quad (1)$$

where subscript i denotes a firm and t denotes the year relative to the treatment period ($t = 0$ is the reference period); since our period of analysis is $(-3, 6)$, t takes an integer value in this range. *Innovation* is measured as $\log(Total\ patent + 1)$, where *Total patent* represents the total number of patent applications. *Polcon loss* is a key variable described earlier that represents the unexpected loss of political connections, which is a dummy variable taking a value of one if a firm has experienced a sudden death for its politically connected independent director and zero otherwise. Control variables X include *Size*, *Leverage*, *Age*, *Cash*, *ROA*, *TobinQ*, *Duality*, *CEO shareholding*, and *ID ratio*, all lagged by 1 period (to account for the time needed for firms to adjust their R&D investment and produce patents). We also include firm fixed effects, μ_i , to capture time-invariant factors and time fixed effects, η_t , to capture aggregate shocks. The key coefficient of interest, β , captures the effect of a loss of political connections on a firm's patent applications. We cluster standard errors at the firm level to allow for dependence in error terms ($\varepsilon_{i,t}$).

Before showing estimation results, we examine whether pretrends were parallel across treated and control firms: were the innovation dynamics similar during the pretreatment period? As shown in figure 2, the total number of patent applications across these two groups shared similar trajectories before the treatment occurred, which provides reassuring evidence that the parallel trend assumption is likely to hold. After the treatment began, innovation patterns across the two groups of firms started to diverge: treated firms generated more patents, while control firms maintained a similar trend as before.

B. Baseline Results

We now evaluate the effects of a sudden loss of political connections on a firm's innovative activities. Regression results from equation (1) are presented in table 4. Notice that regardless of whether control variables are included, the coefficients on *Polcon loss* are statistically significant and positive, which indicates that a loss of political connections enhances a firm's innovation. Their magnitude is also quite stable across specifications. Taking column 4 as our preferred specification, a loss of political connections increases the number of patent applications by 34% ($= e^{0.2946} - 1$). Since the sample mean of the number of patent applications is 42.2 (see table 3), the estimated coefficient represents

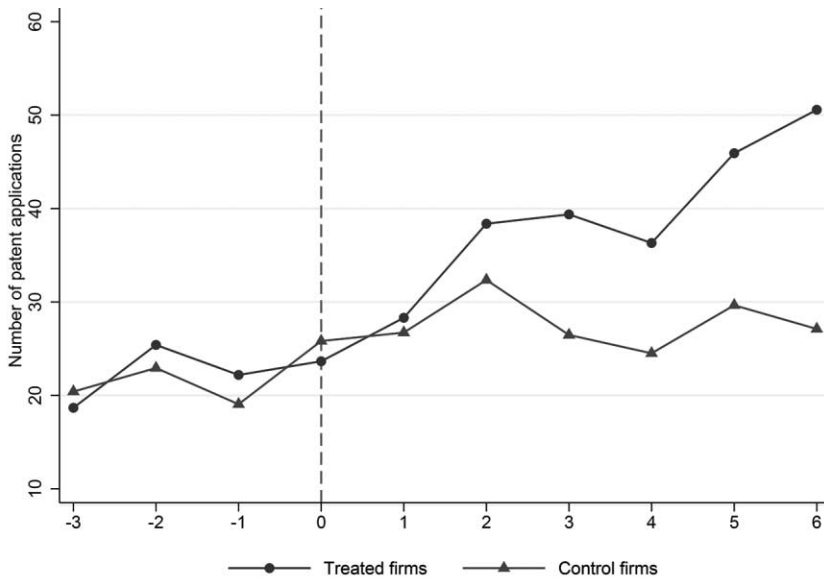


Figure 2. Trends of patent applications for treated and control firms. The y-axis gives the number of patent applications, and the x-axis gives the year relative to the treatment period. A treated firm is one that experiences a sudden death of a politically connected independent director. A control firm is one whose politically connected independent director is alive at the treatment time and that operated in the same industry and the same geographical region as the treated firm. A color version of this figure is available online.

an increase of 14 patent applications ($42.2 \times 34\%$). This estimate is much bigger than that in the United States. For example, Kim (2018) finds that the exit of a connected legislator (a proxy for political connections) from the US Congress leads a firm to increase patent applications by merely 5%. In a similar vein, Li and Cheng (2020) find a significantly larger impact on physical capital investment—as opposed to intellectual capital investment, in our case—in China than in the United States. These differences may reflect the more prominent influence of political connections on corporate behavior in developing countries compared with the United States due to weaker institutions, such as protection of property rights.

The coefficients on control variables are also presented in table 4 and largely consistent with the findings in previous studies (Brogaard, Denes, and Duchin 2015). As shown in column 4, for example, a firm tends to apply for more patents if it has a larger size, a lower asset-liability ratio, a longer listing history, a larger cash flow, and a better performance (e.g., higher *ROA*). Moreover, larger shares held by the chairman and CEO also contribute to firm innovation.²¹

²¹ We omit the reporting of the coefficients of control variables in subsequent tables for brevity.

TABLE 4
EFFECTS OF LOSING POLITICAL CONNECTIONS ON CORPORATE INNOVATION

	Dependent Variable: log(Total Number of Patent Application + 1)			
	(1)	(2)	(3)	(4)
<i>Polcon loss_{i,t-1}</i>	.2891*** (.0961)	.2932*** (.0929)	.2939*** (.0920)	.2946*** (.0926)
<i>Size_{i,t-1}</i>		.2622*** (.0559)	.2708*** (.0553)	.2736*** (.0546)
<i>Leverage_{i,t-1}</i>		-.6313*** (.1810)	-.5555*** (.1691)	-.5478*** (.1697)
<i>Age_{i,t-1}</i>		.0672*** (.0141)	.0714*** (.0146)	.0751*** (.0146)
<i>Cash_{i,t-1}</i>			.5660*** (.1929)	.5398*** (.1932)
<i>ROA_{i,t-1}</i>			.5780** (.2788)	.5764** (.2828)
<i>TobinQ_{i,t-1}</i>			.0035 (.0177)	.0030 (.0175)
<i>Duality_{i,t-1}</i>				.0657 (.0512)
<i>CEO shareholding_{i,t-1}</i>				.8477** (.3449)
<i>ID ratio_{i,t-1}</i>				-.2882 (.4592)
Constant	1.8712*** (.0929)	-3.4044*** (1.1506)	-3.8066*** (1.1664)	-3.9013*** (1.1834)
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Observations	7,283	7,283	7,283	7,283

Note. Robust standard errors clustered at the firm level are shown in parentheses.

