The Political Economy of Innovation in China

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Abstract

Firms in emerging economies like China must innovate to switch from copying products invented in advanced economies to creating innovative products themselves. But innovation is impeded when formal political-economic institutions are weak, as is common in emerging economies. To overcome weak formal institutions and foster innovation, some scholars argue that firms can use political connections. Other scholars argue instead that political connections impede, rather than foster, innovation. To test these opposing arguments, we focus on a common form of political connection: having former state officials serve as CEO or Chairman, the most powerful corporate positions. In addition to testing the main hypotheses, we assess two important regional contingencies: the strength of market development and rule of law. And we probe two causal mechanisms: the amount and effectiveness of R&D spending. Analysis of panel data on listed firms in China reveals that political connections impede innovation, especially when market institutions are well developed, due to ineffective R&D spending. But political connections do not affect how much firms spend on R&D. These findings indicate that it is politically connected executives' lack of experience with innovation, rather than any tendency to avoid investing in R&D, that hampers innovation.

Innovation keeps firms competitive by improving their capacity to serve existing customers and attract new ones. Innovation is also a critical driver of national economic growth (Solow, 1957), especially as countries move from growth via capital accumulation and imitation to producing at the technological frontier, as is happening in China. Although China's growth has been phenomenal, averaging 8.7 percent per year from 1980 to 2015, it has slowed since 2008 due to rising domestic wage rates, shrinking working-age cohorts, and the global economic slowdown that followed the financial crisis (Wei, Xie, and Zhang, 2017). For its economy to continue to grow and for China to escape the "middle-income trap" (Gill and Kharas, 2007), Chinese firms must switch from simply copying products invented by companies in advanced economies to creating innovative, and thus higher-value, products themselves. There is some evidence that this is starting to happen: by 2014, China's spending on research and development (R&D) exceeded the OECD mean, and by 2011, China had the third-highest patent filing rate in the world, net of population size and national income level, putting it behind only the United States and Japan (Wei et al., 2017).

There are two very different views on innovation in emerging economies. First, the innovation efforts of firms in any nation may be impeded when that nation's *formal political-economic institutions* are not well developed (North, 1990; Acemoglu and Robinson, 2012; Walder, Isaacson, and Lu, 2015). Especially in autocratic regimes, the legal system is not independent of the state (Ginsburg and Moustafa, 2008). This is true in China. The Communist Party controls the state bureaucracy and the legal system. Because of the Party's collectivist legacy, laws concerning property rights, contracts, and competition have been slow to develop. Moreover, the judiciary is not independent of the Party, so the laws that have been passed have not been enforced impartially or transparently (Clarke, Murrell, and Whiting, 2008; McGregor, 2012). The weakness of these formal institutions may impair Chinese firms' ability to profit from their innovations, and so deter innovation.

Second, *informal institutions* – most importantly, governance of reputation through social relations – may foster economic growth through innovation, even when formal institutions are weak (Zucker, 1986; Allen, Qian, and Qian, 2005; Nee and Opper, 2012; Marquis and Raynard, 2015). Social relations engender trust and cooperation among economic actors, thereby increasing the perceived benefits of economic exchange and reducing the perceived costs (Granovetter, 1985; Zucker, 1986). Social relations also facilitate securing favors from powerful state authorities (Hillman, 2005). Although they are important in all societies, social relations are especially important in China (Fei, 1948 [1992]; Xin and Pearce, 1996; N. Lin, 2001). This means that they may be particularly powerful informal institutions in this country, excellent substitutes for weak formal institutions or bases for favor-seeking, so they may have especially strong effects on economic growth in general and innovation in particular.

One common form of social relation in emerging economies consists of ties between firms and state bureaucrats. These political connections may foster innovation when formal institutions are weak, for two reasons. First, political connections improve legal oversight and reduce the likelihood of piracy or unlicensed imitation by other firms, so they increase the economic attractiveness of innovation. Second, political connections offer firms insights into how things get done in state agencies, based on the knowledge that executives developed from working as bureaucrats (Haveman, Jia, Shi, and Wang, 2017). Therefore, they make it easier for firms to get patent applications granted, which may stimulate innovation efforts. Finally, political connections are especially important in China because state authorities have great power over the economy, not only because they issue business permits and levy fines and fees, but also because they control access to land and bank loans, they own stakes in many firms, and there is no way to vote state officials out of office (Shi, Markóczy, and Stan, 2014; Haveman et al., 2017).

But politically connected firms have a number of weaknesses that may outweigh these strengths. Politically connected executives may generate profits by seeking favorable regulatory or bureaucratic treatment (Xin and Pearce, 1996; Hillman, 2005), rather than by innovating and improving product quality. Additionally, politically connected executives have little experience with innovation, having worked as state bureaucrats, so they lack industry-specific experience (Fisman and Wang, 2015). So even if they pursue R&D, politically connected executives may be less likely than politically unconnected executives to direct funds efficiently, which will lead to worse innovation outcomes. Finally, politically connected executives may want to maintain the status quo, rather than shaking things up by pursuing innovation.

In sum, it is unclear whether political connections, on net, will foster or stifle innovation. To test these opposing arguments, we study a commonplace form of political connection: having former state bureaucrats serve as the CEO or Chairman of the board of directors, the two most powerful corporate positions; such connections literally embed the state in the top of the corporate hierarchy. We study China because economic reform over the past four decades – the replacement of the planned economy by market exchange, the efflorescence of small enterprises in rural areas, the rise of private firms in urban areas, and the breakup of "China Inc." into state-owned enterprises and their conversion into publicly traded corporations – has lifted the country into the middle-income ranks, which has made innovation to create higher-value products more important. We focus on Chinese listed firms, which are some of the biggest and most powerful in that country, from 1992, the year after the domestic stock markets were established, to 2010, the last year data on innovation are available to us. We use patents as indicators of innovation because they are objective, unambiguously measurable, and comparable over time (Griliches, 1990). We also assess two regional contingencies: levels of market development and strength of the rule of law. Finally, we probe two causal mechanisms: how much firms spend on R&D and the effectiveness of their R&D spending.

Theory

Innovation is essential for emerging economies that seek to escape the "middle-income trap" (Gill and Kharas, 2007). Countries rise from low-income to middle-income status by fostering the development of low-cost manufacturing facilities whose products are exported to wealthier nations. Such developments will raise standards of living and therefore will raise wage rates. Eventually, however, rising wage rates make manufactured products more expensive and less globally competitive, which depresses economic growth and traps countries in the middle-income ranks. One way to break out of this trap is to shift from low-value manufacturing to producing more innovative, and thus higher-value, products.

Below, we investigate how connections between state authorities and firms affect innovation in middle-income countries.[1] We begin by reviewing arguments for both positive and negative effects of political connections on innovation. We then consider regional variation in the development of formal institutions, such as the rule of law, which may moderate the effects of political connections. Finally, we assess mechanisms to clarify causality.

The benefits of political connections

In emerging economies, political connections may be used to fill in the gaps created by weak formal institutions (Allen et al., 2005; Nee and Opper, 2012; Marquis and Raynard, 2015). Political connections, like all social relations, can engender trust and cooperation between actors, which facilitates cooperation and forestalls bad behavior, thereby increasing the perceived benefits of economic activity and lowering the perceived costs (Granovetter, 1985; Zucker, 1986; Nee and Opper, 2012). If so, political connections may bolster innovation, for two reasons. First, political connections reduce the likelihood of firms' inventions being pirated or imitated without license by other firms, because political connections help improve legal oversight in favor of connected parties (Parish and Michelson, 1996; Guseva and Róna-Tas, 2001; Hillman, 2005). Political connections build trust between state authorities and firms, which makes it easier for firms to get states to enforce whatever laws and regulations exist, including ones that protect firms' intellectual and material property rights (Guseva and Róna-Tas, 2001; Qian, 2008; Haveman et al., 2017). Political connections can also complement whatever laws do exist, by making it easier for firms to influence state authorities to apply those laws in firms' favor (Hillman, 2005; Marquis and Raynard, 2015). There is ample evidence

[1] Note that our arguments do not apply to emerging economies that have not made investments in manufacturing capacity that have elevated them from the low-income ranks into the middle-income ranks.

that this happens in China. For example, politically connected Chinese lawyers more easily avoided harassment by state authorities than their politically unconnected counterparts (Michelson, 2007); politically connected Chinese firms used courts to settle disputes more than similar unconnected firms because political connections provided a pathway to influence the adjudication process (Ang and Jia, 2014); politically connected Chinese firms had less trouble with related-party loans, which often are used to tunnel assets out of firms, than similar unconnected firms (Haveman et al., 2017); and politically connected Chinese firms developed more new products than similar unconnected firms (Zhang, Jiang, Wu, and Li, 2018). By improving legal oversight and ensuring that formal legal processes favor politically connected firms, political connections reduce pirating and unlicensed imitation by other firms, increasing the economic attractiveness of innovating and therefore the likelihood of expending resources on innovation.

