Corruption, Government Subsidies, and Innovation: Evidence from China

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Abstract

Government subsidies account for 22% of Chinese firms' R&D expenditures. We exploit the staggered removal of provincial heads on corruption charges during China's anti-corruption campaign and the routine departures of local government officials responsible for innovation programs as two separate types of events that lead to plausibly exogenous reductions in corruption. We document that subsidies became significantly more strongly associated with future innovation after both types of events. Meanwhile, the allocation of subsidies became more sensitive to firm merit and less to corruption. Our results indicate that reducing the impact of corruption improves the allocational efficiency of government subsidies.

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Introduction

R&D activities are central to economic growth. However, R&D is expensive and frequently generates large positive spillovers to other entities, which can lead to under-investment by the private sector (Nelson, 1959; Arrow, 1962). As a result, all major industrialized nations subsidize R&D to some extent. Among the G-8 nations, direct government subsidies for R&D by businesses ranged from 0.02% of GDP (Japan) to 0.38% (Russian Federation).[2]

In an ideal world, government subsidies foster innovation not only by providing capital but also by alleviating information frictions that might otherwise impede investments in innovation. In the U.S., the roles of government agencies such as the Defense Advanced Research Projects Agency and the National Institutes of Health in stimulating innovation have been well-documented (e.g., Mazzucato, 2013). Similarly, Israel's Innovation Authority (previously known as the Office of Chief Scientist) has been frequently emulated elsewhere (Senor and Singer, 2009). In recent years, economists have become increasingly interested in understanding the design of public subsidies for innovation (e.g., Howell, 2017; Wang et al., 2017).

One major concern regarding government R&D subsidies—and governments' role in resource allocation in general—is that they can be subject to corruption, leading to misallocation of resources. Although there is an extensive literature on corruption focusing on rent-seeking behaviors of politically connected firms (see, for example, Akcigit et al., 2017; Khwaja and Mian, 2005; and Shleifer and Vishny, 1998 for a thoughtful review), the consequences of corruption in governments' R&D subsidy programs have not been examined in depth, as a review of the major papers in this literature suggests (e.g., Almus and Czarnitzki, 2003; Bond et al., 2005; Bronzini and Iachini, 2014; Jaffe and Le, 2015; Lach, 2002; Lerner, 1999; and Wallsten, 2000). This

[2] Organisation for Economic Cooperation and Development, "Measuring Tax Support for R&D and Innovation," http://www.oecd.org/sti/rd-tax-stats.htm.

omission is striking given the importance of innovation for economic growth and the concern that the innovative sector is particularly vulnerable to rent-seeking (Murphy et al., 1993).

In this paper, we examine corruption's effect on governments' R&D subsidy programs using data from China, where nearly a quarter of firms' R&D expenditures come from government subsidies.[3] China is an important setting for this question because innovation has become a top policy focus both inside and outside China in recent years. China's push for innovation, solidified in its most recent Five-Year Plan,[4] has been accompanied by substantial subsidies. According to the *China Statistical Yearbook*, between 2005 and 2015, China spent on average about 1% of GDP on R&D subsidies, multiple times the OECD mean. This figure may still be understated because it does not include separate funds for government-backed venture capital investments, which amounted to $338 billion in 2015 alone.[5]

At the same time, another top concern for China's leaders has been the pervasiveness of corruption, which prompted President Xi Jinping's sweeping anti-corruption campaign in 2012. Corruption is a first-order concern when it comes to R&D subsidies in China because decisions to grant subsidies are made by mid-level government officials rather than peer reviewers and expert panels, as in most Western nations. Collectively, these officials control the allocation of tens of billions of dollars in R&D subsidies annually.

We explore whether government subsidies are associated with firms' future innovation, and how corruption affects this relationship. To identify corruption's impact on the subsidy-

[3] China's 2015 Statistical Year Book reports a figure of 22.2%, almost identical to our in-sample calculation of 22.3%.
[4] Five-Year Plans are China's top policy blueprints containing its social, economic, and political goals. The 13th Five-Year Plan (the most recent) covers 2016 to 2020. See Apco Worldwide, "The 13th Five-Year Plan: Xi Jinping Reiterates His Vision for China," http://www.apcoworldwide.com/docs/default-source/default-document-library/Thought-Leadership/13-five-year-plan-think-piece.pdf?sfvrsn=2 for information on and analyses of the most recent Five-Year Plan.
[5] Shai Oster and Lulu Yilun Chen, "Inside China's Historic $338 Billion Tech Startup Experiment," https://www.bloomberg.com/news/articles/2016-03-08/china-state-backed-venture-funds-tripled-to-338-billion-in-2015.

innovation relationship, we use difference-in-differences approaches and rely on two separate means of identification.[6] The first is based on the anti-corruption campaign that President Xi Jinping launched in 2012. However, instead of using the event as a single treatment, we exploit the staggered removal of top provincial officials (i.e., provincial governors or Party secretaries) on corruption charges between 2012 and 2016. A sizable body of empirical evidence has shown that the anti-corruption campaign has been effective in curbing corruption (see Chen and Kung, 2019; Goh et al., 2018; Ke et al., 2016; Griffin et al., 2018; and Lin et al., 2018, among others). By comparing the subsidy-innovation relationship before and after the removal events, we can identify the impact of corruption on this relationship.

Our second method of identification exploits some unique features of Chinese government administration. As we detail in Section I, the Chinese government has since the 1990s set up an elaborate system of technology bureaus at the municipal, provincial, and central government levels. These are the ministries that allocate government R&D subsidies. The Chinese government routinely changes the officials in charge of these technology bureaus due to retirements, term limits, or simply its rotation of cadres. We use these rotations of local technology bureau heads as our second and separate identification instrument. Here the maintained assumption—for which we find empirical support—is that after the departure of an existing bureau head, the close relationships that some firms have built up with that individual would be diminished, rendering past bribes ineffectual in influencing subsidies. In addition, extensive research has shown that the newly appointed government officials are more likely to resist engaging in corruption in the first few

[6] One additional identification approach that we examined is the staggered and unanticipated inspections by the Central Commission for Discipline Inspection (CCDI) of the different provinces on their anti-corruption efforts. These are the same events used by Chen and Kung (2019). Results pertaining to this identification are reported and discussed in Section 4. One drawback of using the years of inspections is that the events are clustered in 2013 and 2014. Hence in the text of this paper, we report the results using the staggered removals or departures of individual officials between 2012 and 2016, which provide us a richer time variation.

years of their tenure (Rose-Ackerman, 1999; Gino et al., 2011; Liao et al., 2017; Coviello and Gagliarducci, 2017). Exploiting the drop in corruption around the rotations of local technology bureau heads, we again compare the subsidy-innovation relationship before and after these events to study corruption's impact.

Our analyses contain two main parts. In the first part, we examine the relationship between subsidies and future innovation. Using the difference-in-differences approaches outlined above, we find that subsidies became significantly more positively associated with future innovation (measured as patents scaled by sales and relative citation strength) in the years when corruption was likely to abate. Coefficient estimates indicate that the subsidy-innovation relationship is at least twice as strong after corruption-reduction events than before. In a model where firm fixed effects are included, we find that the subsidy-innovation relationship was insignificant before but became significant after these events. These patterns hold for both of our innovation measures, using either U.S. or China patent data.

The second part of our analyses examines the subsidy-grant decisions themselves. In doing so we attempt to shed light on the mechanisms through which the subsidy-innovation relationship changed. This analysis is guided by three hypotheses regarding the relationship between firms' ability to innovate, corruption, and subsidy decisions. In the first-best world, incorruptible government officials make subsidy decisions based on firms' merits. Under this hypothesis, subsidies should be positively related to firms' ability to innovate and unrelated to corruption. In contrast, under cronyism, the allocation of R&D subsidies is driven by corruption; a firm's merit has little bearing. The third hypothesis lies between these two extremes. Government officials try to allocate subsidies based on merit, but they can be tempted by the private benefits from corruption. Under this hypothesis, both corruption and firm merit influence subsidies; the relative weight of each affects the efficacy of the subsidy decisions. When subsidy decisions are made more in line with merit and less with corruption, subsidies would be more positively associated with future innovation outcomes.

To empirically test these hypotheses in the second part of our paper, we need measures of firm merit and corruption prior to subsidy awards. For merit, we use the historical ratio of firms' patents over R&D expenditures (which we call R&D efficiency) as a measure of firms' track record in converting R&D resources into output. To measure firm-level corruption, we exploit a reporting rule in China that requires domestically listed firms to report "Entertainment and Travel Costs" (ETC) as a sub-category of Sales, General and Administrative (SG&A) costs. This variable has increasingly become a standard measure of corruption in China-related literature (e.g., Cai et al., 2011; Griffin et al., 2016; and Huang et al., 2017, among others).

In China, social activities such as eating, drinking, entertainment and gifting that develop "guan xi" (relationships) are the ubiquitous lubricants for business transactions. These activities are among the most visible targets of the anti-corruption campaign.[7] To be clear, the type of corruption ETC captures is "petty corruption" by mid-level officials. However, this is precisely our point. This is the type of corruption that represents "side payments" which some economists view as "greasing the wheel" of commerce.[8] They may be harmless in their magnitude and scope; but they nevertheless can influence mid-level officials with significant decision power over the

[7] A *New York Times* article in March 2013 likens the anti-corruption campaign to an austerity measure for the country's elite (https://www.nytimes.com/2013/03/28/world/asia/xi-jinping-imposes-austerity-measures-on-chinas-elite.html). Among other measures, President Xi Jinping required business meals to be limited to "four dishes and a soup". The article reports that 60% of restaurants surveyed in the two months after the start of the campaign reported reduced business reservations. Sales of shark fin, a Chinese delicacy, dropped by 70%. The 53-proof Mao Tai, a favorite Chinese spirit in business banquets, also reported declining sales and prices. The price of one bottle fell from a peak of over 2300 RMB in 2012 (roughly US$380 at the then-prevailing exchange rate), to less than 1000 RMB by 2014. See Chinese media reports such as "茅台酒价格或成腐败指数," http://money.163.com/10/1210/10/6NHKHQRR00253B0H.html and "告别腐败指数 茅台应让老百姓喝得起." http://business.sohu.com/s2013/others702/.

[8] For the "grease of the wheel" view, see Leff (1964), Huntington (1968), and Lui (1985).

allocation of resources. In this sense, our paper sheds light on the "grease of the wheel" view vis-à-vis the distortionary view of corruption, in line with Bertrand et al. (2007); it is distinct from studies that focus on political connections and corruption at the highest level of government (e.g., Chen and Kung, 2019; Schoenherr, 2018).

We find that corruption and firm merit both affect the subsidies firms receive. In fact, the two inputs have roughly equal influence: a one standard deviation increase in either variable leads to a roughly 10% increase in subsidies (as a percentage of revenue) received. However, we find that both the removal of top provincial officials during the anticorruption campaign and the departures of provincial technology bureau heads sharply altered the relative impact of merit (R&D efficiency) and corruption on subsidy allocations. Both events increased the influence of merit and simultaneously decreased the influence of corruption on subsidies. In fact, the positive impact of merit on subsidies is concentrated in the years after both types of events and, in contrast, while corruption was an important determinant of subsidies before these events, its impact diminished afterwards.

It is important to emphasize that our evidence does not indicate that government subsidies *cause* firm innovation. Instead, the consistent patterns from multiple difference-in-differences analyses indicate that events that reduced the influence of corruption strengthened the subsidies-innovation relationship, and thus improved the allocational efficiency of R&D subsidies. This result implies that corruption is not mere "greasing the wheel" of commerce but instead has significant negative consequences on resource allocation.

The plan of this paper is as follows. In Section 1, we summarize the key institutional features and present descriptive statistics. Section 2 examines the relationship between subsidies and future innovation. Section 3 analyzes the allocation decisions of subsidies. Section 4 discusses additional analyses and robustness checks. Section 5 concludes the paper.

1. Institutional Background and Empirical Design

The government plays a central role in resource allocation in China, and R&D subsidies are no exception. Since the 1990s, each level of China's government—central, provincial, and municipal—has established technology bureaus that are responsible for technology development and innovation. The labyrinth of technology bureaus offers a variety of subsidies, including funds for the development and testing of new products, major R&D projects, commercialization of new technologies, small and medium technology enterprises, and even patent application fees. Although tax credits are also used as a form of R&D subsidy by the Chinese government, we focus on direct monetary R&D subsidies in this paper.

The approval process for subsidy applications follows a pyramidal structure. Virtually all applications for R&D subsidies are initially filed at the municipal level, where officials screen applications for completeness and eligibility. Although municipal officials may provide some funding, they mainly pass eligible applications up to the provincial level for substantial funding. In this way, the local government officials—especially those at the provincial level—play a key role not only as fund allocators but also as gatekeepers and referees. This dynamic creates a strong incentive for firms to cultivate good relationships with these mid-level officials. In China's rigid, nine-level hierarchy of government officials, provincial technology bureau heads sit at "Level Five," exactly the middle. It is well documented in the Chinese literature that mid-level petty corruption is rampant and represents the most widespread form of corruption in China.[9]

[9] Gong and Wu (2012) estimate that corruption cases involving mid-level officials accepting bribes, gifts, and entertainment accounted for about two-thirds of the total government official corruption cases during 2000 to 2009.

At the same time, local officials have strong incentives to select the firms most likely to succeed. An extensive political science literature (e.g., Li and Zhou, 2005) suggests that officials' future promotion prospects depend on local economic performance in the region for which they are responsible. Career concerns thus create incentives for the government officials responsible for innovation programs to reward the most promising firms.

Consequently, officials' decisions on applications can be affected both by firms' merit and by corruption. To study the effect of corruption, we rely on two types of events that changed the amount of corruption in a plausibly exogenous way. Our first identification is based on the anti-corruption campaign waged by President Xi Jinping starting in 2012. The sweeping and sudden nature of the campaign was a shock to the amount of corruption in the system; the onset of the campaign was neither controlled by individual firms, nor was it anticipated. Figure 1 traces the frequency of Chinese newspaper articles that contain the phrase "anti-corruption" in the title.[10] It shows a sharp increase in media mention of anti-corruption in 2012, the first year of the anti-corruption campaign.

One approach would be to use 2012 as a single event year in a difference-in-difference analysis, but other structural changes might have been taking place in the Chinese economy that would confound our inferences. To sharpen the identification, we exploit the fact that the central government's corruption cases are staggered over time across different provinces and (as documented below) are not related to local economic conditions and local firm performance. Between 2012 and 2016, Xi's administration charged 26 top provincial officials across 18

[10] We searched for the key word "anti-corruption" in the titles of all newspaper articles published in all official provincial government newspapers between 2007 and 2015. In China, the media are strictly controlled by the government. Each provincial-level government has an official publication called the "Daily": for example, the Henan Daily and the Hebei Daily are the official newspapers published by the Henan and Hebei provincial governments, respectively. Beijing, Shanghai, Tianjin, and Chongqing are four municipalities that enjoy the same administrative status as a province. Publications by these municipal governments (e.g., the Beijing Daily) are also in our sample.

provinces and removed them from their posts. These high-profile cases were publicized on the Central Commission of Discipline Inspection (CCDI) website.[11] We use these staggered removals of top provincial officials to identify the effects of corruption, with the maintained assumption that local corruption would abate in the aftermath of these arrests.

Table 1 summarizes the year, province, and number of officials removed based on data from the CCDI website. Starting with two officials removed in 2012, the campaign gathered force and led to the removal of seven officials in five provinces in 2014 and seven officials in six provinces in 2015. The provinces affected each year were geographically diverse and not all clustered in the same region. For each official removal event in year *t*, we examine the three years before (i.e., *t*-1, *t*-2, *t*-3) as the pre-removal window and up to three years after (i.e., *t*-1, *t*-2, *t*-3) as the post window. Multiple removals in the same province-year are considered one event.

Although one might be concerned that these corruption charges were politically motivated, a growing body of empirical evidence indicates that the anti-corruption campaign has had real effects on China's business culture. For example, Chen and Kung (2019) document rampant corruption in China's land sale market before the campaign and its reduction afterwards; Griffin et al. (2018) found that firms reduced expenditures on business entertainment; Li et al. (2018) found that bank loans were made more on commercial bases and less on political connections after the campaign; and Zhang (2018) shows that the anti-corruption campaign reduced the likelihood of corporate fraud by nearly 50%. These findings provide external validity to our maintained assumption that local corruption abated after high-profile corruption cases. Our own data

[11] http://www.ccdi.gov.cn/special/zyxszt/. For an excellent discussion of the central role of the CCDI in China's anti-corruption campaign, see Chen and Kung (2019). In China, the prosecution of government officials starts within the CCDI. The cases are then brought to a court hearing by the CCDI. The judges officially pronounce the sentencing and punishment, which is typically a combination of removal from all official posts, prohibition from serving in any future official posts, confiscation of ill-gotten assets, fines, and jail time. The officials charged with corruption in our sample were given as little as three-year jail sentences and as much as life imprisonment.

corroborates this: Figure 2 plots the average ETC spending among our sample firms over time and shows a sharp drop in this expenditure since the inception of the anti-corruption campaign. In unreported calculations (available upon request), we find similarly sharp drops in local firms' ETC spending after the staggered removal of provincial heads.

Our second identification strategy relies on the routine departures of provincial-level technology bureau heads. These events are largely unrelated to the anti-corruption campaign and hence offer a separate and independent test of our hypotheses. The rationale for this approach is first that these technology bureau heads are (collectively) directly in charge of billions of dollars of subsidies every year. China's government postings are frequently reshuffled due to retirements, term limits, or simply the Chinese Communist Party's opaque rotation of its cadres (for a discussion, see Huang, 2002). According to the "Party and Government Leading Cadres Selection and Appointment Regulations" put in place in 2002,[12] technology bureau heads (along with other officials at the same administrative level in the Chinese Community Party's cadre system) are required to step down after a five-year term. In rare cases, appointments can be extended for another term to ten years total. Sometimes, special promotions and rotations also occur, leading to sudden, unannounced official departures.[13] These departures of technology bureau heads thus offer another clean identification of the impact of corruption because they sever the cozy relationships between firms and local officials that breed cronyism. At the same time, due to their centrally controlled nature, they are beyond the control of individual firms and local officials alike and appear to be unrelated to local economic conditions.

[12] http://renshi.people.com.cn/n/2014/0116/c139617-24132478.html.

[13] The personnel rotation is typically conducted by the secretive Organization Department of the Chinese Communist Party. For instance, Downs and Meidan (2011) discuss an example in April 2011 in which the leaders of Sinopec, CNOON, and CNPC, China's three largest state-owned oil companies, were simultaneously rotated, to the surprise of the market and even the insiders of these firms.

Figure 3 shows the number of departures of provincial technology bureau heads from 2007 to 2016. The departures occurred both before and after the anti-corruption campaign; they thus provide a separate, independent identification for our analyses. We manually compiled the list of departures from various online and offline sources, including the official websites of each provincial government and the central government, newspaper reports, and postings and announcements about personnel movements from the Chinese Communist Party's Organization Department.[14] There are in total 53 cases of official departures occurring in 30 provinces (all Chinese provinces except for Yunnan). For each event, we again define up to three years before (after) as the pre (post) windows, respectively.

Are these departures related to changes in firm-level ETC spending? Our data suggest yes. In the aggregate level, we find that local firms' average ETC spending dropped from 0.62% of sales to 0.52% of sales from the three years before to the three years after the departures (*t*-stat= 4.04). In the cross-section, we find that high pre-departure spenders (defined as top-tercile firms in terms of ETC/Sales in a given province-year) significantly decreased spending after official departures from 1.26% to 0.98% of sales (*t*-stat=4.27), while low pre-departure spenders (the two bottom-tercile firms in terms of ETC/Sales in a given province-year) remained essentially unchanged in their spending at 0.29% of sales (t-stat=0.04). These patterns suggest that firms attempt to re-align interests amidst government official shuffles. In particular, the large spending drop among previous high spenders indicates that their built-up relationship with the government has been depreciated and they are less likely to benefit from influencing behaviors under the new

[14] The Organization Department is equivalent to the human resources department of the Chinese Communist Party. Our specific search procedure is as follows. We searched for the key words "technology bureau," and "technology head" from the mentioned sources and general web portals. From these records, we constructed a database of the names of the technology bureau heads for each province during our sample period. We then identified departure dates.

official (at least temporarily).[15] This stems from a different mechanism from the overall drop of corruption after the anti-corruption campaign and thus offers a separate, independent source of variation for our analyses.

One concern is that the removals of top provincial officials or the routine departures of provincial technology bureau heads may be related to local economic conditions and firm performance. We conducted probit analysis of these events using lagged provincial GDP growth, local firms' average return on assets and patent counts (scaled by sales) as proxies of local economic conditions. None of these variables has explanatory power for either the removals or the departures. These results are reported in Table IA1 in our Internet Appendix.[16]

2. Subsidies and Future Innovation

A. Data sources, measurements, and descriptive statistics

Our sample is drawn from Chinese firms listed in the Shanghai and Shenzhen stock exchanges. We focus on firms in the following sectors (the Chinese Securities Regulation Commission (CSRC) industry codes in parentheses), which Jaffe and Trajtenberg (2002) argue are relatively R&D-intensive: petro-chemicals (C4), electronics (C5), metals and materials (C6), machinery and equipment (C7), pharmaceuticals and biotechnology (C8), and information technology (G). After this screening, our sample represents 60% of the total market capitalization of China's A-share market and 73% and 90% of their total R&D expenses and U.S. patents respectively during our sample period of 2007–2016.