** Significant at the 5% level.

*** Significant at the 1% level.

To show the dynamics of the effects visually, we also estimate the coefficients on the treatment—the sudden death of a politically connected independent director—period by period and display them in figure 3. A couple of patterns are worth noting. First, all coefficients before the treatment period are statistically insignificant, which is comforting evidence about the validity of our research design. Second, the impact is not uniform across periods: it is concentrated around 2–4 years after the loss of political connections and then weakens, and even disappears, 5 years after.²² The lack of immediate effects is not surprising since innovation requires time and persistent efforts.

Our baseline results show that a firm's loss of political connections enhances corporate innovation, consistent with the view that political connections and innovation are strategic substitutes. The implication is that political connections impede innovation. This phenomenon confirms the “curse of political resources”

²² We extend the period of analysis to 8 years after treatment and find that the effects are also insignificant after year 5.

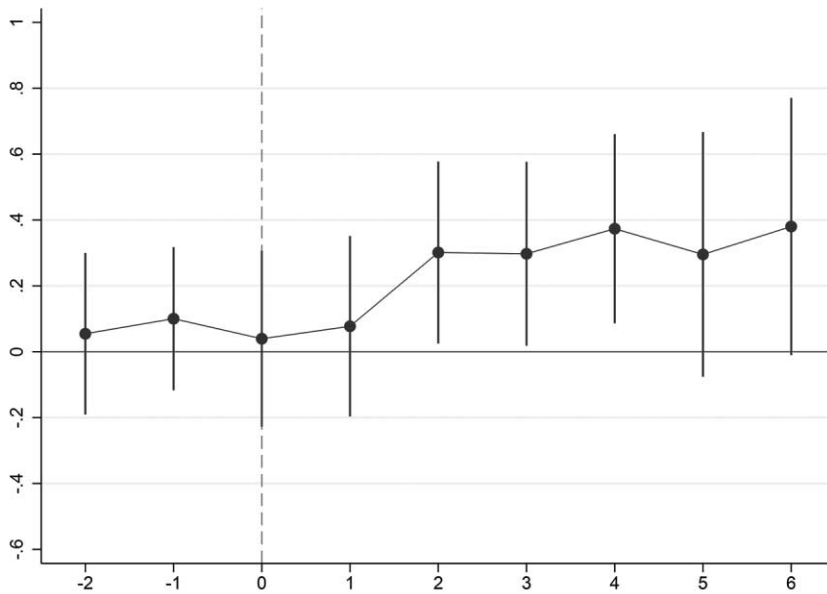


Figure 3. By-period effects of a loss of political connections on patent applications. Shown are 95% confidence intervals of the by-period coefficients. Pretreatment period 3 is the reference period. A color version of this figure is available online.

(Brollo et al. 2013) at the firm level: the endowment of political resources—political connections in our context—adversely affects long-term economic growth due to rent seeking and corruption. This finding is consistent with Haveman et al. (2019), who show that hiring former bureaucrats as CEO or chairman, though a different proxy of political connections than ours, hinders innovation.

By showing the positive impact of losing political connections on firm innovation, our paper offers an explanation of the acceleration of innovation in China in the last decade. Since the anticorruption campaign in 2012, many firms have lost political connections due to forced resignations of independent directors with political ties. The proportion of politically connected private firms in our sample has dropped by 22 percentage points between 2012 and 2017 (from 48.2% to 26.3%), while the average number of patent applications has risen by 76% (from 25 to 44 patents). As a back-of-the-envelope calculation, the reduction in the prevalence of political connections, according to our baseline estimate, explains about 10% of the takeoff in innovative activities in China in recent years.²³

²³ The amount explained is 0.22 (the drop of proportion of politically connected firms) $\times 34\%$ (baseline estimate) = 7.5% , which is about 10% of the overall percentage increase in patenting.

C. The Strength of Political Connections

We conduct heterogeneity tests to see whether the rise in patent applications is larger in firms that previously possessed stronger political connections and hence could maintain a greater market advantage over rival firms. If readjustment of the innovation strategy is due to heightened exposure to competition, we should see a more pronounced effect for those firms.

To test this hypothesis, we need to define the strength of the connection. There are two related aspects: (a) the political power of the politically connected independent director, which could be measured by their administrative level or by whether the firm operates within their geographical or industrial jurisdictions, and (b) the closeness of the director's relationship with the company—that is, to what extent the director would be willing to use their political influence to help the company, which could be measured by how seriously the director has been involved in company-related matters or by the tenure in the company.

Regarding aspect *a*, we construct three dummy variables: *Top politician*, which takes a value of one if the administrative level of the deceased official was above the bureau level (e.g., central or provincial and ministerial level); *Within jurisdiction*, which takes a value of one if the official once worked in a government agency in the province where the firm that hired them is based; and *Work experience*, which takes a value of one if the director had work experience in the industry to which the firm belongs before being hired. Regarding aspect *b*, we create two dummy variables: *Meeting absence*, which takes a value of one if they were absent from at least 50% of board meetings during their tenure as an independent director, and *Tenure*, which takes a value of one if the independent director's working years in the firm are greater than the sample median.

Table 5 shows the estimation results where we add the interaction terms of the dummy variables above with *Polcon loss* to the baseline regression equation. The coefficients on the interaction terms with *Top politician* and *Within jurisdiction* are significantly positive. Since government officials holding higher-level positions or inside their geographical jurisdictions wield greater political power, hiring them endows firms with stronger political ties to the authority, which can help secure more government-backed benefits. As shown in table 2, it is unsurprising that more than 40% of politically connected independent directors held higher-level positions and that they tend to be hired by firms located within their geographic jurisdictions. Alternatively, the coefficients on the interaction terms with *Work experience*, *Meeting absence*, and *Tenure* are statistically insignificant, which suggests that work experience in the industry or the closeness of the director's relationship with the company do not seem to matter—after all, the director's political clout should not systematically correlate

TABLE 5
INNOVATION INCENTIVE AND STRENGTH OF POLITICAL CONNECTIONS

	Dependent Variable: $\log(\text{Total Number of Patent Application} + 1)$					
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Polcon loss</i> _{<i>i,t-1</i>}	.2946*** (.0926)	.0718 (.1147)	.0833 (.1241)	.3562*** (.1235)	.3835*** (.1247)	.3064*** (.1068)
<i>Polcon loss</i> _{<i>i,t-1</i>} × <i>Top politician</i> _{<i>i</i>}		.4254** (.1693)				
<i>Polcon loss</i> _{<i>i,t-1</i>} × <i>Within jurisdiction</i> _{<i>i</i>}			.3538** (.1698)			
<i>Polcon loss</i> _{<i>i,t-1</i>} × <i>Work experience</i> _{<i>i</i>}				-.1470 (.1749)		
<i>Polcon loss</i> _{<i>i,t-1</i>} × <i>Meeting absence</i> _{<i>i</i>}					-.2379 (.1658)	
<i>Polcon loss</i> _{<i>i,t-1</i>} × <i>Tenure</i> _{<i>i</i>}						-.0656 (.1722)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,283	7,283	7,283	7,283	7,283	7,283

Note. *Top politician* is a dummy variable that takes a value of one if the administrative level of the politically connected independent director is above bureau level (e.g., central level or provincial and ministerial level). *Within jurisdiction* is a dummy variable that takes a value of one if the politically connected independent director once worked in the province where the firm is located. *Work experience* is a dummy variable that takes a value of one if the retired government official had relevant work experience before being hired as an independent director. *Meeting absence* is a dummy variable that takes a value of one if the retired government official was absent from at least 50% of board meetings during tenure as an independent director. *Tenure* is a dummy variable that takes a value of one if the independent director's working years in the firm is greater than the sample median. Control variables include *Size*, *Leverage*, *Age*, *Cash*, *ROA*, *TobinQ*, *Duality*, *CEO shareholding*, and *ID ratio*. We omit the reporting of the coefficients on control variables for brevity. Robust standard errors clustered at the firm level are given in parentheses.