Second, political connections increase the likelihood that firms' patent applications will be granted, by providing insights into how things get done in state agencies based on the knowledge that executives developed from working as bureaucrats (Haveman et al., 2017). Such knowledge makes it easier for firms to "check all the boxes" that are necessary to get bureaucrats to approve patent applications. Improving the likelihood of getting patents approved will, in turn, stimulate innovation efforts.

Together, these two lines of argument lead us to predict:

> **Hypothesis 1**: Compared to politically unconnected firms, politically connected firms will (a) apply for more patents and (b) be granted more patents.

The costs of political connections

But political connections may hamper, rather than foster, innovation. There are three primary reasons. First, politically connected executives have less experience with innovation than unconnected executives, so they will be less skilled at managing R&D and innovation (Fisman and Wang, 2015). Politically connected executives previously worked as state bureaucrats, where the focus is on maintaining control of the political-economic system, while unconnected executives worked in firms that may be more likely to prize innovation.[2] Field interviews by accounting researchers support this expectation: "Former government officials think like government officials even after they join boards of directors….They tend to approach questions from a macro-economic perspective…" (Du, Tang, and Young, 2012: 1561). Such differences in experience may also underlie the second reason why political connections may hamper innovation: politically connected executives may prefer to enjoy the "quiet life" (Bertrand and Mullainathan, 2003) because their work in the government was generally routine. If so, politically connected executives will seek to maintain the status quo at the firms they join, rather than shake things up by actively pursuing innovation. As a result, they may allocate less money to R&D than politically unconnected executives, which will hamper innovation in politically connected firms. Finally, politically connected firms may focus their efforts on capturing "influence rents" (Ahuja and Yayavaram, 2011) by seeking favors from bureaucrats, rather than by innovating and improving product quality (Xin and Pearce, 1996; Hillman, 2005; for reviews, see Marquis and Raynard [2015]; Fisman and Golden [2017]). Therefore we predict:

> **Hypothesis 2**: Compared to politically unconnected firms, politically connected firms will (a) apply for fewer patents and (b) be granted fewer patents.

Contingencies: Rule of law and market development

Within emerging economies, development efforts are often uneven, proceeding at different paces in different regions, especially in countries with large landmasses, such as India, Brazil, and China (Williamson, 1965; Zhang and Zhang, 2003). In China, economic reforms have occurred through "decentralized experimentation." The central government conducted trial reforms in a few regions, and different regions developed distinctive forms of market

[2] While in many countries, the state sector is seen as less of a driver of innovation than the private sector, this may be especially the case for the China, where the state tends to emphasize the preservation of a "harmonious society" above all. See, for example, the well-known 2005 speech of Hu Jintao (Hu, 2005).

institutions (Naughton, 2007; Brandt and Rawski, 2008). Economic reform generally began earlier in coastal provinces than inland provinces. This heterogeneity in the timing of economic reform means that we must consider variation in the development of market institutions across provinces, not just the "average" development of market institutions in the nation as a whole. Accordingly, rather than focus on a single nation-wide political economy, here we attend to different regional political *economies*.

Innovation is enhanced when the rule of law is strong; i.e., when the legal system constrains the power of the government so that laws concerning property rights, contracts, and competition are clear and enforced impartially (North, 1990; Acemoglu and Robinson, 2012; Walder, Isaacson, and Lu, 2015). The stronger the rule of law, the less uncertainty firms face about whether they can profit from their innovation efforts (for example, about whether the law will protect them from patent infringement), and the more firms are motivated to innovate. Previous research has shown that this argument holds for Chinese firms: they are more likely to innovate when they are located in regions with stronger protection for intellectual-property rights (Fang, Lerner, and Wu, 2016). Moreover, in transition economies, the stronger the rule of law, the easier it is for market exchange to develop. The decline of central planning and the development of formal institutions that support market exchange increases competition, which in turn may motivate firms to innovate so they can best their rivals (Aghion et al., 2005). In sum, then, extant theory clearly predicts that firms innovate more when and where the rule of law is stronger and markets are better developed.

The question remains, though, as to how regional variations in the rule of law and market development might alter the impact of political connections on innovation. Above, we offered two opposing arguments about how political connections affect innovation; here, we consider the insights each argument offers into contingencies due to regional variation. First, if political connections are substitutes for formal (market-supporting) institutions, such as the rule of law, then political connections will become less valuable as the rule of law strengthens and markets develop. Such changes will reduce the need for politically connected executives to prevent pirating of innovations, level the playing field in terms of access to funding to support innovation efforts, and reduce politically connected executives' relative ability to ensure that their firms' patent applications are granted. For these reasons, any *positive* effect of political connections on innovation will be *reduced* as the rule of law strengthens and markets develop.

Second, as the rule of law strengthens and the market-based economy becomes more vibrant, jobs in the private sector will become increasingly attractive relative to jobs in the government sector, so the former will increasingly attract better talent. Cross-sectional research supports the expectation that state bureaucrats' skills and abilities are of lower quality when market-supporting institutions are more developed: the wage premium for working in the government sector is lower for high-income countries (with strong market-based economies) than for low-income countries (with weak market-supporting institutions), even after accounting for employee age, gender, education, and occupation (Finan, Olken, and Pande, 2015). Therefore, we expect that as the rule of law strengthens and markets develop, politically connected firms (overseen by increasingly less-capable executives) will do increasingly poorly at innovation, compared with politically unconnected firms (overseen by increasingly more-capable executives). In sum, any *negative* effect of political connections on innovation will become *stronger* as the rule of law strengthens and markets develop.

Taking into consideration both the weaker positive and stronger negative effects of political connections leads us to predict:

> **Hypothesis 3**: The effect of political connections on patenting will become more negative as the rule of law strengthens and markets develop.

Causal Mechanism: Political Connections Reduce the Effectiveness of R&D Spending

As explained above, according to the definition we employ, politically connected executives previously worked as state bureaucrats, where the overarching goal is to maintain social stability and to control the political-economic system. In contrast, unconnected executives worked in firms, which are more likely than state bureaus to prize innovation. Thus, politically connected executives have less experience in settings that value and invest in innovation than politically unconnected executives and as a result, politically connected firms may spend less on R&D than politically unconnected firms. Politically connected executives have less experience with innovation, which makes them less skilled at managing innovation. Therefore, whatever effort politically connected firms put into innovation will be less successful than effort expended by politically unconnected firms. This leads us to predict:

> **Hypothesis 4**: Politically connected firms will spend less on R&D than politically unconnected firms.

> **Hypothesis 5**: R&D spending by politically connected firms is less likely to generate patents than comparable R&D spending by politically unconnected firms.

Research Design

We study firms whose stocks are publicly traded in China. In China, these big firms dominate many industries, so it is substantively important to understand their behavior (Haveman et al., 2017). In addition, much more information is available on them, which makes it easier to conduct high-quality empirical research. Our analysis begins in 1992, the year after the domestic stock markets were established. It ends in 2010, the last year for which we have access to data on firms' patenting activity. Over this 19-year period, the number firms listed on domestic exchanges increased from 26 to 1,750. After we drop observations for which data are missing on one or more variables (mostly new firms), we have 15,692 annual records on these firms to analyze.