[15] These results are inconsistent with the notion that firms spend more to cultivate relationships with newly appointed officials, but consistent with empirical evidence (noted above) that newly appointed government officials are more likely to resist engaging in corruption at the beginning of their tenures.

[16] We should also point out that the reasons for departures of technology bureau heads included lateral rotations, retirements and term limits. They are thus different from political promotions which have been shown in prior studies (e.g., Li and Zhou, 2005) to depend on local economic performance.

In 2006, the CSRC implemented *The Accounting Rules of China's Enterprises (2006)*, Rule 16 of which required listed firms to start disclosing their annual R&D expenditures as well as the type and amount of government subsidies received. Therefore, our sample period is from 2007 to 2016. We collect firms' R&D expenditures and other financial and ownership data from their annual reports compiled by WIND, a database similar to Compustat in the U.S.

Information on direct monetary R&D subsidies that firms received is hand-collected from the footnotes of firms' annual reports. For each firm-year, we calculate the total R&D subsidies as the sum of the following seven types of funding (scaled by revenue):

1) subsidies for product development, intermediate testing, and major R&D projects;

2) funding from the national and provincial Small and Medium Technology Enterprises Innovation Funds (also known as InnoFunds);

3) subsidies for small and medium enterprises' technological adaptation and upgrading;

4) subsidies for technological modification and upgrading;

5) subsidies for technology commercialization and equipment and systems purchase;

6) R&D grants; and

7) subsidies for patent applications.[17]

Table 2 lists the aggregate amount and the breakdown of these seven categories. The most important sources of subsidies, by far, are R&D grants (category 6) and subsidies for commercialization (category 5). The InnoFund (category 2), which has attracted academic interest recently (e.g., Wang et al., 2017), represents a small part of the total subsidies for our sample firms,

[17] The Chinese headings for these categories are: 1) 科技三项费用; 2) 科技型中小企业创新基金; 3) 中小企业创新资金项目; 4) 技术改造与工业转型升级经费; 5) 产业化经费、以及设备购买、信息化系统、平台建设等其他经费; 6) 科研项目经费; 7) 专利补贴.

no doubt because our sample is drawn from large, listed firms, while the InnoFund is earmarked for small firms, including unlisted ones.

Figure 4 plots the percentages of different types of firms receiving subsidies in each year. Panel A shows that the percentage of our sample firms receiving subsidies increased steadily from 70% in 2008 to 95% in 2015. Panels B and C show that, among new recipients every year, an increasing proportion has been small firms (i.e., those with below-median market capitalization in a given year) and other than State-Owned Enterprises (SOEs).

We construct two variables to measure a firm's innovative output: Patents/Sales and Relative Citation Strength.[18] All variables are defined in Appendix 1 of the paper but, given the importance of the patent-based variables, we discuss their construction in detail here.

Patents/Sales is the number of patent applications filed by a firm in year *t* (through December 31, 2016) that are ultimately granted by the end of 2017, divided by its revenue in year *t*. Our second patent-based measure of innovation output is Relative Citation Strength. Our patent citation data are updated through April 30, 2018. We use a citation cutoff date that falls *after* the patent cutoff date to allow time for citations to accumulate. For each patent, we calculate its Relative Citation Strength as the number of citations it received up to April 30, 2018, divided by the average number of citations per patent received over the same period by all patents applied for in the same application year *t* as the patent in question (that are also ultimately granted by the end of 2017) and in the same primary four-digit technological class.[19] This scaling controls for the application year and technological class. A Relative Citation Strength higher than one means that

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[18] We used two additional measures in earlier drafts of this paper: Foreign Sales/Sales and Total Factor Productivity. Results using these additional measures are consistent with those reported here and are available upon request.

[19] China uses the International Patent Classification (IPC) codes for classifying domestic patents. The U.S. uses the closely related Cooperative Patent Classification (CPC) scheme. The subject and scope of the four-digit technology classes in each case are very similar. We use the modal four-digit CPC class to determine the primary patent class assignment in the U.S. If there are multiple classes with the same modal class, we use the first listed of these.

a patent is cited more than the average patent successfully filed for in the same year in the same technology class.

For each of these two patent-based measures of a firm's future innovation, we construct two versions, one using the Chinese patent and citation data and one using their U.S. counterparts. The Chinese patent data are manually collected from the Chinese State Intellectual Property Office (CSIPO), China's counterpart to the United States Patent and Trademark Office (USPTO).[20] The U.S. patents over the same period (i.e., applications filed by December 31, 2016 and granted by December 31, 2017) come from the USPTO, cross-checked and supplemented with data from the leading full-text Chinese database on Chinese firms' foreign patents, Innojoy.[21] Our results are qualitatively the same using either version. For brevity, we report the results using U.S. patents and citations in the paper. Results using Chinese data are reported in our Internet Appendix (Tables IA2 and IA3).

One issue with these measures is truncation: a relatively small fraction of patents filed in 2016 is likely to have been issued by the end of 2017. We include year fixed effects in our regressions throughout to alleviate this problem. Hall et al. (1986) have highlighted the short lag between R&D spending and patent filing, which somewhat alleviates this concern.[22]

[20] To obtain a complete patent data of China's listed companies, we collect the patent data of listed companies and their whole-owned subsidies from CSIPO website (http://epub.sipo.gov.cn/gjcx.jsp).

[21] http://www.innojoy.com/search/home.html. It is important to cross-check and supplement our direct download from USPTO using this dataset because of the likelihood of (a) disparities in the company names that are the key identifiers for data matching, and (b) some companies registering their patents in the name of subsidiary entities. Innojoy is the leading full text, searchable Chinese dataset on Chinese firms' global patents. It is provided by Dawei Technologies, a Chinese technology and software firm and is widely subscribed to by leading Chinese universities and private sector firms, including asset management firms.

[22] For robustness, we also correct for this truncation bias by multiplying the number of patent applications filed by a firm in year *t* by a weighting index created by econometrically estimating the distribution of the application-grant lag using the methodology of Hall et al. (2001, 2005). One drawback of using this approach is that it requires an additional assumption: that the lag distribution does not change over time. All results in our paper remain unchanged when using time-adjusted patent awards (unreported but available on request).

Table 3 provides summary statistics for our sample, which consists of annual firm-level observations between 2007 and 2016. Several observations can be made. First, subsidies are an important source of overall R&D funding, representing 22.3% of our sample firms' total R&D spending. This magnitude matches almost exactly with the 22.2% reported in the *China Statistical Year Book (2015)* and suggests that our sample is representative of Chinese firms.[23] Second, Chinese firms make substantial R&D investments: on average, the annual R&D expenditure is 3.7% of sales in our sample, on par with the 3.5% R&D/Sales figure reported for U.S. firms, including basic industries not in the Chinese sample.[24] The average relative citation strength for Chinese patents is 0.37. This figure is below one because the table reports unconditional averages, which includes firm-years with zero patents (and hence zero citation counts). Among granted patents, the relative citation strength (unreported) in our sample is 1.001, indicating that the patents in our sample are representative in quality to other comparable Chinese patents. The unconditional relative citation strength for the firms' U.S. patents is only 0.015, reflecting that many firms did not have U.S. patents. The conditional U.S. patent relative citation strength for our sample (unreported) is 0.46, meaning that our sample firms' U.S. patents had a citation strength that is slightly less than half of their U.S. counterparts.[25]

B. Subsidies and future innovation: Findings

To study the association between subsidies and future innovation, we estimate panel regressions of the following form:

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[23] A few very large values of the Subsidies/R&D variable are due to firms receiving large subsidies to be used over multiple years. The results are robust to the winsorization of this variable.

[24] U.S. National Science Foundation, *Business Research and Development and Innovation: 2013 Detailed Statistical Tables*, Report no. NSF 16-313, https://www.nsf.gov/statistics/2016/nsf16313/pdf/nsf16313.pdf, Table 19.

[25] The lower relative citation strength of Chinese firms' U.S. patents relative to comparable U.S. patents could reflect a number of factors: (a) the delays associated with the issuance of foreign patent applications (since the applications are typically filed first at home, and only later in the United States), (b) the likelihood that even after issue, U.S. patents may cite the original Chinese patent, rather than its U.S. counterpart, and (c) a lower technological impact.

$$Y_{i,t} = \beta_0 Y_{i,t-1} + \beta_1 Subsidies/Sales_{i,t-1} + \beta_2 Post\ Event_{i,t} + \beta_3 Subsidies/Sales_{i,t-1} \times Post\ Event_{i,t} + Controls + Fixed\ Effects \quad (1)$$

The dependent variables are the two innovation outcome measures defined above. Lagged dependent variables are included in the regressions to account for serial correlation. The key independent variables are the R&D subsidy in the prior year (scaled by sales), the Post Event indicator (where the event is either the removal of a top provincial official on corruption charges or the departure of a technology bureau head), and the interaction term between the two. We note that the Post Event indicator is province- and year-specific because we use staggered events that affect different provinces at different times. Control variables include measures of firm size, age, leverage, intangible assets, return on assets (ROA), Tobin's Q, whether a firm is a SOE, and whether it is politically connected, all of which are defined in Appendix 1.

Table 4 reports the results pertaining to the removal of top provincial officials on corruption charges. Panel A reports the full regression results using firms' subsequent U.S. patenting as the dependent variable. First, the coefficient of subsidies is positive and significant, indicating that subsidies are correlated with more future patents in general. Second, the interaction term between subsidies and the post-removal indicator is also positive and highly significant, meaning that the subsidy-future innovation relationship is significantly stronger in post-event years than before. In terms of magnitude, models (2) to (4) suggest that the subsidies-innovation relationship is nearly three times stronger post-event as pre-event, since the coefficient of subsidies alone is 0.004 and that of the interaction term is 0.007. These coefficients imply that a one standard deviation increase in subsidies (as a percentage of sales) is associated with a 63% increase in the U.S. patenting rate in post-removal years.[26] Model (5), which includes firm fixed effects, shows that the subsidy-innovation relationship is insignificant in general but only turned significant in post-removal years.[27] Control variables are generally insignificant.

Panel B examines future U.S. patent citation strength. For brevity, control variables are suppressed. This panel shows that the positive relationship between subsidies and future innovation is only present in the years after the removal of corrupt officials; the subsidies variable itself is insignificant.

Table 5 reports a parallel set of results when estimating the same panel regressions using the departures of provincial technology bureau heads as the source of identification. Results in this table are consistent with those in Table 4: subsidies became positively related to future innovation measured by either (scaled) patents counts or relative citation strength.

In sum, results in this sub-section consistently indicate that the relation between subsidies and future innovation became significantly stronger after both types of corruption-reduction events. These results do not indicate that subsidies caused firm-level innovation, which is not the research question of our paper. Instead, the consistently stronger relationship between subsidies and future innovation after corruption-reducing events suggests that corruption negatively affects the efficacy of subsidy programs.

C. Subsidies and future innovation: Do subsidies alleviate financial constraint?

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[26] The 63% is calculated as follows: The coefficient on the interaction term between Subsidies/Sales and the post removal indicator is 0.007 in column (4). The standard deviation of Subsidies/Sales is 0.009 (Table 3). Thus, the magnitude of the associated increase in Patents/Sales is 0.009×0.007. Since the average value of Patents/Sales is 0.0001 (Table 3), in percentage terms the increase is $0.007 \times 0.009/0.0001 = 63\%$.

[27] Nickell (1981) suggests that including lagged dependent variable in firm fixed effect may cause endogeneity problem when the time horizon is relatively short. We thus conduct a robustness check by excluding the lagged dependent variable from model (5). We find the results remain robust (unreported but available on request).

To further investigate how corruption affects the efficacy of subsidies, we would like to focus on financially constrained firms. The previous sub-section shows that subsidies became more strongly related to future innovation after corruption-reducing events. If corruption mitigation improves the efficacy of subsidy programs, we should see this pattern to be more pronounced among financially constrained firms.

We construct a measure of financial constraint based on Rajan and Zingales (RZ, 1998). Specifically, we calculate an industry-level dependence on external financing as follows. First, for each firm in our sample, we calculate its average external-financing dependence using data from 2009, 2010, and 2011, the three years before the anti-corruption campaign. A firm's dependence on external financing in a given year is its capital expenditures in that year minus its cash flow from operations, divided by capital expenditures. We then calculate the equal-weighted average of this financing dependence measure across all firms in a two-digit CSRC industry to obtain the industry-level dependence on external financing. Finally, we use the median of the industry-level financial dependence to divide all industries into those that have "high" and those that have "low" dependence on external finance. Firms' external finance dependence is then defined by their industry affiliation.[28]

Table 6 extends the analyses of Table 4 by separating the sample into constrained and unconstrained firms.[29] For brevity, we report only the regression results using model (5) in Table 4, i.e., the specification that includes firm fixed effects. We find that the interaction term between the post-event indicator and R&D subsidies is positive and significant for more financially

[28] Although we follow the definitions in RZ (1998) as closely as possible, we do not use U.S. industry data to divide our sample firms. We felt that the financial characteristics of Chinese industries would be sharply different, due both to strategic financial choices (e.g., differing reliance on outsourced components and the use of trade credit) and to differing profitability rates.

[29] We also conducted the same sub-sample analyses regarding financial constraints around the departures of technology bureau heads. The results are qualitatively similar and are reported in Table IA4 of our Internet Appendix.

constrained firms; they are insignificant and smaller in magnitude in the unconstrained sample. The Wald-test for coefficient inequality is statistically significant for both the Patents/Sales and the Relative Citation Strength variable.

The results in this sub-section indicate that the stronger relationship between subsides and future innovation after corruption-reducing events is more pronounced for financially constrained firms, which implies that the reduction of corruption improved the efficacy of subsidy programs.

3. Subsidy-Granting Decisions: Firm Merit vs. Corruption

Findings in the previous section indicate that a reduction in corruption is related to a stronger relationship between subsidies and future innovation. Although we do not claim that subsidies caused more future innovation, a stronger subsidy-innovation relationship suggests more efficient resource allocation. What might be driving this improvement? In this section, we examine the subsidy-granting decisions themselves in order to shed light on this question. One caveat is that we cannot claim causal effects from our analysis; our evidence is indicative.

A reduction in corruption may foster a stronger connection between subsidies and innovation as it improves the quality of officials' subsidy-granting decisions. We hypothesize that on the one hand, mid-level officials' career concerns push them to select worthy, justifiable recipients. On the other hand, they are tempted by the private benefits from corruption, be they through gifts or entertainment. The weights on these two factors determine whether we are in the "first best" incorruptible officials' world, the cronyism world, or somewhere in between.

Through different mechanisms, both the corruption charges and the departures of technology bureau heads plausibly decreased the weight of corruption in officials' subsidy-grant decisions in an exogenous way. After the public removal of top provincial officials on corruption charges, their subordinates (including those responsible for R&D subsides) are likely to be afraid to engage in petty corruption. Routine, non-corruption-related departures of technology bureau heads function in a different way. Although not driven by corruption charges, these personnel movements depreciate the established relationships between firms and individual officials, which may render past efforts at relationship building ineffectual in influencing future subsidies. Therefore, we expect corruption to have less influence on subsidies after both types of events, giving firm merit more weight. The resulting subsidy decisions would be more efficient, consistent with the stronger association between subsidies and future innovation documented in Section 2.

The goal of this section's analysis is therefore to examine the effect of both firm merit and corruption on subsidies, and how these effects changed after our identifying events. We will again employ difference-in-differences approaches, as in the previous section. We first discuss measurements of firm merit and corruption before presenting the empirical results.

A. Measurements of firm merit and corruption

As a proxy for firm merit, we construct a measure of a firm's historical R&D output to input ratio to reflect its innovation track record. Specifically, similar to Hirshleifer et al. (2013), we define firms' R&D efficiency as follows:

$$R\&D\ Efficiency_{i,t} = Patent_{i,t}/(R\&D_{i,t} + 0.8 \times R\&D_{i,t-1} + 0.6 \times R\&D_{i,t-2}) \qquad (2)$$

where $Patent_{i,t}$ is firm *i*'s new patent applications filed in year *t* that were approved by the end of 2017; and the $R\&D_{i,t}$, $R\&D_{i,t-1}$, and $R\&D_{i,t-2}$ are the R&D expenditures in millions of RMB during year *t*, *t*-1, and *t*-2 from firms annual statements.[30] We use firms' Chinese patents to construct the R&D efficiency measure because Chinese officials are likely to be primarily concerned with

[30] One concern about the R&D efficiency measure in Equation (2) is the imprecision with which Chinese firms measure and report their R&D expenditures. (This concern extends well beyond China; e.g., National Research Council, 2005, discusses this issue in the U.S.). To address this concern, we repeated the analysis using sales rather than R&D as the scaling variable in Equation (2), as reported in the Internet Appendix (Tables IA5–IA8).

domestic patent counts. Chinese patents are also far more prevalent in our sample: while 84% of our firms have Chinese patents, only 15% have U.S. patents.[31] Statistics in Table 3 show that the average R&D efficiency measure is 0.062, meaning that on average, it took about 16 (1/0.062) million RMB (~2.4 million USD) of R&D capital to generate one Chinese patent.

For firm-level corruption, we use the Entertainment and Travel Costs (ETC) reported by Chinese firms in the footnotes of their annual statements, which has become a widely used measure of corruption in China-related research in recent years. (Appendix 2 contains several tests that we conducted to independently validate ETC as a corruption measure). Cai et al. (2011) is one of the first papers using this measure and the authors point out that while ETC contains legitimate business expenses, in practice there is significant latitude in how employees claim such expenses, making this accounting item indicative of corruption. For example, if bribes such as gifts, alcohol, cigarettes, banquets, and Karaoke entertainment are procured at a business hotel, these expenses can be billed to the room and reported as ETC.

Figure 2 plots the average ETC spending among our sample firms over time. Corroborating the idea that ETC reflects corruption, we observe a sharp drop in ETC after 2012, the onset of the anti-corruption campaign. The magnitude of the ETC deserves a comment. The fact that the average firm spends roughly 0.6% of total sales on ETC implies that, even if only 10% of total ETC is corruption, the aggregate amount of petty corruption is large and a non-trivial share of GDP. In addition, since firms received 0.5% of annual sales as R&D subsidies on average (Table 3), again assuming that 10% of the ETC spending was for corruption, then firms received roughly 8.5 RMBs of innovative subsidies for each RMB of ETC spending.

[31] For robustness, we also use firms' U.S. patents to construct an alternative measure of R&D efficiency, and we obtain qualitatively similar results (available upon request).

The raw ETC data offer a useful but noisy measure of petty corruption. To control for legitimate business costs, we borrow from Cai et al. (2011) and the accounting literature on the treatment of discretionary accruals (Gul et al., 2011; Kothari et al., 2005) and estimate the following cross-sectional regression for each industry-year subsample:

$$ETC/Sales_{i,t} = \gamma_0 + \gamma_1 Ln(Assets)_{i,t} + \gamma_2 Business\ In\ Other\ Regions_{i,t} + \gamma_3 PerCapGDP_{i,t} + \varepsilon_{i,t} \quad (3)$$

where Ln (Assets) is the log of book value of a firm's total assets, Business In Other Regions is the number of geographical regions where a firm's revenue comes from other than the region where the firm is based,[32] and PerCapGDP is the log of per-capita GDP of the firm's home province. We use these three control variables to estimate firms' predicted ETC/Sales, which is likely to vary systematically according to legitimate business needs.[33] We then take the residual from this regression as the abnormal ETC/Sales (AETC/Sales) incurred by the firm, which we use as the primary proxy for corruption in subsequent analyses.

One interesting question concerns the relationship between firm merit and corruption. Do more innovative firms bribe more (perhaps because the benefits from subsidies are higher)? Or are poor innovators more likely to rely on corruption? Or are the two variables uncorrelated? To check, we calculated within-industry-province-year correlations between firms' AETC and R&D efficiency. We find this correlation to be 0.022 (p-value=0.609). Therefore, AETC and R&D

[32] Firms report the regional distribution of their revenues in the annual reports. Chinese provinces are grouped into eight geographic regions in China: North (华北), South (华南), Middle (华中), East (华东), North-East (东北), North-West (西北), South-West (西南), and Hong Kong/Macau/Taiwan (港，澳，台). Other countries are coded as one separate region.

[33] Our results are robust to including additional control variables, such as firm leverage and operating performance (ROA). They are also robust to using panel regressions, rather than industry-year subsample regressions, to estimate the abnormal ETC. These additional results are available on request.

efficiency are largely uncorrelated among firms in the same industry and province in the same year, i.e., firms that are likely to compete for subsidies.

B. Difference-in-Differences Analyses of Subsidies

To examine factors influencing subsidies, we start with difference-in-differences analyses focusing on changes in subsidies before and after our identification events, for firms with high and low merit or corruption.