** Significant at the 5% level.

*** Significant at the 1% level.

with their relevant work experience in the industry, the proclivity to be absent from board meetings, or tenure in the firm. These findings suggest that the political power of the directors plays a key role, which is consistent with the conjecture that firms' primary motive to hire retired government officials is to use their political ties, rather than their actual expertise in company management.

D. Placebo and Robustness Checks

We conduct a placebo test using the sample with nonpolitically connected independent directors (those from academic and business circles) and assess the robustness of our baseline results in a few ways: (a) alternative measures of innovation performance, (b) different regression methods, (c) alternative matching strategies, and (d) different subsamples.

First, we analyze the impact of losing nonpolitically connected independent directors on innovation. As discussed before, most academic or business elites in China do not have any political background, so their sudden deaths should

not represent a loss of political connections. We rerun the main regression equation with the independent variable *Polcon loss* replaced with *Non-Polcon loss*—that is, the sudden death of a nonpolitically connected independent director (175 such events are identified in our sample); the results are presented in appendix D. Not only are the key coefficients statistically insignificant, but their magnitude is also small. These results show that the sudden death of a nonpolitically independent director hardly affects the firm's innovation strategy, as the chief purpose of hiring them is not to obtain political connections.

Second, our results are robust to alternative measures of innovation performance. We consider four relevant measures: the number of patent applications per employee, the number of invention patent applications, R&D intensity measured by the ratio of R&D expenditures to sales revenue, and the ratio of high-skilled workers (those holding a bachelor's degree) to the total number of employees. As shown in panel A of table 6, the key coefficients of interest remain statistically significant and positive.

Third, we employ alternative regression methods given concerns about possible misspecification of the distribution of patent applications. If the number of patent applications is Poisson distributed, ordinary least squares estimates can be biased even if the data are transformed logarithmically (Cameron and Trivedi 2005). We thus use the Poisson model to reestimate equation (1). Moreover, since the number of patent applications contains many zero values in the sample, we also apply the Tobit model to adjust for censoring. As shown in panel B of table 6, the estimated effect of losing political connections on patent applications continues to be significantly positive.

Fourth, we use two alternative matching strategies to check whether our results are robust to the selection criteria of the control group. In the baseline results, the control group consists of firms whose politically connected independent director was still alive at time 0 and that operated in the same industry and geographical region as treated firms. Instead of inverse weighting on firms that satisfy those criteria, we now employ the nearest-neighbor matching method based on propensity scores to select control firms. Specifically, we calculate the propensity score or the predicted treatment probability (i.e., a politically connected independent director experiencing a sudden death) using logistic regression on firms' observable characteristics. We then select a control firm with the closest propensity score without replacement to match each treated firm.²⁴ Additionally, since we chose control firms from the same region as the

²⁴ The observable variables used to calculate the propensity score include *Size*, *Leverage*, *Age*, *Cash*, *ROA*, *TobinQ*, *Duality*, *CEO shareholding*, and *ID ratio*. Since private firms experienced sudden deaths of politically connected independent directors in different years, the matching process is implemented year by year. This procedure gives us a matched sample of 1,764 firm-year observations.

TABLE 6
ROBUSTNESS CHECKS

	(1)	(2)	(3)	(4)
	Patent Application per Employee	log(Invention Patent Application + 1)	Ratio of R&D Expenditure to Sales Revenue	Ratio of High- Skilled Workers
A. Alternative Measures of Innovation Performance				
<i>Polcon loss_{i,t-1}</i>	.0147*** (.0042)	.2833*** (.0823)	.0333*** (.0019)	.0151*** (.0037)
Control variables	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Observations	7,283	7,283	7,283	7,283
B. Alternative Regression Methods				
<i>Polcon loss_{i,t-1}</i>	.1125*** (.0349)	.4742*** (.0738)	.3346*** (.1099)	.2942*** (.0934)
Control variables	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Observations	7,283	7,283	1,540	6,498
C. Alternative Construction of Control Group				
D. Sample Restrictions				
	PCIDs without Higher Education or Relevant Work Experience	"Pure" Private Firms	Period (-3, 3)	Sudden Deaths That Occurred before 2012
<i>Polcon loss_{i,t-1}</i>	.4729*** (.1555)	.3783*** (.1171)	.2161** (.0973)	.2827* (.1558)
Control variables	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Observations	1,852	5,284	5,468	1,627

Note. Control variables include *Size*, *Leverage*, *Age*, *Cash*, *ROA*, *TobinQ*, *Duality*, *CEO shareholding*, and *ID ratio*. We do not report the coefficients on the control variables for brevity. For panels B–D, the dependent variable is log(total number of patent application + 1). Robust standard errors clustered at the firm level are shown in parentheses.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

treated firms, one may worry that this may violate the stable unit treatment value assumption. Given that listed firms tend to be large, a firm's treatment status may affect potential outcomes of another firm. For example, when a firm loses its political connections, government subsidies—often allocated at the provincial level—may be diverted to its competitors in the same province and thus impact their innovative behavior. To alleviate possible spillover effects, we select untreated firms in the same region as the treated firm but in a different province. The results using these two methods—nearest-neighbor matching and choosing firms from a different province from treated units—to construct

the control group are presented in panel C of table 6. Notably, the key coefficient of interest remains quantitatively similar to the baseline estimate.