Listed firms had to secure approval from the central state in order to be traded on the domestic stock exchanges (Zheng, 2013). Therefore, all were politically connected to some extent. This should reduce our ability to discern any impact of the specific form of political connection we study, which is incremental to the level of connectedness shared by all listed firms. This means that our analyses are conservative tests of our arguments as applied to the universe of Chinese firms.

Data sources and measures

Explanatory variable: political connections. We retrieved resumes for each listed firm's Chief Executive Officer (CEO) and Chairman from the website of Sina (finance.sina.com.cn) each year. We reviewed each resume to determine whether the CEO or Chairman had served as a bureaucrat and if so, at what level in the official government hierarchy. Following previous research (Haveman et al., 2017), we defined *political connection* as a binary indicator variable set to one in years when the focal firm's CEO or Chairman (or both) had served as the chief officer or deputy chief officer at the division [*chu*] level or above, and zero otherwise.[3] This threshold is often used in studies of Chinese bureaucrats (e.g., Zhou, 2000; Walder, 2004; Haveman, et al., 2017) because it captures the political elite – bureaucrats whose positions are funded by the central state. Moreover, almost all bureaucrats at and above this threshold are members of the Communist Party of China, so they are connected to the political party as well as the state bureaucracy.

To code political connections, we hired five research assistants at a university in Jiangxi Province and five at a university in Beijing. Each group of students worked separately and followed the same detailed instructions. We compared codes generated by the two groups of students. Together with the fourth author, the groups resolved the few inconsistencies in coding, which constituted less than 4 percent of observations.

Outcome variables: patents. Data on patents came from the Chinese Patent Data Project, which matched data from the Chinese State Intellectual Property Office to data on listed firms from Wind Information, a company that gathers financial data on Chinese firms for industry and academic research, supplemented by cross-checking with many listed firms' annual reports (for details, see He et al. [2013, 2016]). This agency grants three types of patents: invention, utility model (similar to the German *Gebrauchsmuster*), and design. An

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[3] We also looked at how political connections through lower-level executives and directors affected patenting. We found no relationship for these types of political connections, which indicates that the effect of political connections on innovation stems from the highest levels of corporate leadership.

invention patent is defined as a new technical improvement to a product or process, a *utility-model patent* is a new technical solution that improves the shape and/or structure of an industrial product, and a *design patent* is a new aesthetic plan for the shape, pattern, and/or color of an industrial product (He et al., 2013). We counted patent applications across all three categories. Utility-model and design patents are almost always granted as soon as firms register them, while invention patents are examined for originality and applicability, so innovation patents represent more novel and plausibly more important innovations. Therefore, we also created a count of innovation patents granted. Finally, we created a count of invention patents for which firms paid renewal fees, which captures invention patents that ended up having substantial economic value.

Contingencies: market development and the rule of law. We created several variables to capture institutional differences across regions, based on the province where the focal firm was headquartered. Specifically, we used indexes created by researchers at China's National Economic Research Institute (Fan, Wang, and Zhu, 2011) that reflect the development of legal institutions and markets at the provincial level. These indexes have been used widely in research on China's political economy (e.g., Zhang and Keister, 2016; Zhou, Gao, and Zhang, 2017). They were first created in 1997 and have been updated annually. For years before 1997, we used the 1997 values, which is reasonable, given the slow rate of change in these indexes. These measures were missing for a tiny fraction of the sample, for firms located in Tibet (21 of 15,692 observations).

We use indexes capturing the three dimensions of the development of the rule of law and market institutions that are most relevant to innovation. *Legal environment* is based on the proportion of professionals (lawyers and accountants) in the population, the number of trademark violations scaled by GDP, and the number of consumer complaints scaled by GDP. *Government intervention* in the economy is composed of five items: the proportion of economic resources allocated through markets (rather than state transfers), provincial government revenues as a percentage of GDP, the taxation burden imposed on farmers (to help capture off-budget tax revenues), and survey data on how much time and money businesspeople must spend dealing with the government. *Non-state sector investment* is the percentage of GDP produced by non-state-owned firms, plus the percentage of capital investment made by non-state-owned firms, and the percentage of urban employment in non-state-owned firms. We reverse-coded government intervention to create the variable *less government intervention* so that for all three indexes, higher values indicate more market development or stronger rule of law.

Causal mechanisms: the level and effectiveness of R&D spending. We gathered data on R&D expenditures from the Guo Tai An Information Technology Company, which gathers data for industry and academic research. We used this organization's China Stock Market Trading Database. We calculated the R&D ratio as R&D spending[4] scaled by total sales, which creates a measure that is easy to compare across firms operating on different scales. Because Chinese listed firms did not have to report R&D spending until 2006, this part of our analysis is limited to the period 2006-2010, and effect estimates are therefore less precise than for our main analysis.

Control variables. We used data from Guo Tai An and Wind to control for several firm characteristics that previous research has found is related to innovation: *firm size* in terms of total assets (logged to normalize the distribution); *market value* with Tobin's Q, measured as the ratio of the total market value of equity and the total book value of liabilities to the total book value of the firm; *performance* with net return on assets (ROA); and the ratio of long-term debt to assets (*debt ratio*). We also controlled for *state ownership*, measured as the percentage of shares owned by government agencies.

[4] According to Chinese accounting rules (Chinese Ministry of Finance, 2006), R&D spending includes compensation and benefits paid to R&D staff; expenditures on fixed assets used in R&D; amortization on materials, software, and technology used in R&D; costs of conducting experiments; costs of outsourcing R&D effort; and miscellaneous R&D expenses (e.g., travel to conferences, books, and training expenses).

Model specification and estimation

For the main dependent variables, patent applications and patents granted, we estimated ordinary-least-squares (OLS) regression models of the logged number of patents. (To ensure real values, we added one before taking the log.) We assessed the robustness of our estimates by estimating Poisson regression models of the number of patents. (In other robustness checks, we estimated negative-binomial models. Both event-count specifications yielded similar results, so we show only the Poisson regression results here.) To account for the non-independence of observations across years for each firm, we estimated robust standard errors for all models, clustered by firm. For R&D spending, we also estimated OLS regressions, with robust standard errors for all models, clustered by firm.

Results

We begin by showing the main patterns in our data, to motivate our multivariate analyses. Figure 1 shows the cross-sectional relationship between the fraction of firms in an industry that had politically connected CEOs or chairmen and industry-level average rates of patenting, as measured by the industry mean of log(1 + patents). In this figure, the size of each circle reflects the number of firm-year observations in each industry. Overall, there is a moderate negative correlation: more innovation-intensive industries tended to employ fewer politically connected CEOs (the raw pairwise correlation is -0.42; adjusted by industry size, the correlation is -0.51). This indicates that firms in industries that valued innovation tended not to have politically connected leaders. This finding is preliminary, since it does not control for other firm or industry attributes, nor does it allow us to take any stand on causation.

[Figure 1 about here]

Figure 2 divides industries into quartiles based on the amount of resources they devote to innovation, as reflected in their industry-level R&D expenditures. Each pair of histograms reflects the average rate of log(1 + patents) for politically connected versus politically unconnected firms. The graph shows that, across all industry-level quartiles of R&D

intensiveness, politically connected firms patented at lower rates than politically unconnected firms. The effect is more pronounced in the top two quartiles, which suggests that, particularly in more R&D-intensive industries, politically connected leadership was associated with lower R&D productivity. In the results presented below, we show that these patterns persist after accounting for a wide range of controls.

[Figure 2 about here]

Before proceeding to the multivariate analyses, Table 1 shows univariate statistics and correlations. Politically connected firms have lower rates of patenting and patent approval (r=[-0.0214, -0.0694]). But the political connection dummy is also correlated with several firm attributes, notably size (assets, r=0.0918) and state ownership (r=-0.0892). It is therefore critical to control for these attributes in the analyses that follow.