Tables 7 and 8 report the results using the removals of top provincial officials on corruption charges and the departures of technology bureau heads as the key events, respectively. In both tables, Panel A examines the pre-event parallel trends assumption. Panels B and C report the difference-in-differences results for firms sorted by merit (R&D efficiency) and by corruption (AETC/Sales), respectively. We sort firms into high and low groups based on merit or corruption as follows. For each event in year *t*, we define up to three years before (i.e., *t*-1, *t*-2, and *t*-3) as the pre-event window, and up to three years after (*t*+1, *t*+2, and *t*+3) as the post-event window. (Due to the timing of events, not all events have three pre- and three post-event years.) For each firm affected by an event, we calculate its average R&D efficiency or AETC during the pre-event window, and use the median value of this average to divide the sample into high- and low-R&D efficiency groups or AETC groups.

Table 7 Panel A examines the parallel trends assumption in the three years prior to the event year by comparing the annual percentage increases in R&D subsidies (scaled by sales) received by more or less meritorious (or corrupt) firms. We do not detect significant differences in the growth pattern of subsidies for the different groups of firms. Figures IA1 and IA2 in our Internet Appendix contain additional plots that examine the parallel trends assumption for other key firm-level variables, such as leverage, ROA, and Tobin's Q, and suggest a similar absence of pre-trends.

Panel B shows that subsidies received by high R&D efficiency firms more than doubled from 0.27% of revenue to 0.66% of revenue. However, subsidies received by low-efficiency firms showed no significant increase before and after the event. The difference-in-differences between the two sets of firms is significant at the 5% level.

In contrast, Panel C shows that firms with high AETC did not experience significant increases in R&D subsidies after the event relative to before, but low-AETC firms' subsidies more than doubled from 0.31% of revenue before to 0.68% of revenue after the event. The difference-in-differences between the two groups is again significant at the 10% level.

The above difference-in-differences results are visually represented in Figure 5. The figure shows that while there is virtually no change in subsidies to low R&D efficiency firms in the post-event window, subsidies to high-efficiency firms increased substantially. At the same time, while there was no change in subsidies to high-AETC firms post-event, subsidies to low-AETC firms increased substantially. Together these patterns indicate that corruption had less impact on subsidies post-event, while firm merit had more impact.

Table 8 reports a parallel set of difference-in-differences analyses of R&D subsidies around the departures of provincial technology bureau heads. Results in this table are qualitatively similar to those in Table 7. Panel A again reveals no differential pre-event trends. Panel B shows that while subsidies to high-efficiency firms more than doubled in the post-event window from 0.19% of revenue to 0.50%, there was no notable increase in subsidies to low-efficiency firms before and after official departures. Panel C shows that while there was no change in subsidies to high-AETC firms post-event, subsidies to low-AETC firms nearly doubled from 0.24% before to 0.47%. These patterns are visually depicted in Figure 6. Overall, the difference-in-differences analyses in Table 7 and 8 indicate that merit had a stronger effect on subsidies (and a weaker one on corruption) after both of these events.

C. Panel Regressions of Subsidies

Tables 9 and 10 augment the difference-in-differences analyses by examining subsidies in a panel regression setting. Table 9 focuses on the removal of top provincial officials due to corruption charges. Panel A presents the full-sample result. The dependent variable is the amount of R&D subsidies received by a firm in a given year (scaled by the firm's revenue in that year). The key independent variables are merit (R&D efficiency), corruption (AETC/Sales), a post-removal indicator variable, and interaction terms between merit and the post-removal indicator and between corruption and the post-event indicator. Control variables include an indicator variable for SOEs, the firms' political connections, and performance and financial variables including ROA, Tobin's Q, and leverage. All detailed variable definitions are in Appendix 1. All control variables are lagged by one year.

Models (1) through (3) focus on the two key independent variables: R&D efficiency and AETC only. Both enter the regressions with positive and highly significant signs, indicating that both were important determinants of subsidies. The coefficients suggest that a one standard deviation increase in R&D efficiency was associated with a 10% increase in R&D subsidies.[34] Likewise, a one standard deviation increase in AETC was associated with a 9.1% increase in R&D subsidies.[35] Thus, the two variables had roughly equal impacts on subsidies.

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[34] The standard deviation of R&D efficiency is 0.169 (Table 3). The coefficient of R&D efficiency is 0.003. Therefore, the associated impact on Subsidies/Sales is 0.0005 (0.169×0.003), which is 10% of the average Subsidies/Sales (0.005 Table 3).

[35] The calculation parallels that above: $0.008 \times 0.057/0.005$=9.1%.

Models (4) through (7) include the interaction terms between R&D efficiency and AETC on the one hand and the post-removal indicator on the other. Across all four specifications, we find that the interaction term between R&D efficiency and the post-removal indicator is positive and significant, indicating that merit had a stronger effect on subsidies in post-removal years. In sharp contrast, the interaction term between AETC and the post-removal indicator is significantly negative across all four models, suggesting that corruption had a weaker effect on subsidies in post-removal years. Furthermore, in model (7), which includes firm fixed effects, R&D efficiency alone is not significant in predicting subsidies; only its interaction term with the post-removal indicator is positive and significant. Therefore, the positive effect of merit was concentrated in the post-removal years. On the other hand, AETC has a positive and significant sign (0.051), and its interaction term with post-removal has a negative and significant sign (-0.063). The magnitudes of these two coefficients imply that the positive effect of corruption on subsidies was negated in post-removal years. These directionally opposite changes clearly indicate that anti-corruption efforts increased the importance of merit and decreased the importance of corruption in officials' subsidy-grant decisions.

Panel B of Table 9 further investigates these patterns in regions with different levels of corruption ex ante. If the changes in subsidy allocations are related to anti-corruption efforts, we might expect the patterns to be stronger in regions that were ex ante more corrupt. To examine this regional variation, we use the corruption index calculated by China's National Economic Research Institute (NERI, see Fan et al., 2010 and 2011).[36] Specifically, we calculate the average corruption

[36] The NERI index is a widely used measure of corruption in China, and it is constructed from survey responses on two issues: 1) the time businesses spend dealing with bureaucracy; and 2) the non-tax expenses levied on enterprises, including informal charges and illegal fines from the local government, as a percentage of sales. We use the NERI reports in 2010 and 2011 to calculate each province's corruption index, as these reports cover the years prior to the anti-corruption campaign.

index for each province in 2009, 2010, and 2011, the three years before the anti-corruption campaign. We use the median to split China's provinces into "high-corruption" and "low-corruption" categories. For brevity, Panel B reports only key coefficients.

Consistent with our expectations, subsidies became more sensitive to R&D efficiency and less sensitive to AETC especially in ex ante high-corruption regions. Interestingly, the results indicate that in high-corruption regions, merit in general did not affect subsidies; only corruption had a positive and significant effect. The pattern was the opposite in low-corruption regions: merit had a positive and significant impact, but corruption had no significant effect. The *changes* in the relative importance of the two variables after the removals of corrupt officials (the interaction terms) were only observed in the high-corruption regions. These results provide further confirmation that the phenomena we document occurred due to anti-corruption efforts.

Panel A of Table 10 presents a parallel set of panel regressions examining the R&D subsidies before and after the departures of technology bureau heads. Results in this table are consistent with those in the previous table. In all regressions, the interaction term between R&D efficiency and the post-departure indicator is positive and significant while the interaction term between AETC and the post-departure dummy is negative and significant. The coefficient estimates suggest that the impact of R&D efficiency on subsidies roughly doubled post-departure: The coefficient on the interaction terms is about 0.002, roughly equal to the coefficient on the R&D efficiency variable alone. In contrast, the effect of corruption on subsidies was essentially negated by the departures. For instance, in model (7) with firm fixed effects, the coefficient of AETC is 0.084 and the interaction term between AETC and the post-departure dummy is -0.081, suggesting that the net effect of AETC on subsidies after the departures was close to zero.

Panel B of Table 10 further investigates these patterns in regions with different levels of corruption ex ante. We use the NERI corruption index for each province in 2006, the year before our sample period (2007–2016), and we use the median to split China's provinces into "high-corruption" and "low-corruption" categories. For brevity, only key coefficients are reported. The pattern of the results is similar to that of Panel B in Table 9. We again find that subsidies became more sensitive to R&D efficiency and less to AETC after the departure of technology bureau heads, especially in ex ante high-corruption regions. The results are consistent with our expectation. Compared with the firms in ex ante low-corruption regions, the firms in ex ante high-corruption regions are more likely to develop close relationships with bureau heads through bribery: thus, the departures of bureau heads could lead to a larger decrease in the association between AETC and subsidies, and a larger increase in the association between R&D efficiency and subsidies.

D. Subsidies and financial constraints

Collectively, the analyses in this section show that subsidy decisions became more sensitive to firm merit and less sensitive to corruption when the level of corruption went down. Although this indicates that subsidy decisions became more efficient, it does not necessarily imply that they became more *effective*. The effectiveness of subsidy programs ultimately depends on whether they helped relax the financial constraints for deserving firms. One alternative possibility is that officials simply became "lazy" and allocated resources to obvious winners (firms with high R&D efficiency). Such a simple strategy would simultaneously make the officials look good and help them escape the wrath of anti-corruption watchdogs. The result of such a strategy, however, could be that subsidies became ever more concentrated in already well-funded firms, leaving deserving yet financially constrained firms under-funded.

To investigate this possibility, we examine the subsidy allocations among sub-samples of firms facing high or low financial constraints. We again use firms' dependence on external financing as the proxy for financial constraints. Table 11 reports regression analyses of the change in subsidies before and after the removal of top provincial officials for firms with high and low dependence on external financing.[37] We find that the increased impact of merit and the decreased impact of corruption on subsidy allocation is concentrated in financially constrained firms—those with high dependence on external financing. Interestingly, the evidence from this analysis also points to a severe misallocation of resources when corruption is high: Prior to the removal of corrupt officials, corruption played a positive role in obtaining subsidies for financially constrained firms, but merit did not.

Overall, the results in this section consistently indicate that events that reduced corruption —whether the replacement of senior leaders during the anti-corruption campaign or the rotations of innovation agency officials—had the effect of strengthening the impact of merit (R&D efficiency) on subsidies and simultaneously reducing the influence of corruption (AETC/Sales) on subsidies. Together with our earlier finding that the connection between subsidies and future innovation became stronger after the same events, our evidence collectively suggests that reducing corruption improves the allocational efficiency of subsidies. These effects are stronger among financially constrained firms, indicating that the reduction of corruption resulted in overall more effective allocation of R&D subsidies.

4. Additional Analyses and Robustness Checks

[37] Parallel results on financial constraints before and after the departures of technology bureau heads are reported in Table IA9 of our Internet Appendix and are qualitatively similar.

We exploited the richness of our data and conducted numerous additional analyses and robustness checks that provide further support for our main findings in the previous sections. In one additional analysis, we examined the nature of the 53 departures of technology bureau heads and found that 14 (26%) were due to promotions or lateral moves within the technology administration function. The remaining 39 (74%) were due to retirements, demotions, or moves that caused the official to leave the technology administration function of the government. We classified the former type of moves as "good moves" and the latter type as "bad moves" from the point of view that the former type of moves maintained the official's influence over his or her former peers, while the latter type permanently diminished it. If our results reflect the breaking of the close relationship between firms and officials, then we should find them to be stronger in the latter type of moves. Results reported in Table IA10 in our Internet Appendix confirm this intuition.

In another set of analyses, we distinguished different types of subsidies. Among the seven categories of subsidies, categories 5 and 7 (subsidies for commercialization and equipment purchases and patent application fees) might be considered less central to innovation than others. We thus expect the results to be stronger for subsidies that are more directly related to innovation. Results in Tables IA11–IA14 in the Internet Appendix confirm that this is indeed the case.

In addition, we conducted a host of robustness checks to our results, all of which are reported in our Internet Appendix. All our results hold qualitatively when we used two additional identification methods. In the first of these, reported in Tables IA15 and IA16 in our Internet Appendix, we use 2012 as the single event year for the start of the anti-corruption campaign and conducted difference-in-differences analyses before and after this year.

In the second alternative, we used the staggered inspections by the central government of the provinces on their anti-corruption efforts. Inspection by the central government of provincial implementation of key policies is part of the standard tools of China's command and control system. Between 2013 and 2014, the China's central government conducted four rounds of inspections in which "Central Inspection Work Leadership Teams" visited provincial governments and Party leaderships to emphasize the importance of the anti-corruption effort and to inspect their results. [38] These four rounds allowed us to divide the sample into two halves: those inspected in 2013, and those inspected in 2014. Although the tight timeline of the inspections is less than ideal for identification purposes, we use these staggered events to conduct difference-in-differences analyses. These results are reported in Tables IA17 and IA18 in our Internet Appendix.

Other robustness checks, in addition to those already described in the text, include using models with linear time trend (Tables IA19 and IA20), using un-scaled subsidy figures (Tables IA21–IA24), and using unscaled patents or patents scaled by assets to measure future innovation (Tables IA25–IA26). Our main conclusions are robust to all these robustness checks.

5. Conclusions

Using data from China, we investigate how corruption affects the relationship between government R&D subsidies and firm innovation. Governments all over the world subsidize innovation efforts, and corruption may be a problem common to these efforts. Individuals who control the rights to allocate resources (R&D subsidies) can be susceptible to corruption, which

[38] For details of these inspections, see the CCDI website: http://www.ccdi.gov.cn/special/zyxszt/. These four rounds are: 2013 Round 1—Inner Mongolia, Chongqing, Hubei, Jiangxi, Guizhou; 2013 Round 2—Shanxi, Jilin, Anhui, Hunan, Guangdong, Yunnan; 2014 Round 3—Beijing, Tianjin, Liaoning, Fujian, Shandong, Henan, Hainan, Gansu, Ningxia, Xinjiang; and 2014 Round 4—Guangxi, Shanghai, Qinghai, Xizang (Tibet), Zhejiang, Hebei, Shaanxi, Heilongjiang, Sichuan, Jiangsu.

might have benign effects but which might also lead to resource misallocation. China is a fertile testing ground for these issues, given the pervasiveness of innovative subsidies and corruption and recent anti-corruption efforts.

Exploiting the staged rollout of the anti-corruption campaign in China and the rotations of government officials responsible for provincial innovation programs as two separate identification methods, we first establish that the association between R&D subsidies and future innovation became significantly positive in the years following these events, while this association was weak in the years before. We then seek to explore the mechanisms behind these patterns. We establish that firms' innovative abilities and petty corruption both affected the allocation of government R&D subsidies. However, the relationship between firms' innovative abilities and subsidies was strengthened by personnel changes (either due to corruption charges or official rotation), while the relationship between corruption and subsidies was weakened.

While our study does not focus on whether government subsidies cause firm innovation and we do not draw such a causal inference, the consistent patterns emerging from the multiple identification methods in our paper indicate that anti-corruption efforts and other mechanisms that break up the ties between firms and officials can improve the allocational efficiency of government R&D subsidies. Reducing the impact of corruption on subsidy decisions allows firm merit to play a larger role, which can lead to more efficient allocation outcomes. These findings not only demonstrate corruption-related distortions in government R&D subsidies, but they also provide insights into the administration of R&D subsidy programs in China and elsewhere.

Other questions are left unanswered by our study. For example, while we focused on the efficiency of R&D allocations, we are less able to address the effectiveness of particular program design elements, which can be critical to success (e.g., Howell, 2017). We leave such important questions for future research.

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Figure 1: Media mentions of anti-corruption

This graph shows the time trend of the percentage of articles in all official provincial newspapers (the "Daily" newspapers published by provincial governments) with the words "anti-corruption" in their titles. For details on Chinese newspapers, see footnote 10.

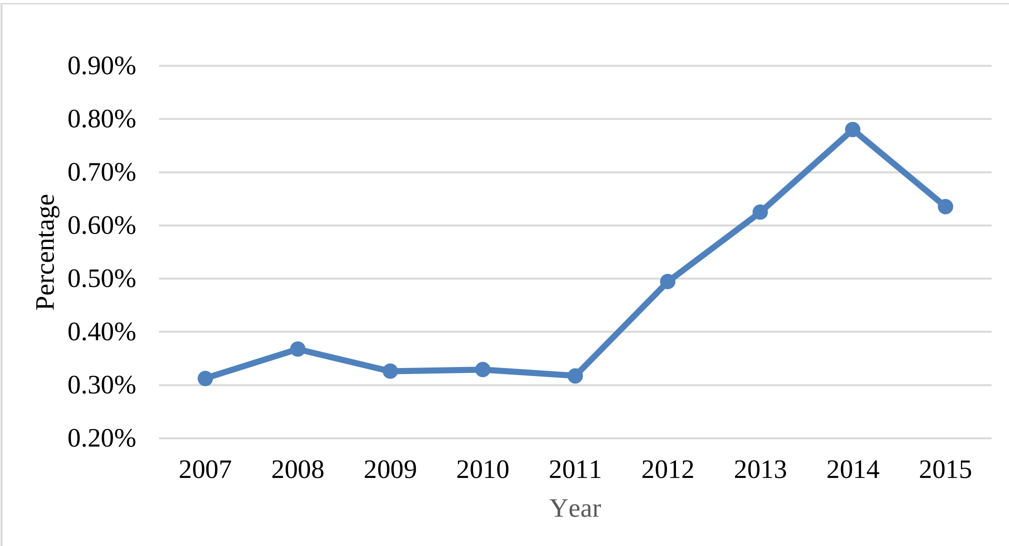


Figure 2: Average ETC spending over time

This figure shows the trend of the average ETC as a percentage of revenue. ETC is firms' entertainment and travel costs, as reported in their annual statements.

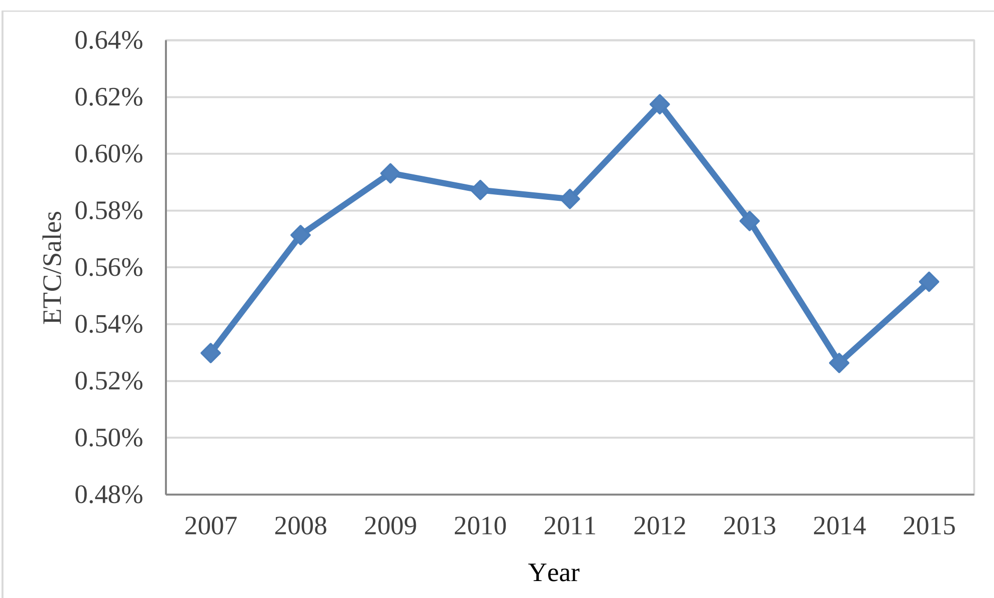


Figure 3: Departures of provincial technology bureau heads

This figure plots the number of departures of provincial technology bureau heads by year.