Last, our results are robust to subsample restrictions to further eliminate confounding effects from director expertise, ownership structure, and choice of the period of analysis. First, since some government officials received higher education or had relevant work experience (see table 2), they may be able to provide constructive advice on firms' innovation plans. To rule out director expertise as a confounder, we consider a subsample of politically connected independent directors without higher education or relevant work experience. Second, one-third of listed firms in our sample were originally state owned and later converted to private ownership through share transfers. Due to their initial SOE status, these firms may still possess certain connections with the government even after the sudden death of their independent directors. To assuage this concern, we delete private firms that underwent such a conversion. Third, one may worry about remaining selection bias in the sense that among companies that experienced an unexpected death of a director, a nonrandom subset of companies will not (be able to) replace the director. As shown previously, it is much harder to replace a politically connected director in the short term, so we shorten the pre- and posttreatment periods year by year as a robustness test.²⁵ We report regression results only in the period $(-3, 3)$ to save space but note that results are not sensitive to other choices. Additionally, we restrict our sample of sudden deaths to those that occurred before 2012, the year when the government launched a large-scale anticorruption campaign, to alleviate the concern about possible confounding effects from the movement. These robustness checks are presented in panel D of table 6. The key coefficient of interest in all specifications remains consistent with the baseline results, which confirms again that a loss of political connections advances private firms' innovation performance.

V. Mechanism: Why Does a Loss of Political Connections Spur Corporate Innovation?

We explore possible channels through which losing political connections spurs corporate innovation. We delve into the competition channel by investigating whether firms face higher competition externally and adjust their resource allocation internally. In particular, we test two related mechanisms: competition (the external mechanism) and resource saving (the internal mechanism). Externally, after a firm loses political connections, its economic advantages

²⁵ Our results are also robust to eliminating from the sample firms that successfully hired a replacement after the sudden loss of a politically connected director.

afforded by those connections deteriorate; this results in stiffer competition facing the firm and in turn drives it to innovate to recoup a competitive edge. Internally, financial resources that were initially used to replenish political connections could now be redirected to investing in innovation inputs.²⁶ We present evidence supporting these mechanisms.

A. External Mechanism: Competition

Competition plays an important role in inducing corporate innovation. However, political connections may impede market competition. In emerging economies such as China, where legal and other market-supporting institutions are insufficient, political connections help firms obtain government-backed benefits or even direct orders, which lower production costs for beneficiary firms and inhibit market competition (Claessens, Feijend, and Laeven 2008; Pan and Tian 2017). Politically connected firms, therefore, do not have strong incentives to innovate due to an artificial advantage enabled by their political ties. After losing political connections, firms will face increased competitive pressure from competitors or potential entrants, which incentivizes them to invest in R&D and innovation (Norbäck and Persson 2012; Marshall and Parra 2019).

We test this mechanism in two steps. First, we estimate whether a firm's loss of political connections leads to higher competition. Since there generally exists an inverse relationship between competition and corporate performance (Phillips 1995; Nickell 1996), we directly study how the performance of the firm and its competitors responds with the following regressions:²⁷

$$Performance_{i,t} = \alpha + \beta Polcon\ loss_{i,t} + \gamma X_{i,t} + \mu_i + \eta_t + \varepsilon_{i,t}, \quad (2)$$

$$Performance_{j,t} = \alpha + \lambda Polcon\ loss_{k(j),t} + \gamma X_{j,t} + \mu_j + \eta_t + \varepsilon_{j,t}, \quad (3)$$

²⁶ Two types of costs can be saved from rent seeking: those associated with both the establishment and the maintenance of political connections. These costs impose social burdens on politically connected firms.

²⁷ Alternative measures of market competition could be the entry barrier using the number of entrants or market concentration using the Herfindahl-Hirschman Index (HHI). However, these do not appear suitable in our context. First, our sample focuses on listed firms, but entrants may not become listed, if at all, until years later. Second, the HHI, albeit a commonly used proxy for market competitiveness, has a serious loophole. The index could decline for two types of reasons, which are hard to disentangle. The market may indeed become more competitive: Market fictions are smoothed, and more firms join the market due to lowered entry barriers. Or perhaps its value decreases mechanically simply because the market share of the top firms is crippled for whatever reason. Indeed, 47% of treated firms in our data are among the top four firms in an industry-province cell, which implies that the resifting of market shares may be substantial. Nonetheless, we would obtain qualitatively similar results were we to use the HHI measure instead.

where performance is measured by the profit rate (*Profitability*), the return on assets (*ROA*), and the return on equity (*ROE*). Equation (2) estimates the effect of losing political connections on the firm's (*i*) economic performance, while (3) estimates the effect on its competitors' (*j*), where a competitor is identified as one from the same industry-region cell (*k*). For equation (2), the full sample is used. For equation (3), we drop all treated firms from the sample and construct a dummy variable, $Polcon\ loss_{k(j),t}$, which takes a value of one if the industry-region cell (*k*) in which the competitor firm (*j*) belongs contains a treated firm that has lost political connections as of year *t*.²⁸ As usual, we include control variables as well as firm and year fixed effects. The coefficients of interest are β and λ . Note that since we regress equation (3) using only the sample of untreated firms, the coefficient λ estimates the impact of a firm's loss of political connections on the performance of its competitors.

The results from estimating equations (2) and (3) are presented in panels A and B of table 7, respectively. The key coefficients of interest in panel A are negative, which indicates that a loss of political connections adversely affects firm performance. In contrast, its competitors' economic performance improves, as shown by the positive coefficients in panel B. When a firm loses political connections, resources previously afforded by its ties to the government may now be released and diverted to its potential competitors.²⁹ This effectively intensifies the market competition faced by the formerly connected firm, as evidenced by a deterioration of its economic performance relative to its competitors.

Next, we study how a firm's innovation responds to a rise in competitive pressure by estimating the regression model:

$$Innovation_{i,t} = \alpha + \beta Diff_performance_{i,t-1} + \gamma X_{i,t-1} + \mu_i + \eta_t + \varepsilon_{i,t}, \quad (4)$$

where $Diff_performance_{i,t-1}$ is the difference between the average performance (*Profitability*, *ROA*, and *ROE*) of all other firms (except *i*) and that of firm *i* in the same industry-province-year cell. This term aims to capture the competitive pressure facing firm *i*; by definition, a larger value indicates greater competitive pressure. The estimation results of equation (4) are presented in panel C of table 7. Overall, the coefficients on $Diff_performance$ are positive for all

²⁸ For example, if a treated firm lost its politically connected independent director in 2010, $Polcon\ loss_{k(j),t}$ for untreated firms within the same industry-region cell takes a value of one in or after 2010 and zero otherwise. Equation (3) estimates the effect of a firm's loss of political connections on its competitors' performance (relative to that of other untreated firms in markets that have not yet encountered a connection loss).

²⁹ We also show in panel A of table 8 shortly that economic benefits a firm receives in terms of bank loans, tax rates, and government subsidies decrease after a loss of political connections.