[Table 1 about here]

Patent applications and patents granted. Table 2 shows multivariate models that test our core hypotheses. Models 1 to 3 analyze the (logged) number of patent applications summing across all three categories (design, utility, and invention); model 4, the number of invention patents granted; and model 5, the number of invention patents for which firms paid renewal fees. As explained above, the second and third outcome variables capture higher and higher thresholds for innovation quality. Model 1 is a baseline model containing all control variables and industry fixed effects (at the 2-digit Chinese Standard Industrial Classification level). As expected, larger firms, those with higher market values, and those with better overall performance (in terms of ROA) applied for more patents. Moreover, state-owned firms and firms with more long-term debt applied for fewer patents. Model 2 adds the indicator variable for political connection. The negative effect of political connection (significant at the 1 percent level) supports hypothesis 2 and fails to support hypothesis 1. The effect is substantial: compared to otherwise similar politically unconnected firms, politically connected firms apply for 10 percent fewer patents (exp[-0.106] – 1 = -0.100). To investigate within-firm dynamics, model 3 replaces industry fixed effects with firm fixed effects. The coefficient on political connection remains statistically significant, although it is slightly diminished (exp[-0.083] – 1 = -0.080), indicating an 8 percent decline when firms become politically connected. This bolsters our conclusion that political connection reduces patent applications. Note that the negative coefficient on state ownership becomes non-significant after we include firm fixed effects, indicating that the negative association between state ownership and patent applications is mainly driven by cross-sectional differences between state-owned and non-state-owned firms. By contrast, the robustness of the impact of political connection to the inclusion of firm fixed effects indicates that, *for a given firm*, patent applications are lower in the presence of a politically connected CEO or chairman.

[Table 2 about here]

In model 4, the dependent variable is limited to invention patents granted, a measure of innovation that incorporates quality considerations. We observe a smaller and only marginally significant ($p<.06$) effect of political connection. In model 5, the dependent variable is further limited to invention patents granted and renewed (upon payment of a fee), an even stricter quality standard. It shows a negative and statistically significant effect of political connection. As firms become politically connected, they have 4.1 percent fewer invention patents granted that they bother to renew (exp[-.042] – 1 = -0.041). In sum, these stricter tests bolster support for hypothesis 2. They indicate that firms' political connections are not substitutes for weak formal institutions, but rather evidence of former bureaucrats' lack of experience with and interest in innovation or their focus on extracting profits by seeking favorable regulatory or bureaucratic treatment.

In Table 3, we show event-count models using Poisson regressions as a robustness check on model specification. (Negative-binomial regressions yield almost-identical results, so we do not show them here.) In model 1, the dependent variable is patent applications; in model 2, invention patents granted; in model 3, invention patents renewed. All models include firm fixed effects. The number of observations varies across models because the Poisson model with firm fixed effects cannot accommodate firms for which the outcome variable is zero in all years (e.g., in model 1, they did not file any patent applications during our observation period), so such firms were dropped from the analysis. Model 1 shows similar results to those shown in model 3 of Table 2: among the control variables, only state ownership has no significant effect on patent applications, and the effect on political connection is again negative and statistically significant. The magnitude of this effect is similar to that found using a linear regression: compared to otherwise similar politically unconnected firms, politically connected firms are granted 10.3 percent fewer invention patents (exp[-0.109] – 1 = -0.103). Model 2 narrows the dependent variable to invention patents granted. It shows an even stronger effect of political connection than in Table 2: compared to otherwise similar politically unconnected firms, politically connected firms are granted 16.9 percent fewer invention patents (exp[-0.185] – 1 = -0.169). Model 3 narrows the dependent variable even further, to invention patents that firms paid to renew. It shows a marginally significant ($p<0.08$) negative effect of political connection: compared to otherwise similar politically unconnected firms, politically connected firms renew 11.1 percent fewer invention patents (exp[-0.118] – 1 = -0.111).

Contingencies: Rule of law and market development. Table 4 presents tests of hypothesis 3, which predicts that political connections will have more negative effects when and where formal institutions are stronger – i.e., the rule of law is stronger and markets are better developed. These models include firm fixed effects and year fixed effects, which capture changes in innovative activity when firms become politically connected. The three measures of formal institutions are moderately highly correlated (average $r = 0.718$), so we estimate their effects individually, in three pairs of models. In each pair of models, the first includes an index of formal institutions; the second adds an interaction with the political connections indicator. For all indexes, higher values indicate stronger formal institutions.

Models 1, 3, and 5 show that all three indexes of the strength of formal institutions – a stronger legal environment, less government intervention, and more non-state-sector investment – have positive associations with innovation, consistent with prior research (e.g., Fang et al., 2016). Models 2, 4, and 6 show mixed results. Although all three interactions are negative, as expected, the interaction with a stronger legal environment is non-significant, the interaction with less government intervention is statistically significant, and the interaction with more non-state-sector investment is marginally significant ($p<.07$). Thus, these models provide some, but not complete, support for hypothesis 3.

The statistically significant effects are sizeable in magnitude. When the index for less government intervention is at its mean, firms that become politically connected see their patent application rate drop by 8.4 percent ($\exp[0.026\times5.705] - \exp[0.044 + (0.026-0.023)\times5.705]) / \exp[0.026\times5.705] = 0.084$). But when that index is one standard deviation above its mean, firms that become politically connected see their patent application rate drop by 14.4 percent ($\exp[0.026\times(5.705+2.958)] - \exp[0.044 + (0.026-0.023)\times(5.705+2.958)]) / \exp[0.026\times(5.705+2.958)] = 0.144$). Similarly, when the index for non-state-sector investment is at its mean, firms that become politically connected see their patent application rate drop by 15.8 percent ($\exp[0.053\times7.414] - \exp[0.065 + [0.053-0.032]\times7.414) / \exp[0.053\times7.414] = 0.158$). But when that index is one standard deviation above its mean, firms that become politically connected see their patent application rate drop by 25.8 percent ($\exp[0.053\times(7.414+3.264)] - \exp[0.065 + (0.053-0.032)\times(7.414+3.264)] / (\exp[0.053\times(7.414+3.264)] = 0.258$). Thus, for two measures, the effect of political connections is more negative in provinces where market development is more advanced. This supports our expectation that the development of market-supporting institutions attenuates the positive effects of political connections and amplifies the negative effects.

Mechanisms: Political connections reduce R&D spending and R&D effectiveness. Table 5 analyzes how firms' political connections affect R&D spending, to test hypothesis 4. Table 6 analyzes how R&D spending affects patenting activity, to test hypothesis 5. Because Chinese listed firms did not report R&D expenditures until 2006, these analyses are limited to the period 2006-2010, and the number of observations is less than half of the full temporal sample. In Table 5, where the dependent variable is the ratio of R&D spending to total sales, there are only 7,393 firm-year observations 2006-2010, compared with 15,692 observations 1992-2010. In

Table 6, where R&D spending is the explanatory variable, we restrict the analysis to firms that invested in R&D and drop those that did not, leaving 1,643 observations. (When we included firms with zero R&D spending, the results were very similar to those shown here.)

[Tables 5 and 6 about here]

In Table 5, model 1 shows a negative and non-significant coefficient for political connection. Model 2 substitutes firm fixed effects for industry fixed effects, to see if there is any within-firm impact of becoming politically connected. Again, it shows a negative and non-significant coefficient for political connection. These results fail to support hypothesis 4; instead, they indicate that politically connected executives do not spend any less (or any more) on R&D than politically unconnected executives.

In Table 6, models 1 to 3 show the analysis of the (logged) number of patent applications summed across all three classes, models 4 and 5 show the analysis of the (logged) number of invention patents received, and models 6 and 7 show the analysis of the (logged) number of invention patents renewed. Model 1 shows a baseline model, identical to that of model 2 in Table 2, except for the addition of the R&D spending ratio. The effect of political connection is negative, as before, but it is now non-significant, while the effect of R&D spending is positive, as expected, but non-significant. Model 2 adds an interaction between R&D spending and the political connection dummy. It shows a significant negative effect on the political connection dummy, as well as a significant positive effect on the constrained main effect of the R&D spending ratio. This pattern of results indicates that, on average, R&D spending *increases* patent applications for politically unconnected firms by 4.4 percent ($(\exp[5.336\times0.008] - 1) = 0.044$), but, on average, R&D spending *reduces* patent applications by 0.8 percent for politically connected firms ($(\exp[(5.336\text{-}6.358)\times0.008] - 1) = \text{-}0.008$). This pattern of results supports hypothesis 5. Model 3 substitutes firm fixed effects for industry fixed effects, to assess whether this pattern holds within firms. It does not: while the constrained main effect of the R&D spending ratio remains positive and the interaction remains negative, neither is statistically significant. This indicates that the results in model 2 are due to between-firm differences, rather than within-firm changes in R&D effectiveness after politically connected executives arrive.