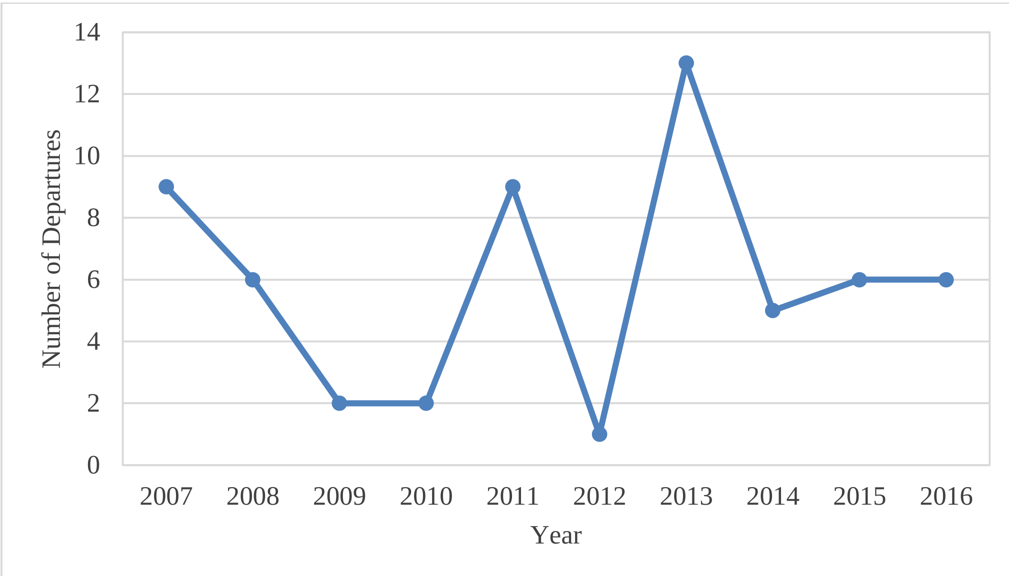
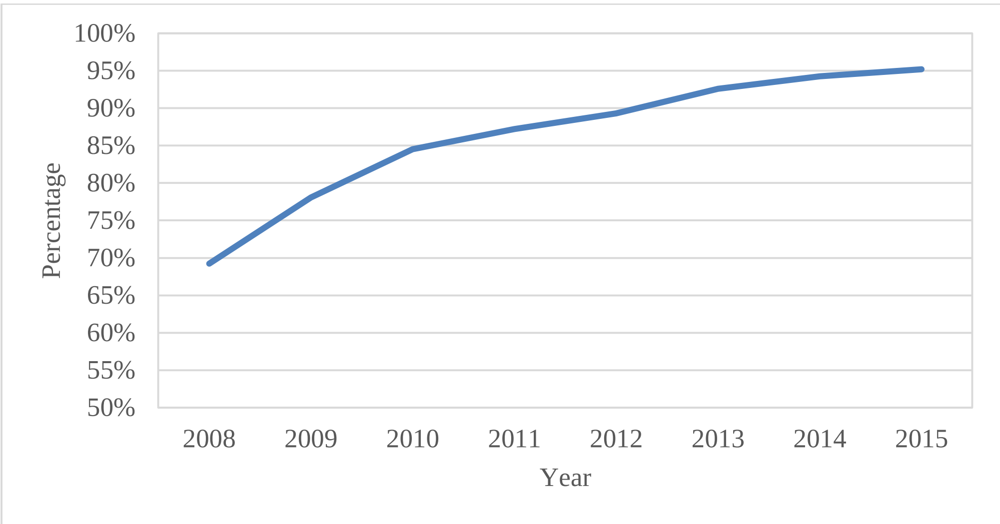


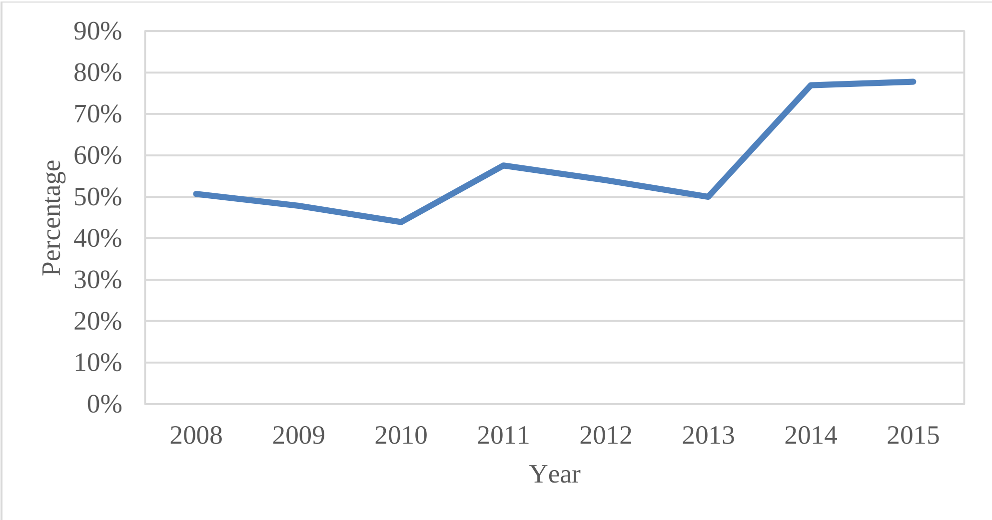
Figure 4: Subsidies among sample firms

This figure plots the percentages of different types of firms receiving R&D subsidies over time. Panel A shows the percentage of firms in our sample that receive subsidies in each year. Panel B shows the percentage of small firms (firms whose total assets were less than the median value in the sample in a given year) among new recipients. Panel C shows the percentage of non-SOE firms among new recipients. The SOE classification is detailed in Appendix 1.

A. Percentage of all sample firms receiving R&D subsidies



B. Percentage of small firms among new recipients



C. Percentage of non-SOE Firms among new subsidy recipients

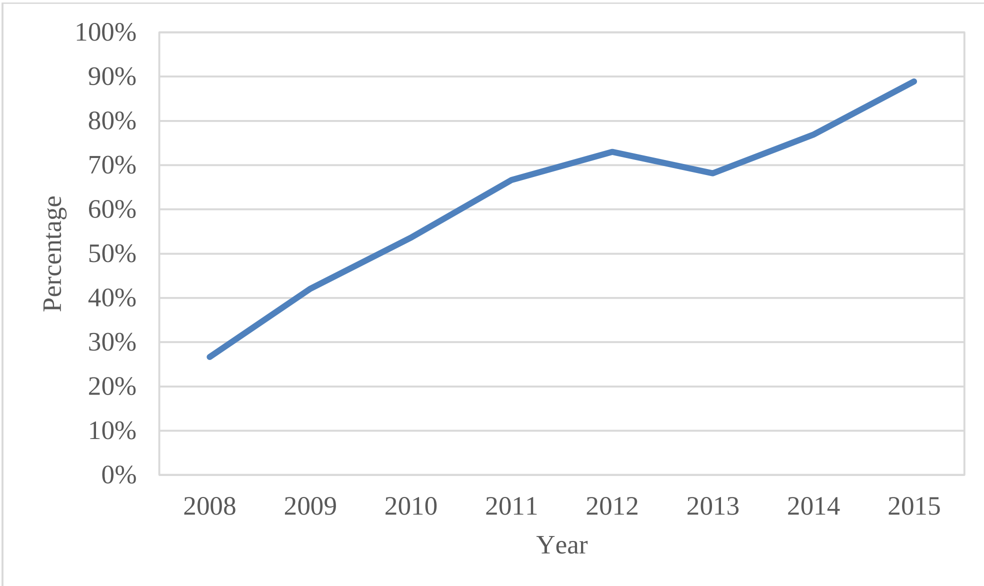
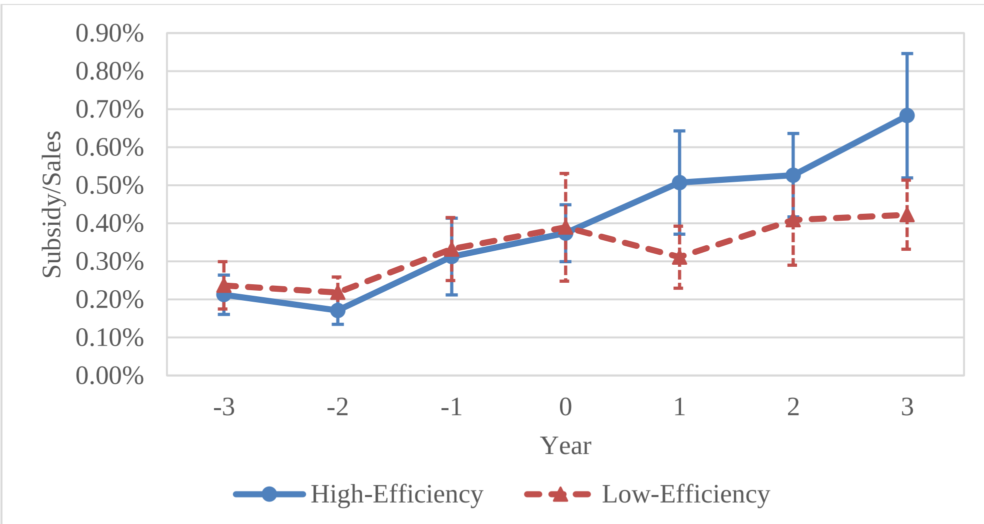


Figure 5: Subsidies before and after the removals of top provincial officials on corruption charges

This figure plots the R&D subsidies (scaled by firm revenue) received by firms before and after the removal of top provincial officials on corruption charges. In Panel A, we sort firms by the average R&D efficiency (calculated as in Equation 2) during the three event years prior to the removals of top provincial officials. Firms with above (below) median efficiency are classified as high- (low-) efficiency firms. In Panel B, we sort firms by the average AETC/Sales during the three event years before the removal of top provincial officials. Firms with above (below) median spending are classified as high- (low-) AETC firms. The vertical bars represent standard errors.

A. Sorting firms by R&D efficiency



B. Sorting firms by AETC/Sales

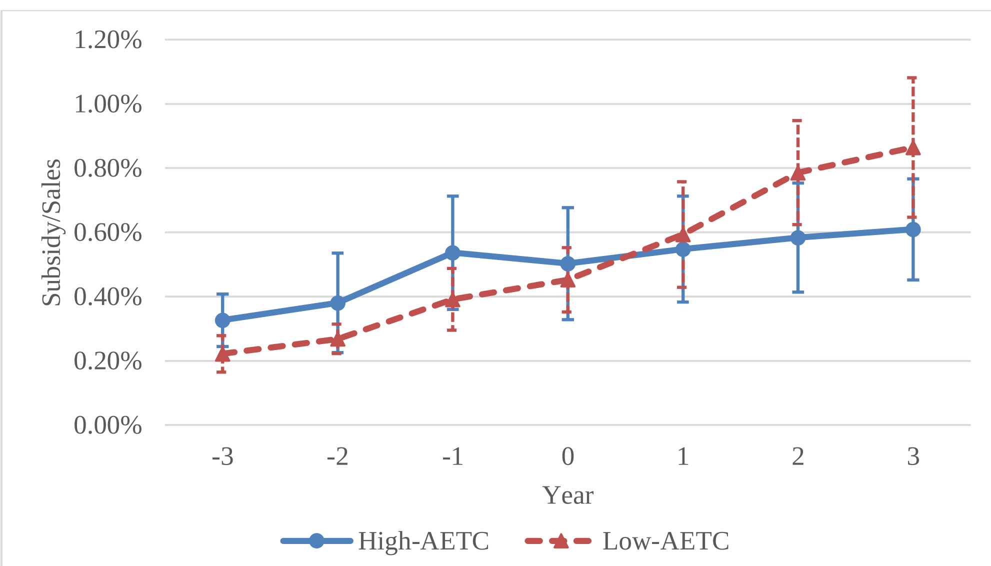
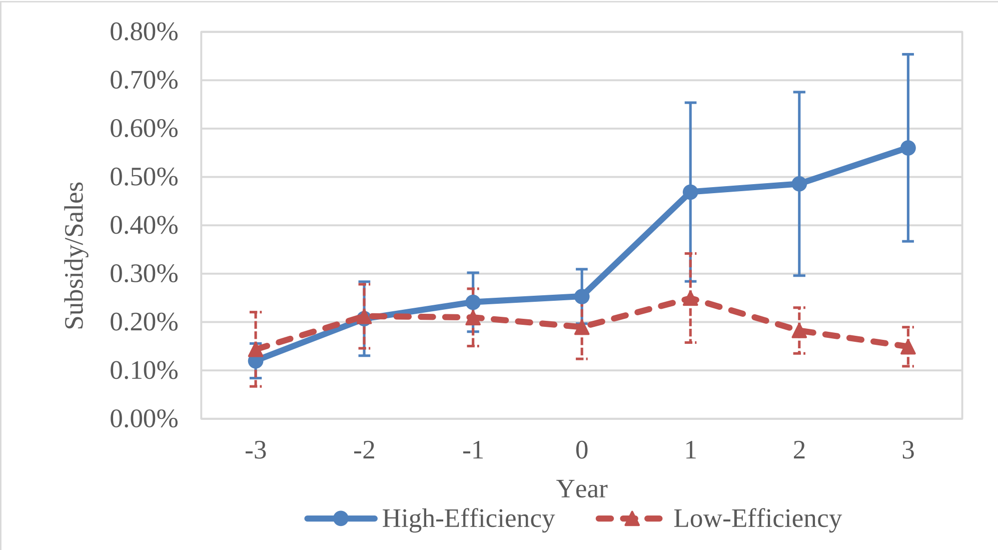


Figure 6: Subsidies before and after departures of provincial technology bureau heads

This figure plots the R&D subsidies (scaled by firm revenue) received by firms before and after the departure of provincial technology bureau heads. In Panel A, we sort firms by the average R&D efficiency (calculated as in Equation 2) during the three event years prior to the official departures. Firms with above (below) median efficiency are classified as high- (low-) efficiency firms. In Panel B, we sort firms by the average AETC/Sales during the three event years before the officials' departures. Firms with above (below) median spending are classified as high- (low-) AETC firms. The vertical bars represent standard errors.

A. Sorting firms by R&D efficiency



B. Sorting firms by AETC/Sales

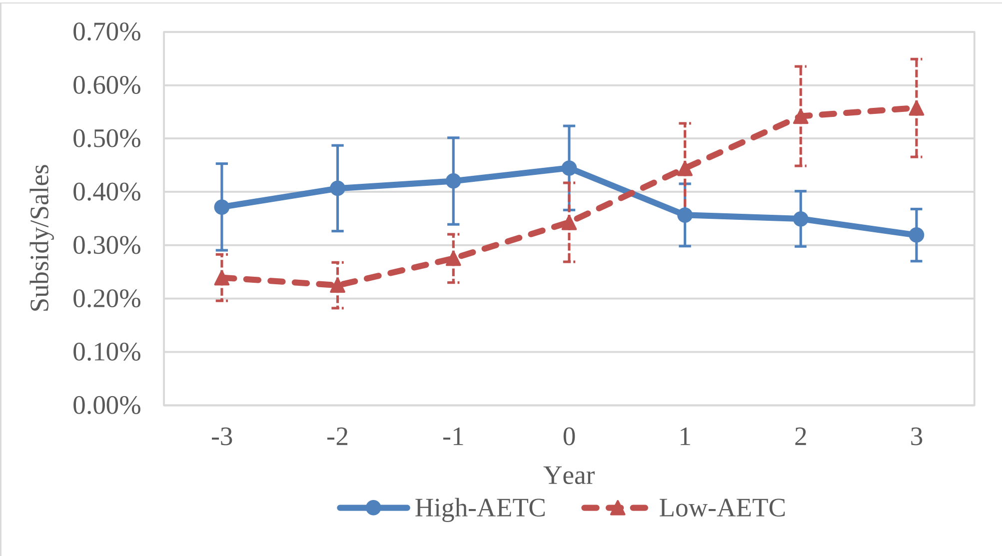


Table 1. The removals of top provincial officials on corruption charges during the anti-corruption campaign

This table summarizes the removal of top provincial officials on corruption charges after the inception of the anti-corruption campaign. Included are removals of either provincial governors or provincial party secretaries. The data are compiled from the website of the Central Commission of Discipline Inspection.

Year	Province	Number of Officials Removed
2012	Sichuan	1
2012	Chongqing	2
2013	Anhui	1
2013	Hubei	1
2013	Sichuan	1
2014	Hainan	2
2014	Yunnan	1
2014	Jiangxi	1
2014	Shanxi	2
2014	Inner Mongolia	1
2015	Fujian	2
2015	Hebei	1
2015	Jilin	1
2015	Shanghai	1
2015	Ningxia	1
2015	Beijing	1
2016	Anhui	2
2016	Guangdong	1
2016	Jiangsu	1
2016	Tianjin	2
Total	18	26

Table 2. Categories of R&D subsidies

This table tabulates the seven categories of subsidies that we collected from the companies' financial report footnotes in order to calculate firms' total subsidies received. We report the aggregate amount and the share of the subsidies.

Funding Category	Subsidy Description	Total Amount (RMB, mil)	% of Total
1	Subsidies for product development, intermediate testing, and major R&D projects	2,123	3.15%
2	National and provincial Small and Medium Technology Enterprises Innovation Funds (InnoFund)	106	0.16%
3	Subsidies for small and medium enterprises' technological adaptation and upgrading	76	0.11%
4	Subsidies for technological modification and upgrading	5,577	8.29%
5	Subsidies for technology commercialization and equipment and systems purchase	15,795	23.47%
6	R&D grants	43,190	64.18%
7	Subsidies for patent applications	427	0.64%
	Total	67,294	100%

Table 3. Sample descriptive statistics

This table provides descriptive statistics of our sample, which consists of annual firm-level observations between 2007 and 2016. Detailed variable definitions are found in Appendix 1. All financial amounts are measured in millions of RMB. All financial ratios are calculated annually using annual statements.

Variable	Mean	Standard Deviation	Min.	Median	Max.	Observations
Panel A: Main Variables						
Subsidies/Sales	0.005	0.009	0	0.002	0.064	8628
ETC/Sales	0.006	0.009	0	0.004	0.086	8628
AETC/Sales	0	0.008	-0.018	-0.001	0.080	8628
R&D/Sales	0.037	0.044	0	0.030	0.311	8628
Subsidies/R&D	0.223	0.618	0	0.071	6.401	7293
Patents/Sales (China)	0.004	0.009	0	0	0.071	8628
Relative Citation Strength (China)	0.374	0.807	0	0	5.116	8628
Patents/Sales (U.S.)	0.0001	0.0008	0	0	0.008	8628
Relative Citation Strength (U.S.)	0.015	0.124	0	0	1.250	8628
R&D Efficiency	0.062	0.169	0	0.007	1.607	8381
Panel B: Control Variables						
Size (Mil. RMB)	5204.41	18451	25.36	1961.16	615319	8628
Age (Year)	15.47	4.843	2	15	37	8628
Leverage	0.415	0.235	0.030	0.400	1.567	8628
Return on Assets	0.039	0.066	-0.335	0.039	0.270	8628
Tobin's Q	3.037	2.357	0.903	2.338	18.98	8628
Intangible Assets/Assets	0.045	0.042	0	0.036	0.310	8628
SOE	0.365	0.481	0	0	1	8628
Political Connection	0.232	0.422	0	0	1	8628
Business in Other Regions	2.631	1.217	0	2	8	8628

Table 4. Subsidies and future innovation: Before and after the removals of top provincial officials on corruption charges

This table investigates the relation between R&D subsidies and future innovation before and after the removals of top provincial officials on corruption charges. We present results using two measures of future innovation as the dependent variable. In Panel A, the dependent variable is Patents/Sales using U.S. patent data. In Panel B, the dependent variable is Relative Citation Strength using U.S. patent data. In Panels B, for brevity, only key coefficients are reported. Detailed variable definitions are found in Appendix 1. In each regression, we include the lagged dependent variable to control for persistence. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (4), and clustered by industry and province are used for regression in Column (5). *p*-values are in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: U.S. patents

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Patents/ Sales (U.S.)	Patents/ Sales (U.S.)	Patents/ Sales (U.S.)	Patents/ Sales (U.S.)	Patents/ Sales (U.S.)
Patents/Sales (U.S.)$_{t-1}$	0.512***	0.512***	0.509***	0.501***	-0.044***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Subsidies/Sales $_{t-1}$	0.005***	0.004***	0.004***	0.004***	0.001
	(0.002)	(0.000)	(0.000)	(0.000)	(0.666)
Post Removal		-0.0001***	-0.0001***	-0.0001*	-0.0001***
		(0.007)	(0.009)	(0.064)	(0.008)
Subsidies/Sales $_{t-1}$×Post Removal		0.007***	0.007***	0.007***	0.010***
		(0.003)	(0.002)	(0.004)	(0.000)
Ln(Assets) $_{t-1}$			0.000002	0.000004	-0.00003
			(0.820)	(0.681)	(0.158)
Ln(Age) $_{t-1}$			0.0001	0.00003	-0.0004**
			(0.255)	(0.327)	(0.011)
Leverage $_{t-1}$			-0.0001*	-0.0001*	-0.0001
			(0.060)	(0.089)	(0.141)
Intangible Assets/Assets $_{t-1}$			-0.0001	-0.0001	0.0002
			(0.530)	(0.647)	(0.508)
Return on Assets $_{t-1}$			0.0002*	0.0003**	-0.00004
			(0.082)	(0.032)	(0.789)
Tobin's Q $_{t-1}$			0.000003	0.000003	-0.00001
			(0.497)	(0.551)	(0.145)
SOE $_{t-1}$			-0.00002	-0.00001	-0.00001
			(0.290)	(0.495)	(0.895)
Political Connection $_{t-1}$			0.00001	0.00002	-0.0001**
			(0.418)	(0.322)	(0.014)
Constant	0.000002	0.00001	-0.0001	-0.0001	0.002***
	(0.871)	(0.901)	(0.694)	(0.443)	(0.002)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	No
Province fixed effects	No	No	No	Yes	No
Firm fixed effects	No	No	No	No	Yes
N	8628	8628	8628	8628	8628
R^2	0.245	0.246	0.248	0.253	0.540

Panel B: U.S. relative patent citation strength

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Relative Citation Strength (U.S.)	Relative Citation Strength (U.S.)	Relative Citation Strength (U.S.)	Relative Citation Strength (U.S.)	Relative Citation Strength (U.S.)
Relative Citation Strength (U.S.)$_{t-1}$	0.182***	0.182***	0.179***	0.174***	-0.104***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Subsidies/Sales $_{t-1}$	0.104	-0.079	-0.098	-0.211	-0.378
	(0.555)	(0.630)	(0.559)	(0.219)	(0.111)
Post Removal		-0.010*	-0.009*	-0.009	-0.005
		(0.068)	(0.076)	(0.146)	(0.457)
Subsidies/Sales $_{t-1}$×Post Removal		1.181***	1.143***	1.098***	1.282***
		(0.004)	(0.006)	(0.008)	(0.006)
Constant	0.014**	0.014**	-0.100***	-0.119***	0.012
	(0.013)	(0.017)	(0.004)	(0.001)	(0.905)
Lagged firm controls	No	No	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	No
Province fixed effects	No	No	No	Yes	No
Firm fixed effects	No	No	No	No	Yes
N	8628	8628	8628	8628	8628
R^2	0.046	0.047	0.049	0.054	0.280