TABLE 7
EXTERNAL MECHANISM: COMPETITION

	(1)	(2)	(3)
	<i>Profitability</i>	<i>ROA</i>	<i>ROE</i>
A. Effects of Losing Political Connections on Treated Firms' Performance			
<i>Polcon loss_{i,t}</i>	-.0115** (.0053)	-.0008 (.0046)	-.0339*** (.0093)
Control variables	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes
Observations	8,331	8,331	8,331
B. Effects of Losing Political Connections on Competitors' Performance			
<i>Polcon loss_{k(j),t}</i>	.0086*** (.0024)	.0075*** (.0026)	.0110*** (.0038)
Control variables	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes
Observations	7,373	7,373	7,373
C. Effects of Competitive Pressure on Corporate Innovation			
<i>Diff_profitability_{i,t-1}</i>	1.0086*** (.2817)		
<i>Diff_ROA_{i,t-1}</i>		.1966 (.4743)	
<i>Diff_ROE_{i,t-1}</i>			.3693*** (.1358)
Control variables	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes
Observations	7,283	7,283	7,283

Note. *Polcon loss_{k(j),t}* is a dummy variable that takes a value of one if the industry-region cell (*k*) in which the competitor firm (*j*) belongs contains a treated firm that has lost political connections in year *t*. *Diff_performance_{i,t-1}* is the difference between the average performance (*Profitability*, *ROA*, and *ROE*) of all other firms (except *i*) and that of firm *i* in the same industry-province-year cell. Control variables include *Size*, *Leverage*, *Age*, *Cash*, *ROA* (except col. 2 of panels A and B), *TobinQ*, *Duality*, *CEO shareholding*, and *ID ratio*. We do not report the coefficients on the control variables for brevity. For panel C, the dependent variable is $\log(\text{Total Number of Patent Application} + 1)$. Robust standard errors clustered at the firm level are shown in parentheses.

** Significant at the 5% level.

*** Significant at the 1% level.

three measures of performance, which confirms the competition hypothesis: an enhanced competitive pressure drives previously connected firms to invest in innovation to reclaim a market advantage.

B. Internal Mechanism: Resource Saving

Internally, a loss of political connections on the face of it can have ambiguous effects on resources available for innovation investment. On the one hand, due to the risky nature of innovation, financial constraints can pose a serious challenge. Since political connections can help firms access cheap bank loans, tax

breaks, and government subsidies (Goldman, Rocholl, and So 2013; Bryce Campodonico, Bonfatti, and Pisano 2016; Kim and Zhang 2016; Mukherjee, Singh, and Žaldokas 2017), a loss of those connections will tighten their fiscal constraints, which leaves less room for innovative activities. On the other hand, politically connected firms may be coerced by the government to prioritize local economic growth targets over the maximization of firm value, leading to overemployment or overinvestment (Bertrand et al. 2018). Bearing these burdens disperses firms' limited resources and crowds out R&D investment. Moreover, rent-seeking costs that firms need to shoulder to obtain and maintain political connections further squeeze investment in innovation (Cai, Fang, and Xu 2011).³⁰ Losing political connections, therefore, allows firms to spare these expenditures and reallocate them to inventive activities.

Whether a loss of political connections increases or decreases financial resources available for innovation is an empirical question. We posit that if costs of regaining political connections are high and benefits low, firms that lose political connections will prefer investing in innovation to investing in rent seeking. This is likely the case given China's institutional context. First, it is difficult for private firms to establish political connections with the government due to the scarcity of retired government officials at high administrative levels able to serve as independent directors. Furthermore, the costs of attaining and keeping political ties have increased substantially since the recent anticorruption campaign (Xu and Yano 2017).

We test this resource-saving mechanism in three steps. First, we investigate how the unexpected loss of political connections affects the economic benefits that previously connected firms obtain. Second, we examine the social burdens faced by these firms measured by overinvestment, overemployment, and entertainment spending. Third, we evaluate the impact on R&D investment. Specifically, we regress the following three equations:

$$Benefit_{i,t} = \alpha + \beta Polcon\ loss_{i,t} + \gamma X_{i,t} + \mu_i + \eta_t + \varepsilon_{i,t}, \quad (5)$$

$$Cost_{i,t} = \alpha + \beta Polcon\ loss_{i,t} + \gamma X_{i,t} + \mu_i + \eta_t + \varepsilon_{i,t}, \quad (6)$$

$$RD\ ratio_{i,t} = \alpha + \beta Polcon\ loss_{i,t} + \gamma X_{i,t} + \mu_i + \eta_t + \varepsilon_{i,t}. \quad (7)$$

³⁰ The average salary of independent directors is not high in China. According to financial news reports, most of them earn RMB50,000–RMB60,000 per year. We browse the resumes of the 120 government official independent directors in the sudden deaths sample and find that their annual salary averages RMB57,831. By comparison, treated firms' R&D expenditure is RMB46,501,232, on average, in the year when the sudden deaths occurred. Compared with the huge amount of R&D expenditure, the salary saved due to the loss of a politically connected independent director is negligible.

Benefit represents economic benefits received by connected firms—bank loans (*Bank loan*), tax benefits (*Tax rate*), and government subsidies (*Subsidy*); *Cost* refers to overinvestment (*Overinvest*), overemployment (*Overemploy*), and entertainment expenditures (*Entertainment*); and *RD ratio* represents R&D intensity, a measure of spending on innovation inputs (the definitions and statistical descriptions of these variables are presented in app. C and table 3). The other variables are the same as before. Standard errors are again clustered at the firm level.

We report estimation results of equations (5)–(7) in table 8. As shown in panel A, the coefficients on the three measures of benefits are highly significant, which indicates that a loss of political connections does reduce a firm's economic benefits. Specifically, if a firm loses political connections, the ratio of total bank loans to total assets (*Loan rate*) and the ratio of government subsidies to net profits (*Subsidy*) decrease by 3.21 and 2.77 percentage points, respectively, while the tax rate (*Tax rate*) it faces increases by 2.63 percentage points relative to other firms. Second, the coefficients on the three cost measures are also highly significant, as shown in panel B, which suggests that a firm bears fewer social burdens and spends less on rent-seeking activities after a loss of political connections. Last, baseline results in column 1 of panel C show that losing political connections has a positive effect on R&D investment. With recent anti-corruption efforts, the values of political connections have become attenuated, and rent-seeking costs have risen, which may lead to a larger response in R&D investment to a loss of political connections. To test this argument, we construct a dummy variable, *After*, which takes a value of one for periods in or after 2012 when the anticorruption campaign began. As shown in column 2 of panel C, the coefficient on the interaction term *Polcon loss* \times *After* is significantly positive, which is consistent with our hypothesis. We also show that the baseline results are robust to using the nearest-neighbor matching method and ruling out confounding effects from director expertise, as shown in columns 3 and 4. Taken together, these results show that although a loss of political connections leads to a reduction in a firm's obtainable benefits, it enables the firm to save expenditures that were used in rent seeking and, in the face of higher competition, redirect these resources to innovative activities.