Model 4, which analyzes the (logged) number of invention patents granted, shows similar results to those of model 2: a positive and significant constrained main effect of the R&D spending ratio, and a negative and significant interaction with the political connection dummy. On average, R&D spending increases invention patents granted to politically unconnected firms by 2.7 percent ($(\exp[3.382\times0.008] - 1) = 0.027$), but decreases patents granted to politically connected firms by 0.5 percent ($(\exp[(3.382-3.967)\times0.008] - 1) = -0.005$). Model 5 substitutes firm fixed effects for industry fixed effects, again to probe within-firm dynamics. Here, the constrained main effect of the R&D spending ratio is positive and significant, while the interaction is positive and non-significant. This suggests that firms' R&D expenditures are more effective before they become politically connected than afterward. Finally, model 6 and 7 analyze the (logged) number of invention patents that firms paid to renew, and show almost identical results to those in models 4 and 5. Taken together, these results offer further support for hypothesis 6.

Tables 5 and 6 show a non-significant effect of political connection on the level of R&D spending (Table 5) and a significant negative effect of political connection on the effectiveness of R&D spending, in terms of generating patents (Table 6). Together, these findings indicate that politically connected executives do not fund innovation efforts less than politically unconnected executives, but politically connected executives' firms are less like to turn that funding into patents. This suggests that politically connected executives are less capable than politically unconnected executives, not less motivated to innovate, either because they prefer the status quo or they seek to generate profits by seeking favorable regulatory or bureaucratic treatment. These results are net of factors, such as firm size (assets), performance (in terms of ROA), market value (Tobin's Q), leverage, and state ownership, that affect the level or effectiveness of R&D spending, or both.

Robustness check. In figure 2, the negative relationship between firms' political connections and innovation appears to be stronger for firms in industries that are most likely to patent intellectual property. To explore whether this heterogeneity persists after controlling for other firm attributes, we split the sample by industry innovativeness at the median for industry patenting activity in each year. We thus constructed a dummy variable, high patenting industries, set to one if a firm was in an industry with above-median patent activities that year and zero otherwise. We focused on the main result from Table 2, shown in models 2 and 3 of that table. In Appendix Table A1, adding to each of those models the interaction between the high patenting industries dummy and the political connection dummy. The coefficient on this interaction is not statistically significant in either model, which indicates that our results hold across industry types.

As we observed in Table 1, politically connected firms differ from politically unconnected ones along multiple dimensions, raising the concern that it is these differences, rather than political connection, that drive our results. To address this concern, we used propensity-score matching (Rosenbaum and Rubin, 1983). We estimated a logistic regression predicting whether or not firms become politically connected using market value (Tobin's Q), size (assets), performance (ROA), state ownership, and the long-term debt ratio. Then, for each firm each year, we calculated its predicted probability of becoming politically connected (its propensity score). Next, we matched politically connected and politically unconnected firms, based on their propensity scores. Following previous research on Chinese listed firms' political connections (Haveman et al., 2017), we used nearest-neighbor matching without replacement, and a caliper of 0.25 standard deviations of the propensity score. About 60 percent of the full sample was dropped by the matching procedure, because we could not find good enough matches for them. Appendix Table A2 shows the results of this analysis. Again, it focuses on models 2 and 3 of Table 2. The results hold, largely unchanged, in this more balanced sample. In both models, the coefficients on political connections are negative and statistically significant, and of the same magnitude as in Table 2. Model 1 of Table A3, which contains industry fixed effects and year fixed effects, indicates that being politically connected reduces patent applications by 9.9 percent (exp[-0.104] – 1 = -0.099). Model 2 of Table A3, which contains both firm and year fixed effects, indicates that becoming politically connected reduces a firm's patent applications by 12.6 percent (exp[-0.135] – 1 = -0.126).

Alternative explanations. First, since we have observational, not experimental, data, it is possible that the results we find may be due to reverse causality: firms that struggled to innovate were more likely to appoint state officials as CEOs or chairmen, and they were more likely to do so as market-supporting institutions developed. If this were true, we would expect that the effect of firms' political connections on innovation would be stronger in state-owned than non-state-owned firms, because in state-owned firms, government officials have more power over top-level appointments. To examine this alternative explanation, we added an interaction between the political connection dummy and state ownership to models 2 and 3 of Table 2. These results are presented in Appendix Table A3. In both models, the coefficient on the interaction is nonsignificant. Moreover, in model 2, which contains firm fixed effects, the coefficient is very close to zero. Overall, these results are inconsistent with the most plausible interpretation of our main findings, namely that low levels of patenting prompts the formation of political connections.

Second, because we have observational data, our results may be spurious, driven by a confounding variable that is omitted from our analysis (an unobservable) and that influences both the likelihood of political connection and the rate of innovation. The most likely omitted confounder is something external to the population of listed firms, such as a dramatic change in government regulations or macro-economic conditions. But our models indicate that a relationship between political connection and patenting survives – and is largely invariant to – the inclusion of both industry and firm fixed effects, which absorb the effects of many unobservables. Although we cannot completely rule out omitted variable bias, the stability of our results when we perform more precise matching (as in the propensity score-models shown in Table A2) and focus on within-firm heterogeneity (in models that contain fixed firm effects) alleviates this concern considerably.

Discussion and Conclusion

There are two opposing lines of argument about the potential impact of political connections on innovation in emerging economies, where formal political-economic institutions are weak. First, political connections may foster innovation by improving legal oversight and reducing the likelihood that firms' innovations will be pirated by other firms, or by making it easier for firms to get patent applications granted (Parish and Michelson, 1996; Guseva and Róna-Tas, 2001; Hillman, 2005; Qian, 2008; Haveman et al., 2017). Second, political connections may hamper innovation by pushing firms to improve profits by seeking favors from bureaucrats rather than by innovating (Xin and Pearce, 1996; Hillman, 2005), or by reducing the effectiveness of firms' innovation efforts (Fisman and Wang, 2015). Our results show no support for the first argument, but partial support for the second argument (specifically, for the second part of that argument). Politically connected firms are clearly less innovative than politically unconnected firms: the former apply for fewer patents, are granted fewer invention patents, and are less likely to renew invention patents. Moreover, there is some evidence that the negative effect of political connections on innovation is more pronounced in regions where market-supporting institutions are better developed. But while politically connected firms do not spend less on R&D than politically unconnected firms, politically connected firms' R&D spending is less likely to yield results, in terms of patent applications, invention patents granted, and invention patents renewed.

Taken together, these results indicate that it is the quality of human capital in the top of firms' hierarchies – their CEOs and Chairmen – that explains why politically connected firms are less effective at innovating than politically unconnected firms. Politically connected executives and directors have little experience with innovation, having worked as state bureaucrats, so they lack industry-specific experience (Fisman and Wang, 2015). While politically connected firms pursue R&D at the same rate as their unconnected counterparts, politically connected executives and directors are less likely to direct funds efficiently, which leads to poor innovation outcomes. This conclusion is bolstered by findings that the effect of political connections becomes more negative as market-supporting institutions develop in different regions of China. As markets develop, jobs in the private sector, including in listed firms, will become increasingly attractive relative to jobs in the state sector, so the former will increasingly attract better talent.

These patterns hold across the full range of industry types, in terms of their level of innovation, suggesting that our findings hold quite broadly for Chinese businesses, rather than just those at the technological frontier. Furthermore, our findings are robust to the use of propensity-score matching to generate a balanced sample of politically connected and politically unconnected firms, as well as to the inclusion of firm fixed effects. Taken together, these findings indicate that our results are unlikely to be an artifact of a particular model specification or of unobserved macro-economic or regulatory changes that affect the rate of innovation and the likelihood of having politically a connected CEO or Chairman.