Table 5. Subsidies and future innovation: Analysis around the departures of provincial technology bureau heads

This table investigates the relation between R&D subsidies and future innovation, around the departures of provincial technology bureau heads. We present results using two measures of future innovation as the dependent variable. In Panel A, the dependent variable is Patents/Sales using U.S. patent data. In Panel B, the dependent variable is Relative Citation Strength using U.S. patent citation data. In Panels B, for brevity, only key coefficients are reported. All variables are defined as in Appendix 1. In each regression, we include the lagged dependent variable to control for persistence. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (4), and clustered by industry and province are used for regression in Column (5). *p*-values are in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: U.S. patents

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Patents/ Sales (U.S.)	Patents/ Sales (U.S.)	Patents/ Sales (U.S.)	Patents/ Sales (U.S.)	Patents/ Sales (U.S.)
Patents/Sales (U.S.)$_{t-1}$	0.512***	0.512***	0.509***	0.501***	-0.033**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.010)
Subsidies/Sales $_{t-1}$	0.005***	0.003*	0.002	0.002	0.002
	(0.002)	(0.050)	(0.150)	(0.221)	(0.136)
Post Departure		-0.00001	-0.00001	-0.00002	0.000003
		(0.454)	(0.457)	(0.309)	(0.854)
Subsidies/Sales$_{t-1}$×Post Departure		0.005***	0.005***	0.005***	0.004**
		(0.003)	(0.002)	(0.003)	(0.025)
Ln(Assets) $_{t-1}$			0.000002	0.000004	0.00001
			(0.790)	(0.682)	(0.484)
Ln(Age) $_{t-1}$			0.00003	0.00003	-0.0004***
			(0.285)	(0.325)	(0.009)
Leverage $_{t-1}$			-0.0001**	-0.0001*	-0.0001
			(0.046)	(0.077)	(0.123)
Intangible Assets/Assets $_{t-1}$			-0.0001	-0.0001	0.0002
			(0.549)	(0.693)	(0.407)
Return on Assets $_{t-1}$			0.0002*	0.0003**	-0.00004
			(0.098)	(0.042)	(0.794)
Tobin's Q $_{t-1}$			0.000003	0.000003	-0.000004
			(0.417)	(0.496)	(0.405)
SOE $_{t-1}$			-0.00002	-0.00001	-0.00002
			(0.293)	(0.520)	(0.802)
Political Connection $_{t-1}$			0.00001	0.00002	-0.0001
			(0.420)	(0.303)	(0.105)
Constant	0.000002	0.00001	-0.0001	-0.0002	0.002***
	(0.871)	(0.802)	(0.702)	(0.479)	(0.003)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	No
Province fixed effects	No	No	No	Yes	No
Firm fixed effects	No	No	No	No	Yes
N	8628	8628	8628	8628	8628
R^2	0.245	0.246	0.248	0.253	0.534

Panel B. U.S. relative patent citation strength

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Relative Citation Strength (U.S.)	Relative Citation Strength (U.S.)	Relative Citation Strength (U.S.)	Relative Citation Strength (U.S.)	Relative Citation Strength (U.S.)
Relative Citation Strength (U.S.)$_{t-1}$	0.182***	0.182***	0.179***	0.174***	-0.100***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Subsidies/Sales $_{t-1}$	0.104	-0.251	-0.268	-0.371	-0.307
	(0.555)	(0.262)	(0.239)	(0.110)	(0.294)
Post Departure		-0.002	-0.001	-0.002	0.002
		(0.590)	(0.738)	(0.585)	(0.660)
Subsidies/Sales$_{t-1}$×Post Departure		0.646**	0.625**	0.589*	0.685**
		(0.031)	(0.037)	(0.052)	(0.048)
Constant	0.014**	0.014**	-0.101***	-0.119***	0.152
	(0.013)	(0.017)	(0.004)	(0.001)	(0.141)
Lagged firm controls	No	No	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	No
Province fixed effects	No	No	No	Yes	No
Firm fixed effects	No	No	No	No	Yes
N	8628	8628	8628	8628	8628
R^2	0.046	0.046	0.049	0.053	0.277

Table 6. Subsidies and future innovation, by financial constraints

This table investigates the relation between R&D subsidies and future innovation before and after the removals of top provincial officials, for firms with high or low financial constraints. Firms' financial constraints are measured by a modified RZ index of dependence on external financing (see text for description). Firms with high (low) dependence on external financing are considered constrained (unconstrained). The regression model is identical to Model (5) in Table 4, the specification including firm fixed effects. All variable definitions are identical to Table 4 and are defined in Appendix 1. For brevity, only key coefficients are reported. Huber-White heteroskedasticity-consistent standard errors are clustered by industry and province. *, **, *** indicates statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
Dependent Variable	Patents/ Sales (U.S.)		Relative Citation Strength (U.S.)	
	High Dependent on External Financing	Low Dependence on External Financing	High Dependent on External Financing	Low Dependence on External Financing
Subsidies/Sales $_{t-1}$	-0.002	0.001	0.012	-0.460
	(0.241)	(0.745)	(0.972)	(0.215)
Post Removal	-0.0001**	-0.00003	-0.019**	0.007
	(0.027)	(0.629)	(0.048)	(0.472)
Subsidies/Sales$_{t-1}$×Post Removal	0.019***	-0.008	1.596**	0.135
	(0.000)	(0.148)	(0.012)	(0.861)
Patents/Sales (U.S.)$_{t-1}$	0.047**	-0.206**		
	(0.013)	(0.017)		
Relative Citation Strength (U.S.)$_{t-1}$			-0.110***	-0.153***
			(0.000)	(0.000)
Constant	0.002**	0.002*	0.325**	0.196
	(0.032)	(0.051)	(0.033)	(0.211)
Lagged firm controls	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	4317	4311	4317	4311
R^2	0.600	0.636	0.387	0.459
Wald test for interaction term coefficient difference: (1) - (2)		(0.004)		
Wald test for interaction term coefficient difference: (3) - (4)				(0.052)

Table 7. Difference-in-differences analysis: Subsidies before and after the removals of top provincial officials on corruption charges

This table reports results of difference-in-differences analyses of the R&D subsidies received by firms before and after the removals of top provincial officials on corruption charges. Subsidies/Sales are measured as the amount of R&D subsidies a firm receives in a given year, divided by its annual revenue in that year. For each official removal event in year *t*, we use the three years before the event year (*t*-1, *t*-2, and *t*-3) as the "before" window, and up to three years after the event year (*t*+1, *t*+2, and *t*+3) as the "after" window. We sort firms by the average R&D efficiency (or average AETC/Sales) during the three event years prior to the official turnover. Firms with above (below) median efficiency (AETC) are classified as high- (low-) efficiency (AETC) firms. Panel A investigates the parallel trends assumption in the pre-turnover years by comparing the year-on-year growth in R&D subsidies (scaled by sales) received by the high- and low-efficiency groups. Panel B (C) reports the difference-in-differences in the levels of R&D subsidies scaled by sales received by firms with high and low R&D efficiency (AETC) groups. Detailed variable definitions are found in Appendix 1. *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels in a two-tailed test, respectively.

Panel A: Pre-trend test: Annual growth in Subsidies/Sales

	Event Year -3	Event Year -2	Event Year -1
High R&D Efficiency	0.084	-0.217	0.365
Low R&D Efficiency	0.018	-0.036	0.374
t-stat (High – Low)	0.242	-1.499	-0.040
	Event Year -3	Event Year -2	Event Year -1
High AETC	0.048	0.093	0.416
Low AETC	-0.023	0.028	0.569
t-stat (High – Low)	0.260	0.281	-0.420

Panel B: Difference-in-differences in Subsidies/Sales for firms with high and low R&D efficiency

	Before	After	After - Before	*t*-stat
High R&D Efficiency	0.0027	0.0066	0.0039	2.611**
Low R&D Efficiency	0.0028	0.0035	0.0007	1.081
High - Low	-0.0001	0.0031	0.0032	2.017**

Panel C: Difference-in-differences in Subsidies/Sales for firms with high and low AETC/Sales

	Before	After	After - Before	*t*-stat
High AETC	0.0044	0.0051	0.0007	0.834
Low AETC	0.0031	0.0068	0.0037	2.660**
High - Low	0.0013	-0.0017	-0.0030	-1.821*

Table 8. Difference-in-differences analysis: Subsidies before and after the departures of provincial technology bureau heads

This table conducts a difference-in-difference analysis of the change in R&D subsidies received by firms with high and low R&D efficiency (or high and low AETC) before and after the departures of provincial technology bureau heads. Subsidies/Sales are measured as the amount of R&D subsidies a firm receives in a given year, divided by its annual revenue in that year. For each official departure event in year *t*, we use up to three years before the departure year (*t*-1, *t*-2, and *t*-3) as the "before" window, and up to three years after the departure year (*t*+1, *t*+2, and *t*+3) as the "after" window. We sort firms by the average R&D efficiency (or average AETC/Sales) during the three event years prior to the official departures. Firms with above (below) median efficiency (AETC) are classified as high- (low-) efficiency (AETC) firms. Panel A investigates the parallel trends assumption in the "before" window by comparing the year-one-year growth in R&D subsidies scaled by sales received by the high and low R&D efficiency (AETC) groups. Panel B (C) reports the difference-in-differences in the levels of R&D subsidies scaled by sales received by firms with high and low R&D efficiency (AETC) groups. Detailed variable definitions are found in Appendix 1. *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels in a two-tailed test, respectively.

Panel A: Pre-trend annual growth in Subsidies/Sales

	Event Year -3	Event Year -2	Event Year -1
High R&D Efficiency	0.032	0.285	0.074
Low R&D Efficiency	0.270	0.530	-0.135
t-stat (High – Low)	-0.692	-0.584	0.107
	Event Year -3	Event Year -2	Event Year -1
High AETC	0.440	0.309	-0.034
Low AETC	0.391	0.226	0.018
t-stat (High – Low)	0.157	0.279	-0.366

Panel B: Difference-in-differences in Subsidies/Sales for firms with high and low R&D efficiency

	Before	After	After - Before	*t*-stat
High R&D Efficiency	0.0019	0.0050	0.0031	2.119**
Low R&D Efficiency	0.0018	0.0019	0.0001	0.157
High – Low	0.0001	0.0031	0.0030	2.030**

Panel C: Difference-in-differences in Subsidies/Sales for firms with high and low AETC/Sales

	Before	After	After - Before	*t*-stat
High AETC	0.0043	0.0035	-0.0008	-0.046
Low AETC	0.0024	0.0047	0.0023	2.831***
High – Low	0.0019	-0.0012	-0.0031	-2.849***

Table 9. Panel regressions: Subsidies before and after the removals of top provincial officials on corruption charges

This table reports results of panel regressions of R&D subsidies before and after the removals of top provincial officials on corruption charges. The dependent variable is Subsidies/Sales, measured as the amount of R&D subsidies a firm receives in a given year, divided by its annual revenue in that year. Panel A presents the results pertaining to the full sample; Panel B presents results when splitting the sample into high- and low-corruption regions. In Panel B, for brevity, only key coefficients are reported. Detailed variable definitions are found in Appendix 1. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (6) of Panel A, and clustered by industry and province are used for regression in Column (7) of Panel A and Columns (1) to (4) of Panel B. *p*-values are in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Full sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Subsidies/ Sales	Subsidies/ Sales	Subsidies/ Sales	Subsidies/ Sales	Subsidies/ Sales	Subsidies/ Sales	Subsidies/ Sales
R&D Efficiency$_{t-1}$	0.003***		0.003***	0.003***	0.003***	0.003***	0.001
	(0.001)		(0.001)	(0.000)	(0.000)	(0.000)	(0.103)
AETC/Sales $_{t-1}$		0.057**	0.059**	0.065***	0.064***	0.060***	0.051***
		(0.031)	(0.026)	(0.000)	(0.000)	(0.000)	(0.003)
Post Removal			0.001	0.0002	0.0002	0.001	0.0003
			(0.145)	(0.728)	(0.753)	(0.406)	(0.555)
R&D Efficiency $_{t-1}$×Post Removal				0.007*	0.007*	0.007*	0.011***
				(0.094)	(0.095)	(0.064)	(0.000)
AETC/Sales $_{t-1}$×Post Removal				-0.078*	-0.085*	-0.079*	-0.063*
				(0.090)	(0.064)	(0.081)	(0.077)
SOE $_{t-1}$					-0.001***	0.0001	-0.001*
					(0.000)	(0.782)	(0.079)
Political Connection $_{t-1}$					0.001***	0.001***	0.0003
					(0.002)	(0.004)	(0.475)
Return on Assets $_{t-1}$						-0.005***	-0.005***
						(0.002)	(0.001)
Tobin's Q $_{t-1}$						0.0003***	-0.00001
						(0.000)	(0.882)
Leverage $_{t-1}$						-0.007***	-0.002**
						(0.000)	(0.041)
Constant	0.001	0.001	0.001	0.001***	0.002***	0.004***	0.007***
	(0.280)	(0.182)	(0.227)	(0.005)	(0.000)	(0.000)	(0.000)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Firm fixed effects	No	No	No	No	No	No	Yes
N	7052	7052	7052	7052	7052	7052	7052
R^2	0.082	0.081	0.085	0.086	0.088	0.120	0.643

Panel B: High- versus low-corruption regions

	(1)	(2)	(3)	(4)
	High Corruption	High Corruption	Low Corruption	Low Corruption
Dependent Variable	Subsidies/Sales	Subsidies/Sales	Subsidies/Sales	Subsidies/Sales
R&D Efficiency$_{t-1}$	0.002	0.002	0.002**	0.002**
	(0.115)	(0.306)	(0.029)	(0.035)
AETC/Sales $_{t-1}$	0.069***	0.055*	0.044	0.035
	(0.007)	(0.076)	(0.169)	(0.320)
Post Removal		-0.001		0.001
		(0.445)		(0.542)
R&D Efficiency $_{t-1}$ ×Post Removal		0.004**		0.001
		(0.014)		(0.682)
AETC/Sales $_{t-1}$ ×Post Removal		-0.108*		0.082
		(0.057)		(0.393)
Constant	0.008***	0.009	0.009**	0.012**
	0.000	(0.341)	(0.038)	(0.033)
Lagged firm controls	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	1408	1408	5644	5644
R^2	0.518	0.527	0.614	0.617

Table 10. Panel regressions: Subsidies before and after the departures of provincial technology bureau heads

This table reports panel regression results of R&D subsidies around the departures of provincial technology bureau heads. The dependent variable is Subsidies/Sales, measured as the amount of R&D subsidies a firm receives in a given year, divided by its annual revenue in that year. Panel A presents the results pertaining to the full sample; Panel B presents results when splitting the sample into high- and low-corruption regions base on corruption index for each province in 2006, the year before our sample period. In Panel B, for brevity, only key coefficients are reported. Detailed variable definitions are found in Appendix 1. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (6) of Panel A, and clustered by industry and province are used for regression in Column (7) of Panel A and Columns (1) to (4) of Panel B. *p*-values are in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Full sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales
R&D Efficiency $_{t-1}$	0.003***		0.003***	0.002***	0.002***	0.002***	-0.001
	(0.001)		(0.001)	(0.003)	(0.004)	(0.007)	(0.456)
AETC/Sales $_{t-1}$		0.057**	0.059**	0.085***	0.083***	0.076***	0.084***
		(0.031)	(0.025)	(0.000)	(0.000)	(0.000)	(0.000)
Post Departure			-0.0003	-0.001*	-0.001*	-0.001*	-0.0001
			(0.117)	(0.072)	(0.076)	(0.064)	(0.999)
R&D Efficiency $_{t-1}$×Post Departure				0.002*	0.002*	0.002*	0.002*
				(0.078)	(0.066)	(0.099)	(0.077)
AETC/Sales $_{t-1}$×Post Departure				-0.049**	-0.049**	-0.041*	-0.081***
				(0.049)	(0.047)	(0.097)	(0.000)
SOE $_{t-1}$					-0.001***	0.0001	0.0004
					(0.000)	(0.797)	(0.566)
Political Connection $_{t-1}$					0.001***	0.001***	-0.0003
					(0.002)	(0.004)	(0.522)
Return on Assets $_{t-1}$						-0.005***	-0.005***
						(0.002)	(0.002)
Tobin's Q $_{t-1}$						0.0003***	-0.00003
						(0.000)	(0.650)
Leverage $_{t-1}$						-0.007***	-0.003***
						(0.000)	(0.002)
Constant	0.001	0.001	0.001	0.001*	0.002***	0.004***	0.022***
	(0.280)	(0.182)	(0.222)	(0.051)	(0.004)	(0.000)	(0.000)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Firm fixed effects	No	No	No	No	No	No	Yes
N	7052	7052	7052	7052	7052	7052	7052
R^2	0.082	0.081	0.085	0.086	0.091	0.120	0.595

Panel B: High- versus low-corruption regions

	(1)	(2)	(3)	(4)
	High Corruption	High Corruption	Low Corruption	Low Corruption
Dependent Variable	Subsidies/Sales	Subsidies/Sales	Subsidies/Sales	Subsidies/Sales
R&D $Efficiency_{t-1}$	0.001	-0.0004	0.002***	0.002**
	(0.567)	(0.444)	(0.009)	(0.015)
AETC/$Sales_{t-1}$	0.075*	0.173***	0.016	0.034
	(0.091)	(0.000)	(0.382)	(0.134)
Post Departure		-0.0002		-0.0002
		(0.458)		(0.261)
R&D $Efficiency_{t-1}$ ×Post Departure		0.002*		-0.001
		(0.065)		(0.551)
AETC/$Sales_{t-1}$ ×Post Departure		-0.153***		-0.041
		(0.000)		(0.102)
Constant	0.008	0.009***	0.005***	0.007***
	(0.151)	(0.006)	(0.000)	(0.000)
Lagged firm controls	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	1383	1383	5669	5669
R^2	0.484	0.497	0.647	0.648

Table 11. R&D Subsidies and Financial Constraints

This table examines the allocation of R&D subsidies to firms with high or low financial constraints, before and after the removals of top provincial officials. The dependent variable is Subsidies/Sales, measured as the amount of R&D subsidies a firm receives in a given year, divided by its annual revenue in that year. The empirical specification is identical to model (7) in Table 9. Firm's financial constraints are measured by a modified RZ index of dependence on external financing (see text for description). Firms with high (low) dependence on external financing are considered constrained (unconstrained). For brevity, only key coefficients are reported. Detailed variable definitions are found in Appendix 1. Huber-White heteroskedasticity-consistent standard errors clustered by industry and province are used for all regressions. *p*-values are in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)
	High Dependence on External Financing	Low Dependence on External Financing
Dependent Variable	Subsidies/Sales	Subsidies/Sales
R&D Efficiency$_{t-1}$	0.001	0.001
	(0.569)	(0.505)
AETC/Sales $_{t-1}$	0.049*	0.073
	(0.083)	(0.491)
Post Removal	0.001*	0.001
	(0.093)	(0.351)
R&D Efficiency $_{t-1}$ ×Post Removal	0.026***	-0.002
	(0.000)	(0.377)
AETC/Sales $_{t-1}$ ×Post Removal	-0.093*	-0.026
	(0.086)	(0.861)
Constant	0.011***	0.013
	(0.000)	(0.452)
Lagged firm controls	Yes	Yes
Year fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes
N	3528	3524
R^2	0.625	0.706

Appendix 1 – Variable Definitions

AETC/Sales: AETC stands for firms' Abnormal Entertainment and Travel Costs scaled by firms' annual revenue, and is calculated as the residual of Equation (3).

Age: The number of years between a company's establishment and the year of the observation.

Business in Other Regions: The number of geographical regions outside its home region from which a firm derives revenue. Chinese provinces are grouped into eight geographic regions: North (华北), South (华南), Middle (华中), East (华东), North-East (东北), North-West (西北), South-West (西南), and Hong Kong/Macau/Taiwan (港，澳，台). Foreign countries are coded as one separate region.

ETC/Sales: ETC stands for firms' Entertainment and Travel Costs, reported in firm's annual statements. ETC/Sales is a firm's amount of ETC spending, divided by its annual revenue.

Intangible Assets/Assets: The book value of a firm's intangible assets divided by the book value of its total assets.

Leverage: A firm's book value of total liabilities divided by its book value of total assets.

Ln(Assets): The natural logarithm of a firm's book value of total assets (in RMB).

Ln(Age): The natural logarithm of the number of years between a company's establishment and the year of the observation.

Patents/Sales (Chinese): The number of Chinese invention patent applications filed by a firm in a given year that are ultimately granted through the end of 2017, divided by its revenue (measured in millions of RMB) in that year.

Patents/Sales (U.S.): Similarly defined as Patents/Sales (Chinese), but instead using a firm's U.S. patents.

PerCapGDP: The log of per-capita GDP (in RMB) of the firm's home province.

Political Connection: An indicator variable if a company's CEO is currently or formerly an officer in the central government, or a local government, or the military. This definition follows established literature and is the same as in Fan et al. (2007). Data on CEOs are manually collected from the "Profile of Directors and Senior Managers" section of the firms' IPO prospectuses and annual reports.