C. Putting Both Mechanisms Together

We combine both the competition and the resource-saving channels by estimating an extended version of equation (1):

$$\begin{aligned} Innovation_{i,t} = & \alpha + \beta Polcon_loss_{i,t-1} + \rho Diff_profitability_{i,t-1} \\ & + \delta RD_ratio_{i,t-1} + \gamma X_{i,t-1} + \mu_i + \eta_t + \varepsilon_{i,t}. \end{aligned} \quad (8)$$

TABLE 8
INTERNAL MECHANISM: RESOURCE SAVING

	(1)	(2)	(3)	(4)
A. Effects of Losing Political Connections on the Economic Benefits Obtained by Firms				
	Bank Loan(Loan rate)	Tax Rate(Tax rate)	Government Subsidy(Subsidy)	
<i>Polcon loss_{i,t}</i>	-.0321*** (.0095)	.0263*** (.0072)	-.0277** (.0140)	
Control variables	Yes	Yes	Yes	
Firm fixed effects	Yes	Yes	Yes	
Time fixed effects	Yes	Yes	Yes	
Observations	8,331	8,331	8,331	
B. Effects of Losing Political Connections on Costs				
	Overinvestment (Overinvest)	Overemployment (Overemploy)	Entertainment Expenditures (Entertainment)	
<i>Polcon loss_{i,t}</i>	-.0693* (.0386)	-.1168*** (.0355)	-.1169** (.0567)	
Control variables	Yes	Yes	Yes	
Firm fixed effects	Yes	Yes	Yes	
Time fixed effects	Yes	Yes	Yes	
Observations	7,283	8,331	8,331	
C. Effects of Losing Political Connections on R&D Investment				
	Baseline Results	After Anticorruption Campaign	Nearest-Neighbor Matching	PCIDs without Higher Education or Relevant Work Experience
<i>Polcon loss_{i,t}</i>	.0286*** (.0020)	.0191*** (.0030)	.0290*** (.0043)	.0242*** (.0029)
<i>Polcon loss_{i,t} × After_t</i>		.0108*** (.0034)		
Control variables	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Observations	8,331	8,331	1,764	2,120

Note. Control variables include *Size*, *Leverage*, *Age*, *Cash*, *ROA*, *TobinQ*, *Duality*, *CEO shareholding*, and *ID ratio*. We do not report the coefficients on the control variables for brevity. *After* is a dummy variable that takes a value of one for years in or after 2012. The dependent variable for panel C is R&D intensity (*RD ratio*). Robust standard errors clustered at the firm level are shown in parentheses.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

The coefficient on the variable *Polcon loss*, β , shows the effect of losing political connections on the number of patent applications after controlling for both mechanisms, and the degree of attenuation of the coefficient, relative to the baseline estimates from equation (1), indicates the extent to which the two channels act as mediating factors. The estimation results from equation (8) are presented in table 9. First, the coefficients on *Diff_profitability* are significantly

TABLE 9
JOINT TEST OF COMPETITION AND RESOURCE-SAVING MECHANISMS

	Dependent Variable: $\log(\text{Total Number of Patent Application} + 1)$			
	(1)	(2)	(3)	(4)
<i>Polcon loss</i> _{<i>i,t-1</i>}	.2946*** (.0926)	.2752*** (.0928)	.1851* (.0958)	.1562 (.0965)
<i>Diff_profitability</i> _{<i>i,t-1</i>}		1.0112*** (.2819)		1.1319*** (.2831)
<i>RD ratio</i> _{<i>i,t-1</i>}			4.1672*** (.8618)	4.4381*** (.8602)
Control variables	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Observations	7,283	7,283	7,283	7,283

Note. *Diff_profitability*_{*i,t-1*} is the difference between the average profit rate of all other firms (except *i*) and that of firm *i* in the same industry-province-year cell. Control variables include *Size*, *Leverage*, *Age*, *Cash*, *ROA*, *TobinQ*, *Duality*, *CEO shareholding*, and *ID ratio*. We do not report the coefficients on the control variables for brevity. Robust standard errors clustered at the firm level are shown in parentheses.

* Significant at the 10% level.

*** Significant at the 1% level.

positive, which is consistent with our previous results in table 7. Second, the coefficients on the variable *RD ratio* are significantly positive, which indicates that, as expected, an increase in R&D investment leads to more innovative outputs. More importantly, the magnitude of the coefficients on *Polcon loss* becomes smaller as we include one of the variables *Diff_profitability* and *RD ratio* and even insignificant when we control for both. These results suggest that both channels play mediating roles in driving the positive effect of a loss of political connections on corporate innovation.

VI. Discussion on Corporate Profitability and Innovation Quality

A. The Effect on the Transformability of Innovation into Profitability

Previous studies have found that innovation enhances a firm's core competitiveness and improves its long-term development (Hsu 2009; Nanda and Rhodes-Kropf 2013). We examine how a loss of political connections affects the transformability of innovation into corporate profitability—specifically, how innovation affects profitability and how a loss of political connections influences the sensitivity of profitability to innovation. Our baseline results show that politically connected firms become more innovative after they lose political connections. We conjecture that their innovative outputs also have higher transformative ability into economic performance. Results presented in appendix E test this hypothesis and show that a loss of political connections does reinforce the transformative ability of innovation into corporate profitability.

B. The Effect on Innovation Quality

A possible reason is an improvement of patent quality. This is because the competition and resource-saving channels may induce firms that lose political connections to invest more R&D investment on breakthrough innovations (Tian and Wang 2014). We study whether a loss of political connections increases not only the quantity of innovation but also the quality.

To investigate the effect on innovation quality, we consider three types of patents: invention patents, utility model patents, and design patents. Approval of invention patents requires a substantive examination of utility, novelty, and nonobviousness—and entails statutory patent protection of 20 years. By contrast, utility model and design patents involve a more cursory assessment, resulting in fast and almost certain granting. For this reason, utility model and design patents are often referred to as “petty innovations.” We have already shown that losing political connections contributes to the number of invention patent applications (table 6, col. 2, panel A). We now consider the other two types of patents. The results from estimating equation (1) with the dependent variable replaced by the number of utility model and design patent applications are reported in panel A of table 10: although the coefficients on *Polcon loss* are positive, they are statistically insignificant. Moreover, their magnitude is less than half of that for invention patents. These results suggest that the positive

TABLE 10
EFFECT OF LOSING POLITICAL CONNECTIONS ON INNOVATION QUALITY

	(1)	(2)
A. Other Types of Patents		
	log(Utility Model Patent App. + 1)	log(Design Patent App. + 1)
<i>Polcon loss</i> _{<i>t</i>-1}	.1328 (.0892)	.1162 (.0738)
Control variables	Yes	Yes
Firm fixed effects	Yes	Yes
Time fixed effects	Yes	Yes
Observations	7,283	7,283
B. Number of Forward Citations		
	3 Years after Granting	5 Years after Granting
<i>Polcon loss</i> _{<i>t</i>-1}	.2603*** (.0862)	.3187*** (.1137)
Control variables	Yes	Yes
Firm fixed effects	Yes	Yes
Time fixed effects	Yes	Yes
Observations	4,495	4,495

Note. Control variables include *Size*, *Leverage*, *Age*, *Cash*, *ROA*, *TobinQ*, *Duality*, *CEO shareholding*, and *ID ratio*. We do not report the coefficients on the control variables for brevity. Robust standard errors clustered at the firm level are shown in parentheses.