Given its prominence in the global economy and its rapidly expanding R&D efforts (Wei et al., 2017), China is a particularly important setting for studying the role that ties between the private sector and the state bureaucracy play in nurturing or impeding innovation. Our findings indicate that, as the country aims to grow its economy through innovation rather than imitation, it will need to reduce the role played by political connections. The current government's anti-corruption crackdown, which began with the Eighteenth National Congress of the Communist Party of China in November 2012 proclaiming the principle of the rule of law, may suggest that it is acting on such concerns, but analysis of more recent data, which are not yet available to researchers, will be needed to explore whether (and if so, how) the anti-corruption campaign has affected innovation. The 2012 declaration about the rule of law may also have resulted in a shift in attitudes toward property-rights law and contract law, as well as the behavior of firms and courts with regard to intellectual property rights. If so, it the central state would have levelled the playing field for politically connected and politically unconnected firms alike, which would dramatically alter the impact of political connections on innovation. But again, to investigate this possibility, we would need more recent data than are available to us.

Finally, this paper's findings may apply to many other emerging nations – those where (a) investment in manufacturing has succeeded at growing the economy, lifting the country into the middle-income ranks; but (b) the rule of law is weak and market-supporting institutions are not well developed; and (c) social ties between firms and state bureaucrats are common. Examples include Indonesia, Thailand, and Vietnam in Asia, Venezuela in South America, and Poland and Hungary in Europe. Indeed, given that extant theory suggested that the impact of political connections on innovation could plausibly be positive or negative, comparable analyses need to be conducted in other middle-income countries to better understand the extent to which the patterns we documented here hold more broadly.

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Figure 1: Industry-Level Association between Political Connections and Patenting

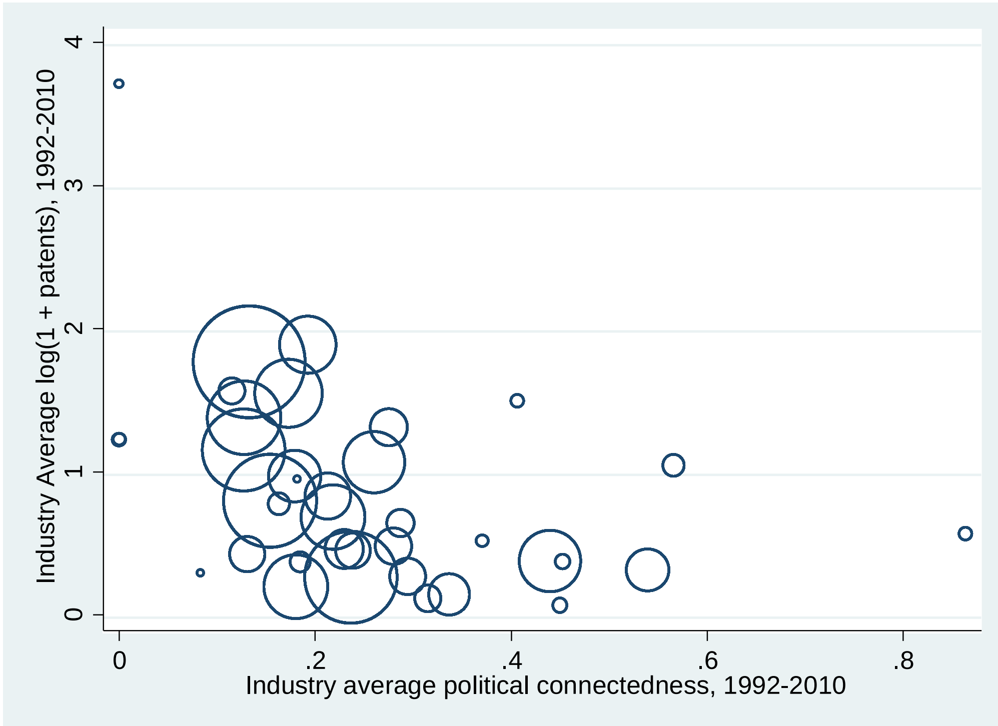

Figure 2: Patenting Activity by Politically Connected and Unconnected Firms by Industry-Level Quartile of R&D Activity

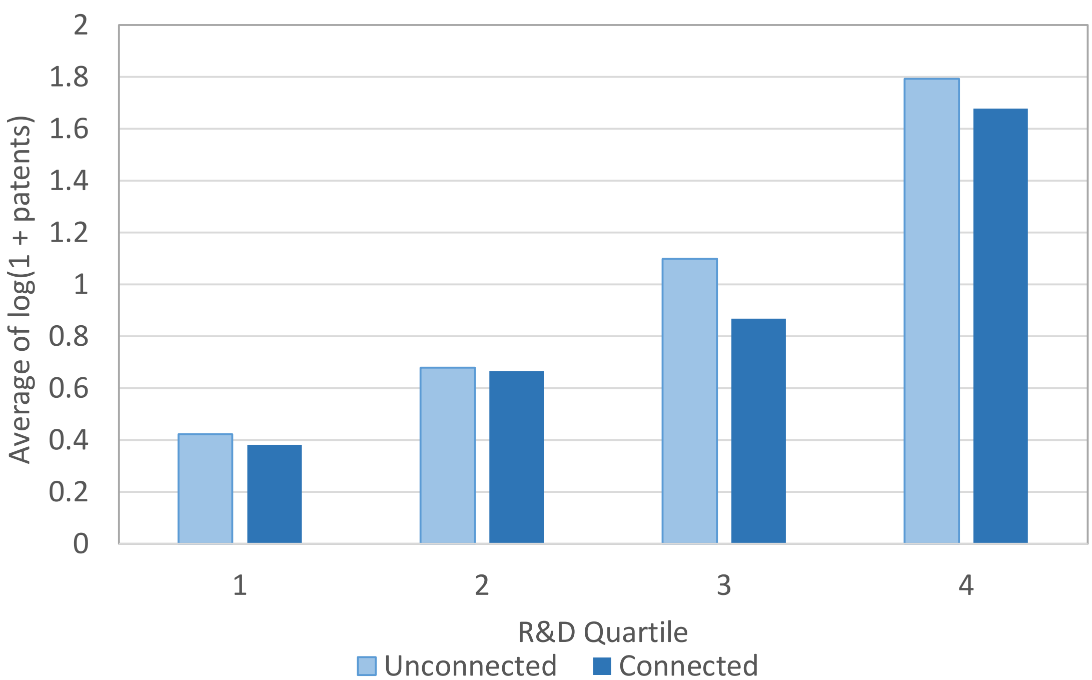

Table 1: Descriptive Statistics

		1	2	3	4	5	6	7	8
	Mean	0.939	0.284	0.258	10.122	1.037	0.974	0.008	21.114
	Standard Deviation	1.427	0.730	0.665	33.259	3.754	3.613	0.032	1.227
	Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.842
	Maximum	8.589	7.862	3.332	251.000	28.000	27.000	1.605	30.098
	N	16,364	16,364	16,364	16,364	16,364	16,364	7,638	17,516
1	Log(1 + all patent applications)	1							
2	Log(1 + invention patents granted)	0.6760*	1						
3	Log(1 + invention patents renewed)	0.6682*	0.9705*	1					
4	Number of All Patent Applications	0.7552*	0.5997*	0.5651*	1				
5	Number of Invention Patents Granted	0.5837*	0.9102*	0.8811*	0.6287*	1			
6	Number of Invention Patents Renewed	0.5774*	0.8982*	0.8890*	0.6264*	0.9903*	1		
7	R&D Expenses/Total Sales	0.1374*	0.0809*	0.0775*	0.1058*	0.0640*	0.0648*	1	
8	Assets (logged)	0.3641*	0.2828*	0.2758*	0.3311*	0.2598*	0.2605*	-0.0713*	1
9	Tobin's Q	-0.1079*	-0.1026*	-0.1066*	-0.0800*	-0.0814*	-0.0823*	0.1404*	-0.4315*
10	Performance (ROA)	0.0736*	0.0597*	0.0584*	0.0488*	0.0470*	0.0463*	0.1081*	0.1061*
11	Long-term Debt Ratio	-0.0302*	0.0019	-0.0031	-0.0101	0.0066	0.0074	-0.0652*	0.2957*
12	State Ownership	-0.0491*	0.0164*	0.0073	-0.0324*	0.0231*	0.0215*	-0.0892*	0.1553*
13	Political Connection (yes=1)	-0.0694*	-0.0281*	-0.0291*	-0.0448*	-0.0214*	-0.0218*	-0.0523*	0.0918*
14	Legal Environment	0.2956*	0.1756*	0.1908*	0.2463*	0.1527*	0.1591*	0.1100*	0.2576*
15	Less Government Intervention	0.1968*	0.1616*	0.1700*	0.1652*	0.1418*	0.1450*	0.0586*	0.1670*
16	Non-state Sector Investment	0.2884*	0.2024*	0.2219*	0.2013*	0.1632*	0.1714*	0.0878*	0.2421*

Notes: This table covers all listed firms in China from 1992 to 2010. * indicates $p<0.05$.