Post Removal: An indicator variable that equals 1 for the years after the removal of top provincial officials on corruption charges.

Post Departure: An indicator variable that equals 1 for the years after a provincial technology bureau official's departure from his/her post.

Relative Citation Strength (Chinese): The number of Chinese patent citations through April 30, 2018 per Chinese patent applied for in year *t* by firm *i* (that was ultimately granted by the end of 2017), divided by the number of citations per patent received over the same period by all Chinese patents applied for in year *t* (that was also ultimately granted by the end of 2017) in the same four-digit technological class according to the International Patent Classification (IPC) code.

Relative Citation Strength (U.S.): Similarly defined as Relative Citation Strength (Chinese), but instead using a firm's U.S. patents and citations, and the Combined Patent Classification (CPC) code.

Return on Assets (ROA): A firm's net income in a given year divided by its book value of total assets in the same year.

R&D Efficiency: A firm's R&D efficiency, calculated as Equation (2) in the paper as the ratio of the number of Chinese patents applied by a firm in a given year that were ultimately approved, divided by a capitalized measure of R&D expenditure measured in millions of RMB.

R&D/Sales: A firm's R&D expenditure in a year divided by its revenues in the same year.

RZ (Rajan-Zingales) measure of dependence on external financing: The average across all the sample firms in the firm's industry (using the Chinese Securities Regulatory Commission's two-digit industry classification codes) of the ratio of capital expenditures in a given year minus cash flow from operations in the same year, divided by capital expenditure.

Size: The book value of a firm's total assets in a given year, in millions of RMB.

Subsidies/Sales: The amount of R&D subsidies a firm receives in a given year, divided by its annual revenue in that year.

SOE: An indicator variable if a company's largest ultimate shareholder, as disclosed in its annual statements, is a government entity. We classify firms' ownership types by tracing their ultimate ownership identified through annual statements. Since 2001, Chinese listed firms are required to report their ownership (equity) structure. Following prior literature (e.g., Wang et al., 2008), we define a company as state-owned if its largest ultimate shareholder is a government entity, which can be a central (e.g., the Ministry of Finance), provincial, or local entity.

Tobin's Q: A firm's market value of equity (average share price in a given year multiplied by its average number of shares outstanding) plus its book value of debt, divided by the book value of its total assets.

Appendix 2. Validation Tests for ETC as a Measure for Corruption

Although the use of ETC as a measure of corruption has increasingly been established in the literature by papers such as Cai et al. (2011) and Huang et al. (2017), we nevertheless conducted a number of tests to validate ETC as a measure of corruption. In the text, we pointed out the steep drop in ETC after the inception of the anti-corruption campaign in 2012 in Figure 2.

We also conducted an event study of stock returns in the spirit of Lin et al. (2018). Specifically, we examined firms with abnormally high and low amounts of ETC during the ten trading days around (i.e., CAR [-5, +5]) December 4, 2012, the date that President Xi Jinping and the Central Committee of the Communist Party of China unveiled the "Eight Rules of the Central Politburo" that described the details of the anti-corruption campaign. We found that, after controlling for size and book-to-market ratio, firms with high (above median) AETC experienced an average -3.96% market-adjusted abnormal return over the ten trading days, compared to an average abnormal return of -2.76% for firms with low (below median) AETC, a difference that is significant at the 10% level.

Our third test examines the contemporaneous correlation between provincial averages of ETC (computed by averaging across all firms in a province in a given year) with three other provincial-level corruption measures, focusing on the period between 2009 and 2011, i.e., the pre-campaign years. Results in Panel A of Table A1 indicate that the average ETC is highly correlated with other corruption measures, supporting ETC as a valid measure for corruption.

One related, though separate, concern is that the anti-corruption campaign of President Xi was a politically motivated effort to consolidate power and had little to do with corruption. To examine this, we correlate the provincial levels of ETC/AETC in the *pre-campaign* years of 2009–2011 with the number of officials punished during the years of 2012–2015. Panel B of Table A1 indicates that these measures are highly correlated, indicating that the anti-corruption campaign was focused on regions of China with higher levels of corruption.

Table A1. ETC and other corruption measures

Panel A of this table reports the contemporaneous cross-sectional correlation between provincial-year average ETC/sales (AETC/sales) and three other provincial-year level corruption measures over the period 2009–2011 (pre anti-corruption campaign). Corruption Index 1 is the number of government officials prosecuted for corruption each year scaled by the province's population. Corruption Index 2 is the number of white-collar crimes in a province each year scaled by the province's population. The Corruption Control Index is an anti-corruption measure (and hence should be negatively correlated with corruption). It is obtained from the Chinese National Economic Research Institute (NERI). The index is constructed from survey responses to two questions: 1) the time spent by businesses in dealing with bureaucracy, and 2) the non-tax expenses levied on enterprises, including informal charges and illegal fines from the local government, as a percentage of sales. Panel B of this table reports the correlation between the pre-campaign (2009–2011) provincial averages of ETC/sales (AETC/sales) and the number of provincial officials removed due to the anti-corruption campaign (2012–2015) scaled by provincial population.

Panel A: ETC and corruption in the 2009–2011 period			
Correlations between:	Corruption Index 1 (Officials prosecuted)	Corruption Index 2 (White Collar Crimes)	Corruption Control Index (NERI Corruption Control)
ETC/Sales	0.161** (p=0.048)	0.155* (p=0.060)	-0.201**(p=0.012)
AETC/Sales	0. 251***(p=0.002)	0.288*** (p=0.000)	-0.172** (p=0.032)

Panel B: Pre-campaign (2009–2011) ETC and corruption in the 2012–2015 period	
Correlations between:	Total number of officials removed in 2012–2015/population
2009–2011 average ETC/Sales	0.461*** (p=0.009)
2009–2011 average AETC/Sales	0.360** (p=0.047)

Corruption, Government Subsidies, and Innovation: Evidence from China

Internet Appendix

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[1] INSEAD; Harvard University and NBER; Xiamen University; Xiamen University. Please see the main paper for acknowledgements, disclosures, and disclaimers.

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- Table IA8. Panel regressions: Subsidies before and after the departures of provincial technology bureau heads, using Patents/Sales as an alternative R&D efficiency measure

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The following table provides robustness checks by breaking down the type of departures of provincial technology bureau heads into "good departures" and "bad departures":

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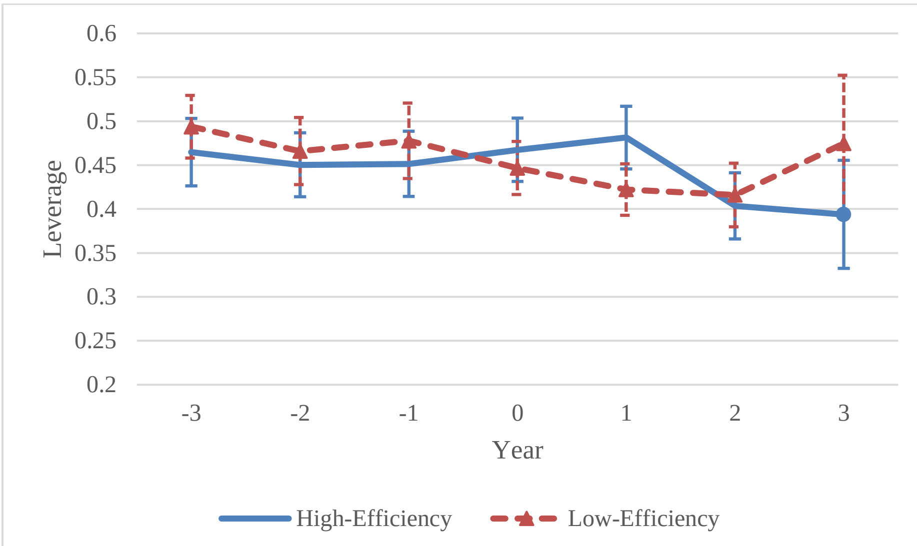
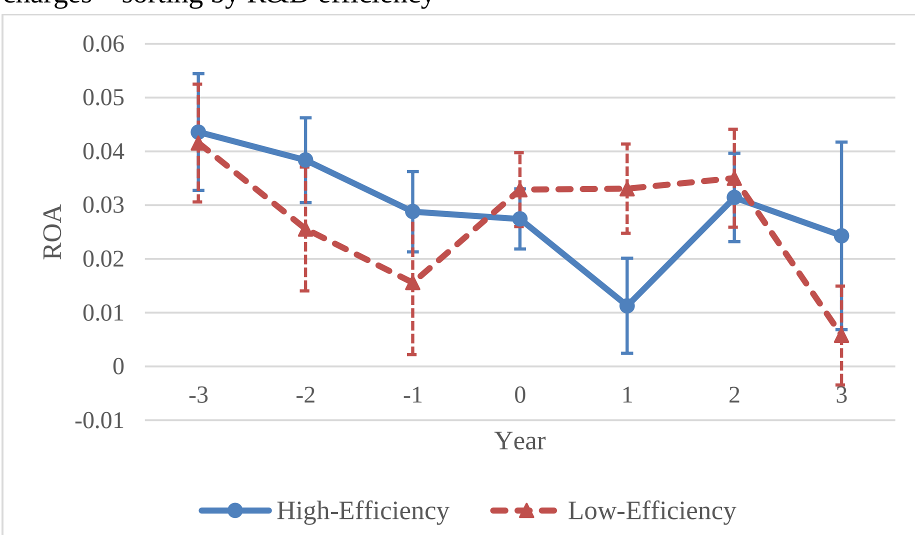
Figure IA1. Parallel trends assumptions for major firm-level variables around the removals of top provincial officials on corruption charges

This figure shows the evolution of firm level variables—leverage, return on assets, Tobin's Q—before and after the removal of top provincial governors on corruption charges. Figures A1-A3 are based on sorting firms by R&D efficiency. Figures B1-B3 are based on sorting firms by AETC/Sales. All variable definitions are the same as in the paper and can be found in Appendix 1 of the paper.

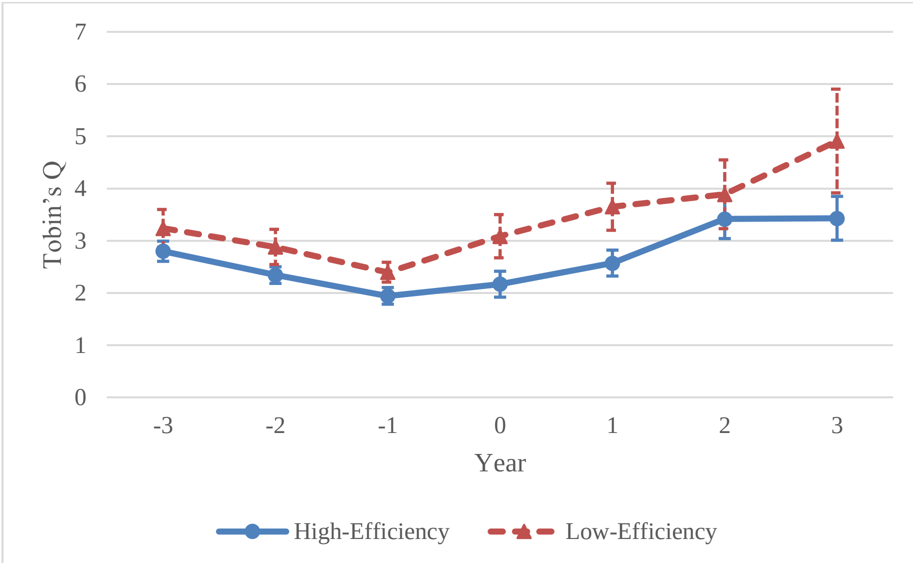
A1. Leverage before and after the removals of top provincial officials on corruption charges– sorting by R&D efficiency



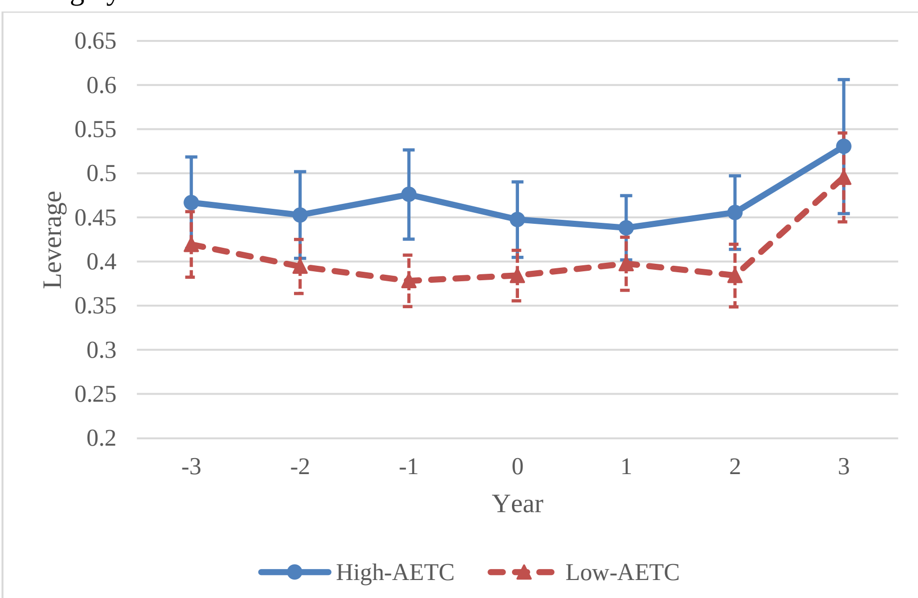
A2. Return on assets before and after the removals of top provincial officials on corruption charges – sorting by R&D efficiency



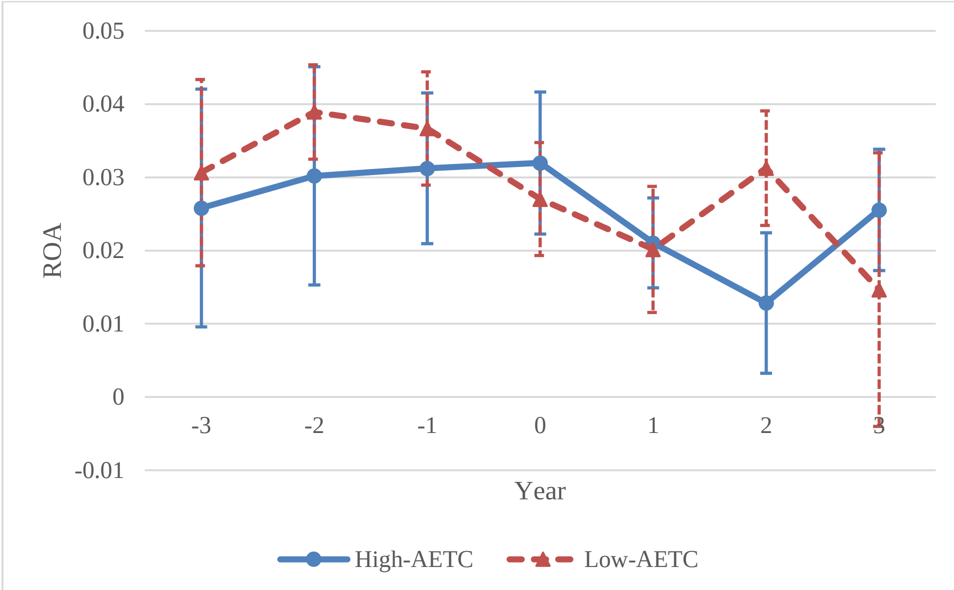
A3. Tobin's Q before and after the removals of top provincial officials on corruption charges – sorting by R&D efficiency



B1. Leverage before and after the removals of top provincial officials on corruption charges – sorting by AETC/Sales



B2. Return on assets before and after the removals of top provincial officials on corruption charges – sorting by AETC/Sales



B3. Tobin's Q before and after the removals of top provincial officials on corruption charges – sorting by AETC/Sales

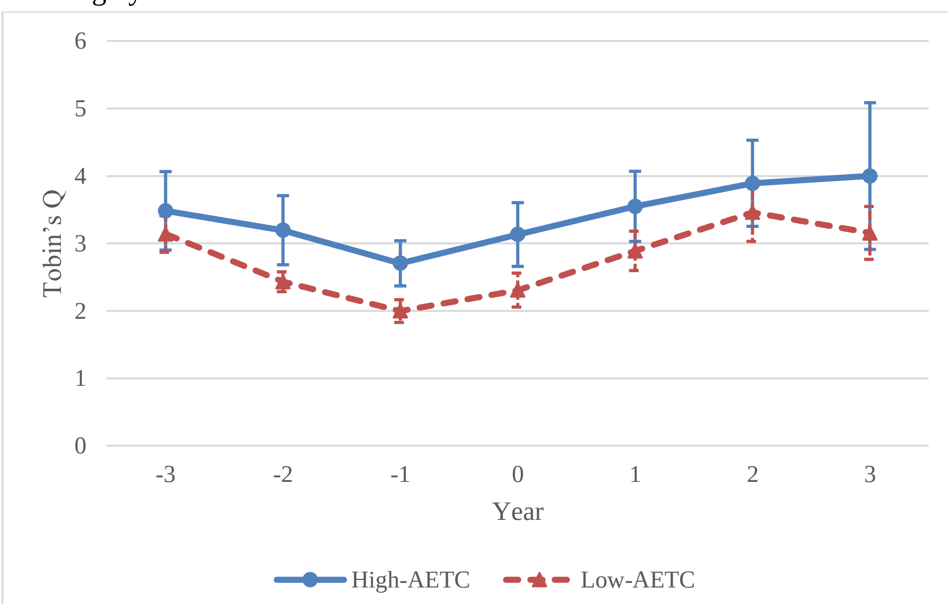
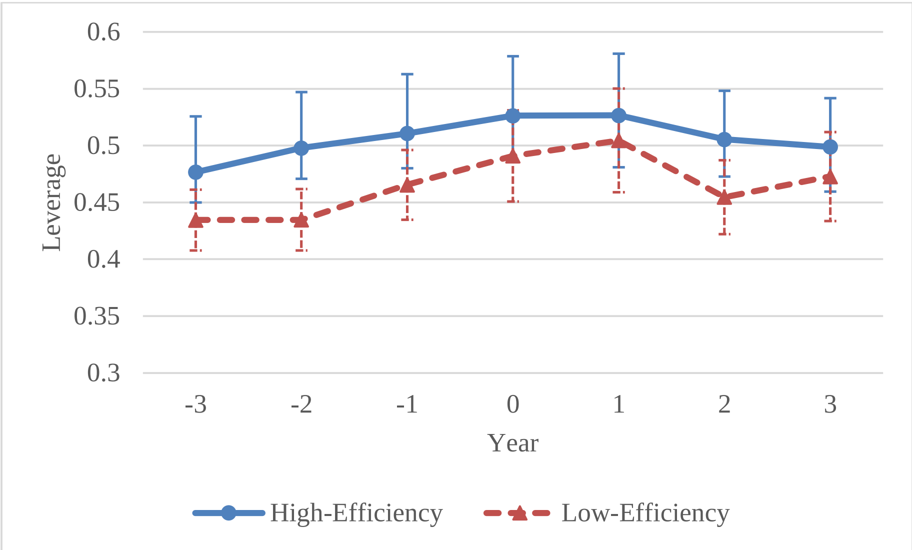


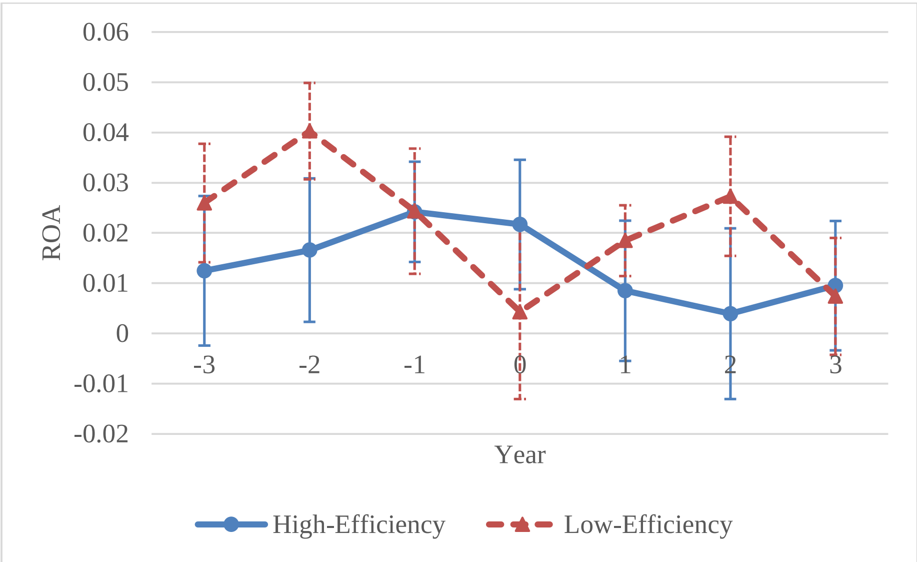
Figure IA2. Parallel trends assumptions for major firm-level variables around the departures of provincial technology bureau heads

This figure shows the evolution of firm level variables—leverage, return on assets, Tobin's Q—before and after the departures of provincial technology bureau heads. Figures A1-A3 are based on sorting firms by R&D efficiency. Figures B1-B3 are based on sorting firms by AETC/Sales. All variable definitions are the same as in the paper and can be found in Appendix 1 of the paper.