*** Significant at the 1% level.

effect of a loss of political connections on innovation is concentrated in high-quality patents.

To provide further evidence on the effect on patent quality, we use patent citations as another measure (Aggarwal and Hsu 2014). Specifically, we proxy for patent quality using the number of forward citations within a 3-year post-application period, scaled by the number of patent applications.³¹ As shown in column 1 of panel B of table 10, patents granted after a firm loses political connections have more forward citations. Results are insensitive to a different time window (i.e., 5 years), as shown in column 2 of panel B.

VII. Conclusion

This paper investigates the causal impact of losing political connections on corporate innovation using the sudden deaths of politically connected independent directors in privately owned firms in China as exogenous shocks. We find that a loss of political connections spurs firm innovation, measured by the total number of patent applications. We present evidence that the effect is driven by increased exposure to market competition, which incentivizes firms to divert resources saved from rent seeking into innovative activities.

Our results highlight the crucial role of market competition in driving the substitution between political connections and corporate innovation in contexts with weak legal and financial institutions. We show that while a loss of political connections increases a firm's innovation, it does reduce its economic performance. Despite this negative effect, our findings suggest that a loss of political connections leads to not only an increase in the quantity of innovation but also an improvement in the quality. These findings speak to the short-versus long-term gains from strengthening the rule of law and weakening the role of political connections in corporate decisions in developing economies.

It is worth noting several limitations of our study. First, our sample consists of listed firms, which tend to be large in scale. Further research can examine small- and medium-sized enterprises, which may be subject to greater influence from political connections in their investment behavior. Second, to isolate an exogenous and clean source of variation, we have focused on a specific type of political connection that is through the hiring of retired government cadres as independent directors. Future research can investigate other types of political connections, such as those cultivated through political election or social

³¹ We manually collect citation data from Google but despite our best efforts are unable to identify the forward citations of all patents used in this paper. Therefore, the number of observations is smaller using these data. This issue of missing data is the reason we do not use the citation data in our main analysis.

ties. For example, Fisman et al. (2020) show that the chance of being selected as a new member in China's Politburo is affected by whether the candidate shares a hometown or university connection with an incumbent member. This type of connection via hometown or education may also matter for corporate decisions. Third, given that our setting is privately owned firms in China, caution should be exercised if one were to extrapolate the findings to other countries, where political connections may take a different form. Finally, we have zoomed in on the increased exposure to competition as the main channel for how a loss of political connections affects innovation. Fieldwork and executive interviews can help inform whether other mechanisms are also at play.

Appendix A

TABLE A1
NUMBER OF FIRMS WITH CEOs OR SENIOR EXECUTIVES ELECTED AS PC OR CPPCC MEMBERS
AFTER SUDDEN DEATH OF POLITICALLY CONNECTED INDEPENDENT DIRECTOR

Year	Number of Sudden Deaths	Elected Over Next 3 Years	Elected Over Next 6 Years
2007	7	0	0
2008	13	0	1
2009	10	1	2
2010	14	0	0
2011	12	1	1
2012	18	0	0
2013	15	0	1
2014	15	2	2
2015	16	1	2
Total number (ratio)	120	5 (4.2%)	9 (7.5%)

Appendix B

The searching process for sudden death events is as follows:

Step 1: We use keywords on independent directors ("independent director" or "outside director") and death ("passed away," "died," "deceased," etc.) to search for news about the death of independent directors from 2007 to 2015. It should be noted that our search terms do not include keywords designed to capture sudden death (e.g., "sudden" or "unexpected"). A general search is important, as many newspaper articles report the medical cause of death—for example, cerebral hemorrhage (stroke)—without explicitly mentioning that the death is sudden. The cost of this design is that it returns a significant number of newspaper articles irrelevant to sudden death.

Step 2: Based on the sample obtained from step 1, we use keywords on government officials to search for reports of deceased politically connected independent directors.

Step 3: From the sample obtained from step 2, we identify privately owned firms based on the identity of the ultimate owner. In our sample, these firms are ultimately controlled by nongovernmental units, such as individuals, collective enterprises, and so on.

Step 4: Based on the sample obtained from step 3, we ascertain that the causes of deaths of politically connected independent directors are sudden. The cause of death is verified by an additional search on the news containing the name of the deceased politically connected independent director in a 1-year period surrounding their death. We also use annual (or quarterly) reports of listed firms, if necessary, as auxiliary materials to determine the cause of death. In particular, we identify the following cases as sudden death: heart attacks, stroke, all other diseases that cause sudden deaths, accidents, and deaths for which the cause is unreported but are described as unanticipated. In cases of inconsistency about the reported cause of death across different sources, our approach is to be conservative and include only death events for which we have no conflicting evidence about their sudden, unexpected nature.

Exogeneity of sudden death events. The retired government officials hired by private firms are often politically important (e.g., about half of them held high-level positions, as shown in table 2), their sudden deaths tend to be sensational events that attract media attention. It is therefore straightforward to collect relevant information from financial websites or annual reports on the occurrence of these sudden deaths.

Table B1 describes the characteristics (causes, timing, and regions) of the sudden deaths of politically connected independent directors. As shown in panel A, heart attacks and strokes, which often afflict the elderly, are the main causes (79.2%) for sudden deaths in our sample. The occurrence of these two types of events is unpredictable, which is confirmed by the fact that all sudden deaths in our sample happened within 8 hours.³² Moreover, 10% of sudden deaths were caused by accidents, such as car accidents, which also tend to be unforeseeable. It is thus unlikely that firms take measures in advance to respond to these unexpected deaths. Panel B reports the quarter in which the sudden deaths occurred. They are evenly distributed throughout the year. Furthermore, panel C lists the region where the sudden death occurred. The mortality rates are almost identical across regions. These observations provide additional evidence that the sudden deaths are unexpected and exogenous.

³² Given the political importance of politically connected independent directors, their sudden deaths tend to be sensational and attract media attention. To the extent possible, we collect information from financial websites or annual reports on the specific time of these death events and find that all of them occurred within 8 hours (which is not surprising since most of them are due to heart attacks and strokes).