Table 1: Descriptive Statistics (continued)

		9	10	11	12	13	14	15	16
	Mean	2.442	0.029	0.051	0.301	0.208	6.460	5.705	7.414
	Standard Deviation	1.610	0.080	0.070	0.258	0.406	4.219	2.958	3.264
	Minimum	0.833	-0.401	0.000	0.000	0.000	0.000	-12.950	-1.930
	Maximum	10.164	0.202	0.235	0.775	1.000	19.890	12.670	13.730
	N	17,331	17,293	17,314	17,518	17,122	17,474	17,474	17474
1	Log(1 + all patent applications)								
2	Log(1 + invention patents granted)								
3	Log(1 + invention patents renewed)								
4	Number of All Patent Applications								
5	Number of Invention Patents Granted								
6	Number of Invention Patents Renewed								
7	R&D Expenses/Total Sales								
8	Assets (logged)								
9	Tobin's Q	1							
10	Performance (ROA)	0.0781*	1						
11	Long-term Debt Ratio	-0.1786*	-0.0228*	1					
12	State Ownership	-0.1217*	0.0531*	0.0840*	1				
13	Political Connection (yes=1)	-0.0222*	0.0034	0.0486*	0.1320*	1			
14	Legal Environment	-0.0076	0.0097	-0.0492*	-0.2178*	-0.0282*	1		
15	Less Government Intervention	0.0084	0.0212*	-0.0582*	-0.1644*	-0.0018	0.7464*	1	
16	Non-state Sector Investment	-0.0819*	-0.0081	-0.0301*	-0.2362*	-0.0561*	0.7332*	0.6738*	1

Notes: This table covers all listed firms in China from 1992 to 2010. * indicates $p<0.05$.

Table 2: OLS Regressions of Patent Applications and Invention Patents Granted

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Log(1 + all patent applications)			Log(1 + invention patents granted)	Log(1 + invention patents renewed)
Assets (logged)	0.519**	0.521**	0.389**	0.136**	0.132***
	(0.033)	(0.033)	(0.038)	(0.019)	(0.018)
Market Value (Tobin's Q)	0.058**	0.058**	0.031**	0.017**	0.015***
	(0.014)	(0.014)	(0.011)	(0.006)	(0.006)
Performance (ROA)	0.810**	0.808**	0.422**	0.157**	0.131**
	(0.155)	(0.155)	(0.125)	(0.060)	(0.060)
Long-term Debt Ratio	-1.625**	-1.626**	-0.964**	-0.187	-0.219*
	(0.248)	(0.248)	(0.211)	(0.115)	(0.113)
State Ownership	-0.306**	-0.292**	-0.006	0.044	0.047
	(0.086)	(0.086)	(0.094)	(0.043)	(0.043)
Political Connection		-0.106**	-0.083*	-0.040+	-0.042**
(yes=1)		(0.039)	(0.039)	(0.021)	(0.020)
Constant	-9.587**	-9.631**	-6.772**	-2.923**	-2.829***
	(0.736)	(0.736)	(0.844)	(0.413)	(0.407)
Fixed Effects	SIC-2&Year	SIC-2&Year	Firm&Year	Firm&Year	Firm&Year
Adjusted R-squared	0.363	0.364	0.635	0.513	0.514

Notes: This table analyzes all listed firms in China from 1992 to 2010, inclusive. N=15,692. Models 1 to 3 show linear regression models of the (logged) number of patents applied for by Chinese listed firms from 1992 to 2010, across all three categories (invention, utility, and design patents). Model 4 shows linear regression models of the (logged) number of invention patents granted. Model 5 shows the (logged) number of invention patents granted for which firms paid renewal fees. Robust standard errors are in parentheses below parameter estimates. + indicates p<0.10, * p<0.05, and ** p<0.01, two-tailed t tests.

Table 3: Poisson Regressions of Number of Patent Applications and Invention Patents Granted and Renewed

Dependent Variable	(1) Number of all patent applications	(2) Number of invention patents granted	(3) Number of invention patents renewed
Assets (logged)	0.478**	0.473**	0.348**
	(0.007)	(0.024)	(0.048)
Market Value (Tobin's Q)	0.025**	-0.010	-0.020
	(0.003)	(0.011)	(0.021)
Performance (ROA)	0.877**	0.897**	0.807*
	(0.054)	(0.180)	(0.350)
Long-term Debt Ratio	0.555**	0.434*	0.026
	(0.067)	(0.207)	(0.400)
State Ownership	0.023	-0.006	-0.088
	(0.019)	(0.073)	(0.137)
Political Connection (yes=1)	-0.109**	-0.185**	-0.118+
	(0.011)	(0.035)	(0.068)
Fixed Effects	Firm&Year	Firm&Year	Firm&Year
No. Observations	12,609	8,942	8,942
Wald χ^2(df=24)	57,707.33	5,088.23	1,247.71
Log-likelihood	-62,308.461	-12,071.518	-4,358.895
Prob > chi2	0	0	0

Notes: These models were estimated on all Chinese listed firms from 1992 to 2010, inclusive. Robust standard errors are in parentheses below parameter estimates. + indicates p<0.10, * p<0.05, and ** p<0.01, two-tailed t tests.

Table 4: The Moderating Effect of the Rule of Law and Market Development

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	Log(1 + all patent applications)					
Assets (logged)	0.392**	0.393**	0.389**	0.390**	0.386**	0.387**
	(0.039)	(0.039)	(0.038)	(0.039)	(0.039)	(0.039)
Market Value (Tobin's Q)	0.033**	0.033**	0.031**	0.031**	0.030**	0.030**
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Performance (ROA)	0.399**	0.405**	0.399**	0.405**	0.405**	0.413**
	(0.124)	(0.124)	(0.124)	(0.124)	(0.125)	(0.125)
Long-term Debt Ratio	-0.960**	-0.958**	-0.967**	-0.966**	-0.947**	-0.945**
	(0.211)	(0.212)	(0.211)	(0.211)	(0.211)	(0.212)
State Ownership	-0.025	-0.024	-0.014	-0.012	-0.020	-0.015
	(0.094)	(0.094)	(0.094)	(0.094)	(0.095)	(0.095)
Political Connection (yes=1)	-0.081*	-0.008	-0.083*	0.044	-0.081*	0.065
	(0.039)	(0.066)	(0.039)	(0.071)	(0.039)	(0.086)
Legal Environment	0.029**	0.031**				
	(0.010)	(0.010)				
Political Connection × Legal Environment		-0.012				
		(0.010)				
Less Government Intervention			0.022**	0.026**		
			(0.007)	(0.008)		
Political Connection × Less Government Intervention				-0.023*		
				(0.011)		
Non-state sector investment					0.049**	0.053**
					(0.015)	(0.016)
Political Connection × Non-state Sector Investment						-0.021+
						(0.012)
Constant	-7.160**	-7.189**	-6.918**	-6.963**	-7.182**	-7.229**
	(0.851)	(0.851)	(0.844)	(0.844)	(0.851)	(0.851)
Fixed Effects	Firm&Year	Firm&Year	Firm&Year	Firm&Year	Firm&Year	Firm&Year
Adjusted R-squared	0.636	0.636	0.635	0.635	0.635	0.635

Notes: This table analyzes all listed firms in China from 1991 to 2010, inclusive. N = 15,671. Robust standard errors are in parentheses below parameter estimates. + indicates p<0.10, * p<0.05, and ** p<0.01, two-tailed t tests.