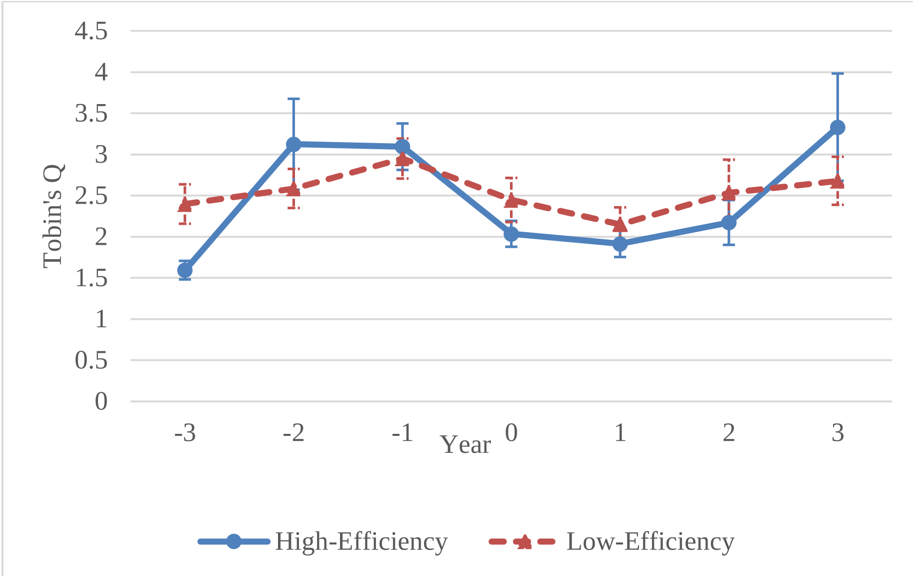
A1. Leverage before and after the departures of provincial technology bureau heads– sorting by R&D efficiency



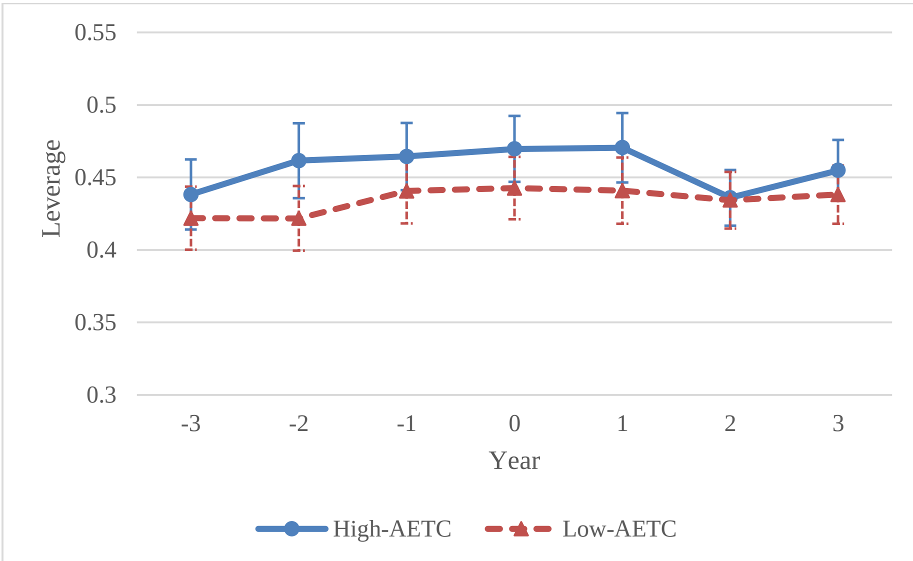
A2. Return on assets before and after the departures of provincial technology bureau heads – sorting by R&D efficiency



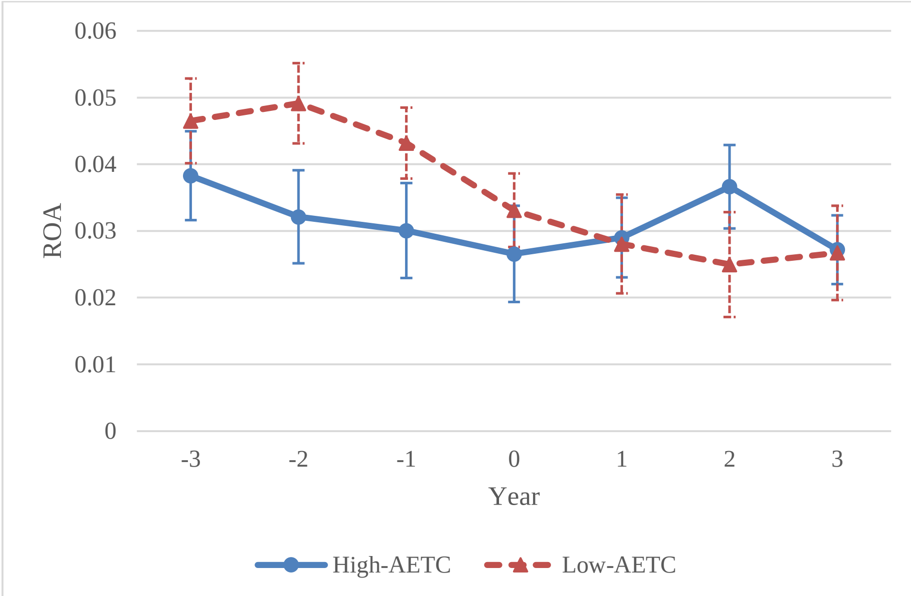
A3. Tobin's Q before and after the departures of provincial technology bureau heads – sorting by R&D efficiency



B1. Leverage before and after the departures of provincial technology bureau heads – sorting by AETC/Sales



B2. Return on assets before and after the departures of provincial technology bureau heads – sorting by AETC/Sales



B3. Tobin's Q before and after the departures of provincial technology bureau heads – sorting by AETC/Sales

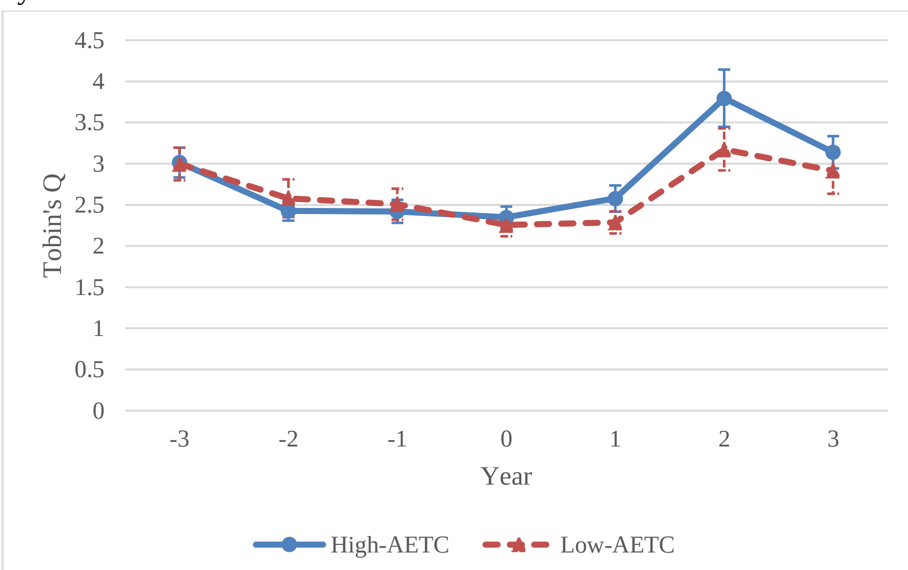


Table IA1. Analysis of local economic conditions before and after the removals of top provincial officials on corruption charges and the departures of provincial technology bureau heads

This table presents statistics and regression results that validate our claim that the removals of top provincial officials on corruption charges and departures of provincial technology bureau heads are unrelated to local business conditions. In Panel A, we compare provincial economic indicators between provincial-years with top provincial official removals and provincial-years without removals. In Panel B, we compare provincial economic indicators between provincial-years with technology bureau heads departures and provincial-years without departures. In Panel C, we report Probit regressions of these removals on lagged provincial GDP growth (to proxy for local economic condition), firms' average return on asset (to proxy for profitability) and patents (scaled by sales, to proxy for innovation). In Panel D, we report Probit regressions of these departures on the same set of independent variables as those in Panel C. *, **, *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Comparison of provincial economic indicators around the removals of top provincial officials on corruption charges

	With Removal	Without Removal	Difference	t-stat
GDP per capital (RMB)	50439	46210	4229	0.860
Unemployment rate (%)	3.432	3.309	0.123	0.819
Fiscal revenue (million RMB)	2693	2122	571	1.440
Fiscal expenditure (million RMB)	4402	3754	648	1.494

Panel B: Comparison of provincial economic indicators around the departures of provincial technology bureau heads

	With Departure	Without Departure	Difference	t-stat
GDP per capital (RMB)	37645	38336	-690.9	-0.206
Unemployment rate (%)	3.502	3.491	0.011	0.111
Fiscal revenue (million RMB)	1688	1671	17.27	0.071
Fiscal expenditure (million RMB)	3214	2887	326.5	1.081

Panel C: Probit regression of the removals of top provincial officials on corruption charges

	(1)	(2)	(3)
Dependent Variable	Removal (province-year level)	Removal (firm-year level)	Removal (firm-year level)
GDP growth$_{t-1}$	-0.661		
	(0.950)		
GDP growth$_{t-2}$	6.163		
	(0.548)		
Return on Assets$_{t-1}$		0.219	
		(0.614)	
Return on Assets$_{t-2}$		-0.181	
		(0.676)	
Patents/Sales$_{t-1}$			2.480

			(0.561)
Patents/Sales$_{t-2}$			-2.486
			(0.568)
Constant	-7.864***	-2.077***	-2.078***
	(0.000)	(0.000)	(0.000)
Year fixed effects	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes
Industry fixed effects	No	Yes	Yes
N	279	5968	5968
Pseudo R^2	0.449	0.218	0.218

Panel D: Probit regression of the departures of provincial technology bureau heads

	(1)	(2)	(3)
Dependent Variable	Departure (province-year level)	Departure (firm-year level)	Departure (firm-year level)
GDP growth$_{t-1}$	-0.160		
	(0.966)		
GDP growth$_{t-2}$	-0.038		
	(0.991)		
Return on Assets$_{t-1}$		-0.254	
		(0.549)	
Return on Assets$_{t-2}$		0.134	
		(0.738)	
Patents/Sales$_{t-1}$			-1.651
			(0.620)
Patents/Sales$_{t-2}$			1.043
			(0.768)
Constant	-1.294**	-6.341***	-6.342***
	(0.019)	(0.000)	(0.000)
Year fixed effects	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes
Industry fixed effects	No	Yes	Yes
N	279	5968	5968
Pseudo R^2	0.157	0.267	0.267

Table IA2. Subsidies and future innovation: before and after the removals of top provincial officials on corruption charges, using Chinese patent data to measure future innovation

This table is a robustness check to Table 4 in the paper which investigates the relation between R&D subsidies and future innovation before and after the removals of top provincial officials on corruption charges. In Panels A and B of Table 4 in the paper, future innovation is measured using U.S. patent and citation data. In this version, we use Chinese patent and citation data as an alternative measure for future innovation. The table's methodology, organization, and data are otherwise identical to Panels A and B of Table 4 in the paper. Detailed variable definitions are found in the Appendix 1 of the paper. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (4), and clustered by industry and province are used for regression in Column (5). *p*-values are reported in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Chinese patents

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Patents/Sales (Chinese)	Patents/Sales (Chinese)	Patents/Sales (Chinese)	Patents/Sales (Chinese)	Patents/Sales (Chinese)
Patents/Sales (Chinese) $_{t-1}$	0.667***	0.667***	0.653***	0.643***	0.211***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Subsidies/Sales $_{t-1}$	0.085***	0.078***	0.067***	0.064***	0.011
	(0.000)	(0.000)	(0.000)	(0.000)	(0.336)
Post Removal		-0.001**	-0.001**	-0.001*	-0.001***
		(0.016)	(0.040)	(0.087)	(0.008)
Subsidies/Sales $_{t-1}$ ×Post Removal		0.044**	0.045**	0.045**	0.073***
		(0.042)	(0.039)	(0.038)	(0.001)
Constant	0.001***	0.001*	0.008***	0.006***	0.020***
	(0.003)	(0.098)	(0.000)	(0.002)	(0.000)
Lagged firm controls	No	No	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	No
Province fixed effects	No	No	No	Yes	No
Firm fixed effects	No	No	No	No	Yes
N	8628	8628	8628	8628	8628
R^2	0.493	0.493	0.498	0.501	0.665

Panel B: Chinese relative patent citation strength

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Relative Citation Strength (Chinese)	Relative Citation Strength (Chinese)	Relative Citation Strength (Chinese)	Relative Citation Strength (Chinese)	Relative Citation Strength (Chinese)
Relative Citation Strength (Chinese) $_{t-1}$	0.236***	0.236***	0.223***	0.212***	-0.059***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Subsidies/Sales $_{t-1}$	4.145***	3.240***	2.940***	3.585***	-2.445*
	(0.005)	(0.001)	(0.005)	(0.001)	(0.095)
Post Removal		-0.044	-0.033	0.034	0.026
		(0.183)	(0.316)	(0.379)	(0.503)
Subsidies/Sales $_{t-1}$ ×Post Removal		5.836**	5.923**	5.123**	6.755**
		(0.024)	(0.021)	(0.047)	(0.019)
Constant	0.307***	0.309***	-0.260	-0.526**	2.234***
	(0.000)	(0.000)	(0.231)	(0.020)	(0.000)
Lagged firm controls	No	No	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	No
Province fixed effects	No	No	No	Yes	No
Firm fixed effects	No	No	No	No	Yes
N	8628	8628	8628	8628	8628
R^2	0.126	0.126	0.135	0.144	0.352

Table IA3. Subsidies and future innovation: before and after of the departures of provincial technology bureau heads, using Chinese patent data to measure future innovation

This table is a robustness check to Table 5 in the paper which investigates the relation between R&D subsidies and future innovation before and after the departures of provincial technology bureau heads. In Panels A and B of Table 5 in the paper, future innovation is measured using U.S. patent and citation data. In this version, we use Chinese patent and citation data as an alternative measure for future innovation. The table's methodology, organization, and data are otherwise identical to Panels A and B of Table 5 in the paper. Detailed variable definitions are found in the Appendix 1 of the paper. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (4), and clustered by industry and province are used for regression in Column (5). *p*-values are reported in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Chinese patents

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Patents/Sales (Chinese)	Patents/Sales (Chinese)	Patents/Sales (Chinese)	Patents/Sales (Chinese)	Patents/Sales (Chinese)
Patents/Sales (Chinese) $_{t-1}$	0.667***	0.667***	0.653***	0.642***	0.217***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Subsidies/Sales $_{t-1}$	0.085***	0.068***	0.056***	0.055***	0.014
	(0.000)	(0.000)	(0.000)	(0.000)	(0.325)
Post Departure		-0.00003	-0.00001	-0.0001	0.00002
		(0.839)	(0.942)	(0.453)	(0.915)
Subsidies/Sales $_{t-1}$ ×Post Departure		0.031*	0.032**	0.029*	0.031*
		(0.051)	(0.039)	(0.067)	(0.070)
Constant	0.001***	0.001	0.008***	0.006***	0.027***
	(0.003)	(0.109)	(0.000)	(0.001)	(0.000)
Lagged firm controls	No	No	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	No
Province fixed effects	No	No	No	Yes	No
Firm fixed effects	No	No	No	No	Yes
N	8628	8628	8628	8628	8628
R^2	0.493	0.493	0.498	0.501	0.663

Panel B. Chinese relative patent citation strength

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Relative Citation Strength (Chinese)	Relative Citation Strength (Chinese)	Relative Citation Strength (Chinese)	Relative Citation Strength (Chinese)	Relative Citation Strength (Chinese)
Relative Citation Strength (Chinese) $_{t-1}$	0.236***	0.236***	0.222***	0.211***	-0.055***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Subsidies/Sales $_{t-1}$	4.145***	1.295	1.104	1.988	-1.658
	(0.005)	(0.353)	(0.434)	(0.166)	(0.359)
Post Departure		-0.020	-0.013	-0.039*	-0.031
		(0.302)	(0.504)	(0.074)	(0.158)
Subsidies/Sales $_{t-1}$ ×Post Departure		5.167***	4.976***	4.278**	3.760*
		(0.006)	(0.007)	(0.023)	(0.080)
Constant	0.307***	0.317***	-0.264	-0.524**	4.089***
	(0.000)	(0.000)	(0.224)	(0.020)	(0.000)
Lagged firm controls	No	No	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	No
Province fixed effects	No	No	No	Yes	No
Firm fixed effects	No	No	No	No	Yes
N	8628	8628	8628	8628	8628
R^2	0.126	0.126	0.136	0.144	0.347

Table IA4. Subsidies and future innovation, by financial constraint: before and after the departures of provincial technology bureau heads

This table investigates the relation between R&D subsidies and future innovation before and after the departures of provincial technology bureau heads, for firms with high or low financial constraints. The analysis of this table parallels that of Table 6 in the paper, which examines subsidies by financial constraint, before and after the removals of top provincial officials on corruption charges. Firms' financial constraints by the RZ index of external financing needs. Firms with high (low) dependence on external financing needs are considered constraint (unconstrained). The regression model is identical to Model (5) in Table 5, the specification including firm fixed effects. All variable definitions are identical to Table 5 and are defined in Appendix 1. *, **, *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)
Dependent Variable	Patents/ Sales (U.S.)		Relative Citation Strength (U.S.)	
	High Dependent on External Financing	Low Dependence on External Financing	High Dependent on External Financing	Low Dependence on External Financing
Patents/Sales (U.S.)$_{t-1}$	0.062***	-0.201***		
	(0.001)	(0.000)		
Relative Citation Strength (U.S.)$_{t-1}$			-0.116***	-0.155***
			(0.000)	(0.000)
Subsidies/Sales $_{t-1}$	-0.0002	0.001	-0.166	-0.624
	(0.921)	(0.664)	(0.707)	(0.149)
Post Departure	-0.000001	-0.00001	0.014**	-0.005
	(0.975)	(0.602)	(0.015)	(0.341)
Subsidies/Sales$_{t-1}$×Post Departure	0.006**	0.002	0.867*	0.592
	(0.046)	(0.389)	(0.087)	(0.266)
Constant	0.003***	0.001	0.272*	0.040
	(0.004)	(0.105)	(0.068)	(0.795)
Lagged firm controls	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	4317	4311	4317	4311
R^2	0.592	0.631	0.384	0.462

Table IA5. Difference-in-differences analysis: Subsidies before and after the removals of top provincial officials on corruption charges, using Patents/Sales as an alternative R&D efficiency measure

This table is a robustness check to Table 7 in the paper which conducts a difference-in-difference analysis before and after the removals of top provincial officials on corruption charges. In Table 7 in the paper, R&D efficiency is defined as R&D output over R&D input as described in Equation (2) in the paper. In this version, we use Patents/Sales as an alternative R&D efficiency measure. (Patents are the number of patents applied by a firm in a given year that were ultimately approved by Dec 31, 2017; sales is a firm's revenue in a given year). Firms with above (below) median patents/sales are classified as high- (low-) efficiency firms. Panel A investigates the parallel trends assumption in the pre-removal years by comparing the year-on-year growth in R&D subsidies (scaled by sales) received by the high and low efficiency groups. Panel B reports the difference-in-differences in the levels of R&D subsidies (scaled by sales) received by firms with high and low R&D efficiency groups. Detailed variable definitions are found in the Appendix 1 in the paper. *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels in a two-tailed test, respectively.

Panel A: Pre-Trend Test: Annual growth in Subsidies/Sales

	Event Year -3	Event Year -2	Event Year -1
High R&D Efficiency	0.140	0.258	0.675
Low R&D Efficiency	-0.031	0.401	0.351
t-test	0.558	-0.444	1.473

Panel B: Difference-in-differences in Subsidies/Sales for firms with high and low R&D efficiency

	Before	After	After - Before	t-stat
High R&D Efficiency	0.0037	0.0056	0.0019	3.047***
Low R&D Efficiency	0.0023	0.0025	0.0002	0.227
High - Low	0.0014	0.0031	0.0017	1.895*

Table IA6. Difference-in-differences analysis: Subsidies before and after the departures of provincial technology bureau heads, using Patents/Sales as an alternative R&D efficiency measure

This table is a robustness check to Table 8 in the paper which conducts a difference-in-differences analysis of subsidies before and after the departures of provincial technology bureau heads. In Table 8 in the paper, R&D efficiency is defined as R&D output over R&D input as described in Equation (2) in the paper. In this version, we use Patents/Sales as an alternative R&D efficiency measure. (Patents are the number of patents applied by a firm in a given year that were ultimately approved by Dec 31, 2017; sales is a firm's revenue in a given year). Firms with above (below) median patents/sales are classified as high- (low-) efficiency firms. The table's methodology, organization, and variables are otherwise identical to Table 8 in the paper. Detailed variable definitions are found in the Appendix 1. *p*-values are in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels in a two-tailed test, respectively.