TABLE B1
CHARACTERISTICS OF SUDDEN DEATHS OF POLITICALLY CONNECTED INDEPENDENT DIRECTORS (PCIDs)

	A. Cause of Sudden Death		
	Number of Sudden Deaths	Proportion	
Heart attack	57	.475	
Stroke	38	.317	
All other diseases	10	.083	
Accident	12	.100	
Sudden and unexpected death but unspecified cause	3	.025	
All	120	1	
	B. Time of Sudden Death		
	Number of Sudden Deaths	Proportion	
First quarter (January–March)	27	.225	
Second quarter (April–June)	34	.283	
Third quarter (July–September)	29	.242	
Fourth quarter (October–December)	30	.250	
All	120	1	
	C. Region of Sudden Death		
	Number of Sudden Deaths	All PCIDs	Mortality Rate (%)
East	73	1,680	4.35
Middle	25	597	4.19
West	22	475	4.63
All	120	2,752	4.36

Appendix C

TABLE C1
DEFINITIONS OF KEY VARIABLES

Variable	Definition
<i>Total patent</i>	Total number of patent applications
<i>Invention patent</i>	Total number of invention patent applications
<i>RD ratio</i>	R&D intensity: ratio of R&D expenditure to sales revenue
<i>Polcon loss</i>	= 1 if firm's government official independent director suddenly died and firm is in posttreatment period
<i>Size</i>	log(total assets)
<i>Leverage</i>	Ratio of total debt to total assets
<i>Age</i>	Number of years since firm went public
<i>Cash</i>	Ratio of cash flow to total assets
<i>ROA</i>	Ratio of net profits to total assets
<i>TobinQ</i>	Tobin's Q, measured as sum of market value of tradable shares, book value of nontradable shares and liabilities, divided by sum of book value of equity and liabilities
<i>Duality</i>	= 1 if firm's chairman is also CEO
<i>CEO shareholding</i>	Shares held by chairman and CEO
<i>ID ratio</i>	Proportion of independent directors on board of directors
<i>Loan rate</i>	Ratio of total bank loans (including short-term loans and long-term loans) to total assets
<i>Tax rate</i>	Ratio of income tax to pretax accounting profit
<i>Subsidy</i>	Ratio of total subsidy (deducting value-added tax return) to net profits (= total profits – income tax)
<i>Overinvest</i>	= 1 if regression residual is greater than zero; estimating the regression residual is $Inv_t = \alpha + \beta_1 Growth_{t-1} + \beta_2 Lev_{t-1} + \beta_3 Cash_{t-1} + \beta_4 Age_{t-1} + \beta_5 Size_{t-1} + \beta_6 Rev_{t-1} + \beta_7 Int_{t-1} + Industry\ FE + Region\ FE + Year\ FE + \varepsilon_t$, where Inv_t represents firm's investment in year t ; $Growth_{t-1}$ measures firm's growth opportunity using growth rate of primary business revenue in year $t - 1$; and Lev_{t-1} , $Cash_{t-1}$, Age_{t-1} , $Size_{t-1}$, Rev_{t-1} , and Int_{t-1} are leverage, cash holdings, firm age, firm size, stock return, and investment in year $t - 1$, respectively
<i>Overemploy</i>	= 1 if percentage of surplus labor is greater than zero; percentage of surplus labor is calculated as $(Employ_i - IndEmp \times [Sales_i / IndSales]) / Employ_i$, where $Employ_i$ represents number of employees in firm i , $Sales_i$ represents sales revenue, $IndEmp$ represents industry average number of employees, and $IndSales$ represents industry average sales revenue
<i>Entertainment</i>	log(entertainment costs + 1)
<i>Profitability</i>	Ratio of profits to sales revenue
<i>ROA</i>	Ratio of net profits to net assets
<i>ROE</i>	Ratio of net profits to net equity

Appendix D

TABLE D1
EFFECTS OF LOSING NONPOLITICALLY CONNECTED INDEPENDENT DIRECTORS ON CORPORATE INNOVATION

	Dependent Variable: log(Total Number of Patent Application + 1)			
	(1)	(2)	(3)	(4)
<i>Non-Polcon loss_{i,t-1}</i>	.0309 (.1163)	.0130 (.1178)	.0299 (.1189)	.0254 (.1192)
<i>Size_{i,t-1}</i>		.3260*** (.1176)	.3916*** (.1514)	.3952** (.2012)
<i>Leverage_{i,t-1}</i>		-.5092** (.2135)	-.6087*** (.2255)	-.6261*** (.2300)
<i>Age_{i,t-1}</i>		.0640*** (.0216)	.0609*** (.0233)	.0620*** (.0235)
<i>Cash_{i,t-1}</i>			.5856*** (.1727)	.5820*** (.1755)
<i>ROA_{i,t-1}</i>			.5810** (.2794)	.6416** (.3190)
<i>TobinQ_{i,t-1}</i>			.0051 (.0037)	.0059 (.0045)
<i>Duality_{i,t-1}</i>				.0504 (.0691)
<i>CEO shareholding_{i,t-1}</i>				.8272* (.4303)
<i>ID ratio_{i,t-1}</i>				-.2699 (.2027)
Constant	.5151 (.6536)	-6.1194* (3.6688)	-7.5261* (4.2488)	-7.5846* (4.2418)
Firm fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Observations	4,612	4,612	4,612	4,612

Note. Robust standard errors clustered at the firm level are shown in parentheses.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

Appendix E

Our baseline results show that politically connected firms become more innovative after they lose political connections. We conjecture that their innovative outputs also have higher transformative ability into economic performance. To test this hypothesis, we estimate the following regression:

$$Performance_{i,t} = \alpha + \rho Innovation_{i,t-1} + \beta Polcon_{i,t-1} + \delta Polcon_{i,t-1} \times Innovation_{i,t-1} + \gamma X_{it-1} + \mu_i + \eta_t + \varepsilon_{i,t},$$

where *Performance* is measured by the profit rate (*Profitability*) and the return on assets (*ROA*). The other variables are defined as before. The results are presented in the table below. The coefficients on *Innovation* are significantly positive, consistent with prior studies: innovation improves a firm's future

performance. Importantly, the coefficients on the interaction terms are also positive, which is consistent with our hypothesis that a loss of political connections reinforces the transformative ability of innovation into corporate profitability.

TABLE E1
EFFECTS OF POLITICAL CONNECTIONS ON TRANSFORMABILITY
OF INNOVATION INTO PROFITABILITY

	Profitability (1)	ROA (2)
$Innovation_{i,t-1}$.0051*** (.0016)	.0020* (.0012)
$Polcon\ loss_{i,t-1} \times Innovation_{i,t-1}$.0073* (.0042)	.0063** (.0031)
$Polcon\ loss_{i,t-1}$	-.0341*** (.0119)	-.0185* (.0111)
Control variables	Yes	Yes
Firm fixed effects	Yes	Yes
Time fixed effects	Yes	Yes
Observations	7,283	7,283

Note. Control variables include *Size*, *Leverage*, *Age*, *Cash*, *ROA*, *TobinQ*, *Duality*, *CEO shareholding*, and *ID ratio* (lagged by 1 period). We do not report the coefficients on the control variables for brevity. Robust standard errors clustered at the firm level are shown in parentheses.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

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