Table 5: Linear Regressions of the R&D Spending Ratio

	(1)	(2)
Assets (logged)	-0.000	0.001+
	(0.000)	(0.000)
Market Value (Tobin's Q)	0.002**	0.001+
	(0.000)	(0.000)
Performance (ROA)	0.037**	-0.003
	(0.005)	(0.002)
Long-term Debt Ratio	-0.003*	-0.001
	(0.002)	(0.001)
State Ownership	0.006	-0.003
	(0.007)	(0.004)
Political Connection (yes=1)	-0.000	-0.001
	(0.001)	(0.001)
Constant	0.016	-0.008
	(0.010)	(0.011)
Fixed Effects	Industry&Year	Firm&Year
Adjusted R-squared	0.093	0.498

Notes: This table analyzes all listed firms in China from 2006, when data on R&D expenditures become available, to 2010. N=7,363. The dependent variable is R&D spending/sales. Robust standard errors are in parentheses below parameter estimates. + indicates $p<0.10$, * $p<0.05$, and ** $p<0.01$, two-tailed t tests.

Table 6: Political Connections, R&D Spending, and Patenting Activity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Log(1 + all patent applications)			Log(1 + invention patents granted)		Log(1 + invention patents renewed)	
R&D Spending/Sales	1.557	5.336*	0.670	3.382*	1.346*	3.385*	1.332*
	(1.696)	(2.697)	(1.049)	(1.534)	(0.630)	(1.532)	(0.636)
Assets (logged)	0.792**	0.794**	0.660**	0.406**	0.240*	0.409**	0.236
	(0.066)	(0.064)	(0.167)	(0.047)	(0.121)	(0.047)	(0.121)
Tobin's Q	0.052	0.041	0.040	0.056*	0.053	0.057*	0.050
	(0.035)	(0.035)	(0.055)	(0.023)	(0.037)	(0.023)	(0.037)
ROA	1.650**	1.645**	0.831	-0.082	0.503	-0.082	0.509
	(0.600)	(0.596)	(0.684)	(0.386)	(0.538)	(0.385)	(0.535)
Long-Term Debt Ratio	-1.121	-1.215	-1.421	-0.365	-0.165	-0.404	-0.148
	(0.764)	(0.760)	(0.965)	(0.458)	(1.084)	(0.455)	(1.082)
State Ownership	-0.504*	-0.471*	-0.039	-0.150	0.078	-0.147	0.075
	(0.236)	(0.235)	(0.276)	(0.154)	(0.278)	(0.157)	(0.278)
Political Connection (yes=1)	-0.045	0.058	-0.234	0.107	-0.061	0.108	-0.071
	(0.126)	(0.132)	(0.197)	(0.095)	(0.223)	(0.095)	(0.225)
Political Connection ×		-6.358*	-0.979	-3.967*	0.454	-3.974*	0.522
R&D Spending/Sales		(2.736)	(5.574)	(1.569)	(5.772)	(1.568)	(5.768)
Constant	-14.681**	-14.768**	-11.724**	-8.893**	-5.311*	-8.967**	-5.223*
	(1.444)	(1.414)	(3.676)	(1.057)	(2.639)	(1.053)	(2.637)
Fixed Effects	Industry & Year	Industry & Year	Firm & Year	Industry & Year	Firm & Year	Industry & Year	Firm & Year
Adjusted R-squared	0.402	0.411	0.856	0.325	0.714	0.325	0.714

Notes: These analyses cover Chinese listed firms from 2006 to 2010, which are the only years data are available on non-zero R&D expenditures. N=1,643. All models show ordinary-least-squares regression analyses and include year fixed effects. Models 1, 2, 4, and 6 include industry fixed effects (at the SIC-2 level); models 3, 5, and 7 substitute firm fixed effects, to investigate within-firm dynamics. For all models, robust standard errors are in parentheses below parameter estimates. * indicates p<0.05 and ** p<0.01, two-tailed t tests.

Appendix Table A1:
Political Connections and Patenting in High- versus Low-Innovation Industries

	(1)	(2)
Assets (logged)	0.519**	0.385**
	(0.033)	(0.038)
Market Value (Tobin's Q)	0.058**	0.031**
	(0.014)	(0.011)
Performance (ROA)	0.807**	0.413**
	(0.156)	(0.125)
Long-term Debt Ratio	-1.625**	-0.963**
	(0.248)	(0.210)
State Ownership	-0.293**	-0.013
	(0.086)	(0.093)
Political Connection (yes=1)	-0.125**	-0.07+
	(0.044)	(0.043)
High Patenting Industries (yes=1)	0.262**	0.263**
	(0.040)	(0.043)
Political Connection	0.042	-0.012
× High Patenting Industries	(0.074)	(0.067)
Constant	-9.713**	-6.815**
	(0.736)	(0.836)
Fixed Effects	SIC2&Year	Firm&Year
Adjusted R-squared	0.366	0.637

Notes: This table analyzes all listed firms in China from 1992 to 2010, inclusive. N=15,692. The dependent variable is the (logged) number of patents applied for by Chinese listed firms from 1992 to 2010, across all three categories (invention, utility, and design patents). Robust standard errors are in parentheses below parameter estimates.
+ indicates p<0.10, * p<0.05, and ** p<0.01, two-tailed t tests.

Appendix Table A2:
Analysis of Propensity-Score-Matched Sample

	(1)	(2)
Assets (logged)	0.485**	0.334**
	(0.043)	(0.051)
Market Value (Tobin's Q)	0.052**	0.021
	(0.019)	(0.017)
Performance (ROA)	0.710**	0.453*
	(0.220)	(0.208)
Long-term Debt Ratio	-0.283**	-0.076
	(0.096)	(0.133)
State Ownership	-1.461**	-0.488
	(0.308)	(0.307)
Political Connection (yes=1)	-0.104*	-0.135*
	(0.044)	(0.055)
Constant	-9.776**	-6.738**
	(0.962)	(1.109)
Fixed Effects	SIC2&Year	Firm&Year
Adjusted R-squared	0.344	0.644

Notes: This table analyzes all listed firms in China from 1992 to 2010, inclusive. N=6,723. Each column shows a linear regression model of the (logged) number of patents applied for by Chinese listed firms from 1992 to 2010, across all three categories (invention, utility, and design patents). Robust standard errors are in parentheses below parameter estimates. * $p<0.05$, and ** $p<0.01$, two-tailed t tests.

Appendix Table A3:
The Interaction between State Ownership and Political Connections

	(1)	(2)
Assets (logged)	0.520**	0.389**
	(0.033)	(0.038)
Market Value (Tobin's Q)	0.058**	0.031**
	(0.014)	(0.011)
Performance (ROA)	0.809**	0.422**
	(0.155)	(0.125)
Long-term Debt Ratio	-1.625**	-0.964**
	(0.248)	(0.211)
State Ownership	-0.319**	-0.013
	(0.096)	(0.101)
Political Connection (yes=1)	-0.151*	-0.093+
	(0.062)	(0.055)
Political Connection	0.129	0.030
× State Ownership	(0.142)	(0.130)
Constant	-9.606**	-6.769**
	(0.734)	(0.844)
Fixed Effects	SIC2&Year	Firm&Year
Adjusted R-squared	0.364	0.635

Notes: This table analyzes all listed firms in China from 1992 to 2010, inclusive. N=15,692. Each column shows a linear regression model of the (logged) number of patents applied for by Chinese listed firms from 1992 to 2010, across all three categories (invention, utility, and design patents). Robust standard errors are in parentheses below parameter estimates. + indicates p<0.10, * p<0.05, and ** p<0.01, two-tailed t tests.