Panel A: Pre-trend annual growth in Subsidies/Sales

	Event Year -3	Event Year -2	Event Year -1
High R&D Efficiency	0.362	0.378	-0.104
Low R&D Efficiency	0.103	0.461	-0.202
t-test	0.785	-0.255	0.628

Panel B: Difference-in-differences in Subsidies/Sales for firms with high and low R&D efficiency

	Before	After	After - Before	t-stat
High R&D Efficiency	0.0029	0.0055	0.0026	2.850***
Low R&D Efficiency	0.0015	0.0021	0.0006	0.989
High - Low	0.0014	0.0034	0.0020	1.893*

Table IA7. Panel regressions: Subsidies before and after the removals of top provincial officials on corruption charges, using Patents/Sales as an alternative R&D efficiency measure

This table is a robustness check to Table 9 in the paper which reports panel regression analysis of R&D subsidies before and after the removals of top provincial officials on corruption charges. In Table 9 in the paper, R&D efficiency is defined as R&D output over R&D input as described in Equation (2) in the paper. In this version, we use Patents/Sales as an alternative R&D efficiency measure. (Patents are the number of patents applied by a firm in a given year that were ultimately approved by Dec 31, 2017; sales is a firm's revenue in a given year). The table's methodology, organization, and variables are otherwise identical to Table 9 in the paper. Detailed variable definitions are found in the Appendix 1. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (6) of Panel A, and clustered by industry and province are used for regression in Column (7) of Panel A and Column (1) to (4) of Panel B. *p*-values are in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. *p*-values are reported in parentheses.

Panel A: Full sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales
Patents/Sales $_{t-1}$	0.266***		0.204***	0.200***	0.198***	0.174***	0.033**
	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.011)
AETC/Sales $_{t-1}$		0.055**	0.043*	0.049***	0.049***	0.047***	0.047***
		(0.035)	(0.068)	(0.000)	(0.000)	(0.000)	(0.005)
Post Removal			0.001	0.0003	0.0003	0.001	0.0001
			(0.108)	(0.607)	(0.634)	(0.363)	(0.792)
Patents/Sales $_{t-1}$ ×Post Removal				0.098**	0.098**	0.099**	0.176***
				(0.031)	(0.031)	(0.029)	(0.000)
AETC/Sales $_{t-1}$ ×Post Removal				-0.075*	-0.080*	-0.076*	-0.066*
				(0.092)	(0.071)	(0.083)	(0.058)
SOE $_{t-1}$					-0.001***	0.0001	-0.001*
					(0.001)	(0.750)	(0.077)
Political Connection $_{t-1}$					0.001***	0.001***	0.0002
					(0.001)	(0.004)	(0.505)
Return on Assets $_{t-1}$						-0.004**	-0.004***
						(0.010)	(0.005)
Tobin's Q $_{t-1}$						0.0003***	-0.00002
						(0.000)	(0.810)
Leverage $_{t-1}$						-0.006***	-0.001*
						(0.000)	(0.086)
Constant	0.001	0.001	0.001	0.001***	0.002***	0.003***	0.007***
	(0.148)	(0.194)	(0.115)	(0.002)	(0.000)	(0.000)	(0.000)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Firm fixed effects	No	No	No	No	No	No	Yes
N	7295	7295	7295	7295	7295	7295	7295
R^2	0.133	0.082	0.135	0.135	0.138	0.157	0.639

Panel B: High versus low corruption regions

	(1)	(2)	(3)	(4)
	High Corruption	High Corruption	Low Corruption	Low Corruption
Dependent Variable	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales
Patents/Sales $_{t-1}$	0.064**	-0.076	0.042*	0.036***
	(0.016)	(0.365)	(0.090)	(0.009)
AETC/Sales $_{t-1}$	0.056**	0.026	0.035	0.024
	(0.030)	(0.634)	(0.174)	(0.281)
Post Removal		-0.001		0.001
		(0.435)		(0.198)
Patents/Sales $_{t-1}$ ×Post Removal		0.292*		0.046
		(0.092)		(0.280)
AETC/Sales $_{t-1}$ ×Post Removal		-0.096**		0.074
		(0.016)		(0.237)
Constant	0.008***	0.010	-0.0004	0.001
	(0.000)	(0.207)	(0.373)	(0.595)
Lagged firm controls	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	1475	1475	5820	5820
R^2	0.448	0.457	0.665	0.667

Table IA8. Panel regressions: Subsidies before and after the departures of provincial technology bureau heads, using Patents/Sales as an alternative R&D efficiency measure

This table is a robustness check to Table 10 in the paper which reports panel regression results of R&D subsidies before and after the departures of technology bureau heads. In Table 10 in the paper, R&D efficiency is defined as R&D output over R&D input as described in Equation (2) in the paper. In this version, we use Patents/Sales as an alternative R&D efficiency measure. (Patents are the number of patents applied by a firm in a given year that were ultimately approved by Dec 31, 2017; sales is a firm's revenue in a given year). The table's methodology, organization, and variables are otherwise identical to Table 10 in the paper. Detailed variable definitions are found in the Appendix 1. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (6) of Panel A, and clustered by industry and province are used for regression in Column (7) of Panel A and Column (1) to (4) of Panel B. *p*-values are in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Full sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales
Patents/Sales $_{t-1}$	0.266***		0.264***	0.264***	0.259***	0.233***	0.085***
	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
AETC/Sales $_{t-1}$		0.055**	0.044*	0.075**	0.075**	0.069***	0.097***
		(0.035)	(0.054)	(0.021)	(0.021)	(0.000)	(0.000)
Post Departure			-0.0002	-0.0002	-0.0002	-0.0003	-0.0001
			(0.259)	(0.278)	(0.271)	(0.289)	(0.714)
Patents/Sales $_{t-1}$ ×Post Departure				0.001	0.003	0.001	0.029*
				(0.975)	(0.938)	(0.947)	(0.096)
AETC/Sales $_{t-1}$ ×Post Departure				-0.058*	-0.058**	-0.049**	-0.084***
				(0.053)	(0.050)	(0.035)	(0.000)
SOE $_{t-1}$					-0.001*	0.0001	0.003***
					(0.081)	(0.722)	(0.000)
Political Connection $_{t-1}$					0.001*	0.001***	0.0002
					(0.084)	(0.005)	(0.610)
Return on Assets $_{t-1}$						-0.004***	-0.004**
						(0.010)	(0.024)
Tobin's Q $_{t-1}$						0.0003***	-0.0001
						(0.000)	(0.486)
Leverage $_{t-1}$						-0.005***	-0.001
						(0.000)	(0.531)
Constant	0.001	0.001	0.001	0.001	0.002**	0.003***	0.013***
	(0.148)	(0.194)	(0.118)	(0.101)	(0.041)	(0.000)	(0.000)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Firm fixed effects	No	No	No	No	No	No	Yes
N	7295	7295	7295	7295	7295	7295	7295
R^2	0.133	0.082	0.145	0.145	0.148	0.163	0.576

Panel B: High versus low corruption regions

	(1)	(2)	(3)	(4)
	High Corruption	High Corruption	Low Corruption	Low Corruption
Dependent Variable	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales
Patents/Sales $_{t-1}$	0.080	0.047	0.073**	0.068*
	(0.278)	(0.492)	(0.019)	(0.059)
AETC/Sales $_{t-1}$	0.064**	0.161***	0.013	0.030
	(0.033)	(0.000)	(0.726)	(0.451)
Post Departure		0.001		-0.0003
		(0.250)		(0.263)
Patents/Sales $_{t-1}$ ×Post Departure		0.019		0.008
		(0.446)		(0.851)
AETC/Sales $_{t-1}$ ×Post Departure		-0.151***		-0.043
		(0.000)		(0.110)
Constant	0.004	0.010**	0.004***	0.006***
	(0.234)	(0.036)	(0.008)	(0.001)
Lagged firm controls	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	1440	1440	5855	5855
R^2	0.527	0.528	0.657	0.658

Table IA9. Subsidies and financial constraints: before and after the departures of provincial technology bureau heads

This table presents regression analysis of the allocation R&D subsidies to firms with high or low financial constraints, before and after the departures of provincial technology bureau heads. The analysis of this table parallels that of Table 11 in the paper, which analyzes subsidies and financial constraints before and after the removals of top provincial officials on corruption charges. Subsidies are measured as the amount of R&D subsidies a firm receives in a given year, divided by its annual revenue in that year. The empirical specification is identical to model (7) in Table 10. Firm's financial constraints are measured by a modified RZ index of dependence on external financing (see text for description). Firms with high (low) dependence on external financing are considered constrained (unconstrained). For brevity, only key coefficients are reported. Detailed independent variable definitions are found in the Appendix 1. Huber-White heteroskedasticity-consistent standard errors clustered by industry and province are used for all regressions. *p*-values are in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)
	High Dependence on External Financing	Low Dependence on External Financing
Dependent Variable	Subsidies/Sales	Subsidies/Sales
R&D Efficiency$_{t-1}$	0.001	0.002*
	(0.800)	(0.068)
AETC/Sales $_{t-1}$	0.059*	0.020
	(0.081)	(0.818)
Post Departure	0.00001	0.00003
	(0.986)	(0.933)
R&D Efficiency $_{t-1}$ ×Post Departure	-0.0001	-0.001
	(0.971)	(0.714)
AETC/Sales $_{t-1}$ ×Post Departure	-0.041*	-0.081
	(0.063)	(0.187)
Constant	0.014*	0.020***
	(0.055)	(0.000)
Lagged firm controls	Yes	Yes
Year fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes
N	3528	3524
R^2	0.680	0.694

Table IA10. Subsidies before and after the departures of provincial technology bureau heads, by types of departures

This table is a robustness check on Table 10 of the paper which examines subsidies before and after the departures of provincial technology bureau heads. In Table 10 in the paper, we include all official departures we can find. In this version, we separate the departures into "good" and "bad" departures. Good departures include promotions or lateral moves within the technology bureau system. Bad departures include demotions, lateral moves outside the technology bureau system, retirement, or being punished for wrongdoing. Post Good Departure and Post Bad Departure are indicator variables that equal one for three years after the official departures of the respective type. Detailed definitions of other control variables are found in the Appendix 1. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (4), and clustered by industry and province are used for regression in Column (5). *p*-values are in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales
R&D Efficiency $_{t-1}$	0.003***	0.003**	0.003*	0.002**	0.002
	(0.001)	(0.044)	(0.054)	(0.045)	(0.194)
AETC/Sales $_{t-1}$	0.059**	0.094**	0.091**	0.083**	0.043
	(0.025)	(0.016)	(0.014)	(0.019)	(0.255)
Post Good Departure	-0.0002	-0.0001	-0.0002	-0.0002	0.0004
	(0.665)	(0.875)	(0.698)	(0.726)	(0.474)
Post Bad Departure	0.00003	0.0001	-0.00002	-0.0001	0.0002
	(0.900)	(0.628)	(0.964)	(0.889)	(0.372)
R&D Efficiency $_{t-1}$×Post Good Departure		0.005	0.005	0.005	-0.005
		(0.348)	(0.343)	(0.292)	(0.104)
AETC/Sales $_{t-1}$×Post Good Departure		-0.121	-0.124	-0.143	-0.117
		(0.101)	(0.101)	(0.110)	(0.120)
R&D Efficiency $_{t-1}$×Post Bad Departure		0.001	0.001	0.001	-0.001
		(0.878)	(0.813)	(0.852)	(0.534)
AETC/Sales $_{t-1}$×Post Bad Departure		-0.065**	-0.063**	-0.047*	-0.065**
		(0.013)	(0.013)	(0.056)	(0.018)
SOE $_{t-1}$			-0.001**	-0.0001	-0.001
			(0.016)	(0.806)	(0.401)
Political Connection $_{t-1}$			0.001	0.001	0.001
			(0.315)	(0.303)	(0.468)
Return on Assets $_{t-1}$				-0.006*	-0.005
				(0.056)	(0.118)
Tobin's Q $_{t-1}$				0.0003**	-0.00004
				(0.014)	(0.743)
Leverage $_{t-1}$				-0.007***	-0.002
				(0.003)	(0.241)
Constant	0.001	0.002**	0.003***	0.005***	0.007*
	(0.261)	(0.038)	(0.002)	(0.001)	(0.078)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	No
Province fixed effects	Yes	Yes	Yes	Yes	No
Firm fixed effects	No	No	No	No	Yes
N	7052	7052	7052	7052	7052
R^2	0.078	0.080	0.085	0.116	0.641

Table IA11. Subsidies and future innovation, before and after the removals of top provincial officials on corruption charges, by subsidy type

This table is a robustness check on Table 4 of the paper which examines the relation between subsidies and future innovation before and after the removals of top provincial officials on corruption charges. In Table 4 in the paper, we include total R&D subsidies from all seven categories of funding we collected. In this version, we separate the funding sources into funds strongly or weakly related to innovation. Subsidies strongly related to innovation include subsidy types 1, 2, 3, 4, and 6. Funding sources weakly related to innovation include subsidy types 5 and 7. See Section 2A and Table 2 of the paper for definitions and descriptions of the subsidy types. Detailed definitions of other control variables are found in the Appendix 1. Huber-White heteroskedasticity-consistent standard errors clustered by industry and province are used for all regressions. *p*-values are in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Subsidy categories that are strongly related to innovation

	(1)	(2)
Dependent Variable	Patents/ Sales (U.S.)	Relative Citation Strength (U.S.)
Patents/Sales (U.S.)$_{t-1}$	-0.044***	
	(0.001)	
Relative Citation Strength (U.S.)$_{t-1}$		-0.104***
		(0.000)
Subsidies/Sales $_{t-1}$	0.001	-0.340
	(0.339)	(0.231)
Post Removal	-0.0001**	-0.006
	(0.014)	(0.297)
Subsidies/Sales $_{t-1}$×Post Removal	0.011***	2.126***
	(0.000)	(0.000)
Constant	0.002***	0.010
	(0.002)	(0.917)
Lagged firm controls	Yes	Yes
Year fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes
N	8628	8628
R^2	0.540	0.281

Panel B: Subsidy categories that are weakly related to innovation

	(1)	(2)
Dependent Variable	Patents/ Sales (U.S.)	Relative Citation Strength (U.S.)
Patents/Sales (U.S.)$_{t-1}$	-0.042	
	(0.437)	
Relative Citation Strength (U.S.)$_{t-1}$		-0.104**
		(0.017)
Subsidies/Sales $_{t-1}$	-0.005	-0.741*
	(0.306)	(0.080)
Post Removal	-0.0001	0.0002
	(0.235)	(0.976)
Subsidies/Sales $_{t-1}$×Post Removal	0.014	1.689
	(0.266)	(0.201)
Constant	0.002**	-0.002
	(0.021)	(0.987)
Lagged firm controls	Yes	Yes
Year fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes
N	8628	8628
R^2	0.540	0.280

Table IA12. Subsidies and future innovation, before and after the departures of provincial technology bureau heads, by subsidy type

This table is a robustness check on Table 5 of the paper which examines the relation between subsidies and future innovation before and after the departures of provincial technology bureau heads. In Table 5 in the paper, we include total R&D subsidies from all seven categories of funding we collected. In this version, we separate the funding sources into funds strongly or weakly related to innovation. Subsidies strongly related to innovation include subsidy types 1, 2, 3, 4, and 6. Funding sources weakly related to innovation include subsidy types 5 and 7. See Section 2A and Table 2 of the paper for definitions and descriptions of the subsidy types. Detailed definitions of other control variables are found in the Appendix 1. Huber-White heteroskedasticity-consistent standard errors clustered by industry and province are used for all regressions. *p*-values are in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Subsidy categories that are strongly related to innovation

	(1)	(2)
Dependent Variable	Patents/ Sales (U.S.)	Relative Citation Strength (U.S.)
Patents/Sales (U.S.)$_{t-1}$	-0.043***	
	(0.001)	
Relative Citation Strength (U.S.)$_{t-1}$		-0.101***
		(0.000)
Subsidies/Sales $_{t-1}$	0.0003	-0.299
	(0.855)	(0.393)
Post Departure	-0.000001	0.002
	(0.972)	(0.616)
Subsidies/Sales $_{t-1}$×Post Departure	0.005**	0.767*
	(0.022)	(0.069)
Constant	0.002***	0.184*
	(0.003)	(0.079)
Lagged firm controls	Yes	Yes
Year fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes
N	8628	8628
R^2	0.540	0.278

Panel B: Subsidy categories that are weakly related to innovation

	(1)	(2)
Dependent Variable	Patents/ Sales (U.S.)	Relative Citation Strength (U.S.)
Patents/Sales (U.S.)$_{t-1}$	-0.041	
	(0.443)	
Relative Citation Strength (U.S.)$_{t-1}$		-0.104**
		(0.016)
Subsidies/Sales $_{t-1}$	0.002	-0.635
	(0.800)	(0.389)
Post Departure	0.00002	0.004
	(0.257)	(0.424)
Subsidies/Sales $_{t-1}$×Post Departure	-0.007	0.268
	(0.374)	(0.791)
Constant	0.002**	-0.004
	(0.029)	(0.977)
Lagged firm controls	Yes	Yes
Year fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes
N	8628	8628
R^2	0.539	0.280

Table IA13. Subsidies before and after the removals of top provincial officials on corruption charges, by subsidy type

This table is a robustness check on Table 9 of the paper which examines R&D subsidies before and after the removals of top provincial officials on corruption charges. In Table 9 in the paper, we include total R&D subsidies from all seven categories of funding we collected. In this version, we separate the funding sources into funds strongly or weakly related to innovation. Subsidies strongly related to innovation include subsidy types 1, 2, 3, 4, and 6. Funding sources weakly related to innovation include subsidy types 5 and 7. See Section 2A and Table 2 of the paper for definitions and descriptions of the subsidy types. The table's organization is otherwise identical to Table 9 in the paper. Detailed definitions of other control variables are found in the Appendix 1. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (6), and clustered by industry and province are used for regression in Column (7). *p*-values are in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Subsidies strongly related to innovation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales
R&D Efficiency$_{t-1}$	0.002***		0.002***	0.002***	0.002***	0.002***	0.001
	(0.003)		(0.002)	(0.000)	(0.000)	(0.001)	(0.227)
AETC/Sales $_{t-1}$		0.050**	0.051**	0.056***	0.055***	0.052***	0.049*
		(0.019)	(0.016)	(0.000)	(0.000)	(0.000)	(0.091)
Post Removal			0.0004	0.0003	0.0003	0.0003	0.0003
			(0.393)	(0.563)	(0.570)	(0.530)	(0.381)
R&D Efficiency $_{t-1}$ ×Post Removal				0.001	0.001	0.001	0.005*
				(0.797)	(0.824)	(0.696)	(0.076)
AETC/Sales $_{t-1}$ ×Post Removal				-0.055*	-0.059*	-0.057*	-0.046**
				(0.087)	(0.066)	(0.098)	(0.040)
SOE $_{t-1}$					-0.001***	0.0003	0.001
					(0.006)	(0.214)	(0.504)
Political Connection $_{t-1}$					0.001***	0.0002**	0.001**
					(0.009)	(0.015)	(0.015)
Return on Assets $_{t-1}$						-0.004***	-0.004
						(0.007)	(0.203)
Tobin's Q $_{t-1}$						0.0002***	0.00001
						(0.000)	(0.802)
Leverage $_{t-1}$						-0.005***	-0.001
						(0.000)	(0.303)
Constant	0.001	0.001	0.001	0.001*	0.001**	0.003***	0.006***
	(0.329)	(0.222)	(0.278)	(0.095)	(0.031)	(0.000)	(0.006)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Firm fixed effects	No	No	No	No	No	No	Yes
N	7052	7052	7052	7052	7052	7052	7052
R^2	0.063	0.063	0.067	0.067	0.070	0.092	0.614

Panel B: Subsidies weakly related to innovation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales
R&D Efficiency$_{t-1}$	0.001***		0.001***	0.001***	0.001***	0.001**	-0.00001
	(0.008)		(0.007)	(0.004)	(0.003)	(0.010)	(0.950)
AETC/Sales $_{t-1}$		0.009*	0.009	0.010**	0.009*	0.011**	0.013*
		(0.071)	(0.200)	(0.042)	(0.058)	(0.038)	(0.061)
Post Removal			0.0003	0.00001	0.00002	0.00002	0.0001
			(0.239)	(0.965)	(0.960)	(0.947)	(0.702)
R&D Efficiency $_{t-1}$ ×Post Removal				0.006	0.006	0.006	0.001
				(0.245)	(0.255)	(0.220)	(0.474)
AETC/Sales $_{t-1}$ ×Post Removal				-0.016	-0.018	-0.018	-0.007
				(0.219)	(0.154)	(0.196)	(0.646)
SOE $_{t-1}$					-0.001***	-0.0002**	-0.001**
					(0.000)	(0.032)	(0.016)
Political Connection $_{t-1}$					0.0002**	0.0002**	-0.0004***
					(0.028)	(0.050)	(0.009)
Return on Assets $_{t-1}$						-0.001	-0.001
						(0.296)	(0.189)
Tobin's Q $_{t-1}$						0.0001**	-0.00004
						(0.012)	(0.212)
Leverage $_{t-1}$						-0.002***	-0.001***
						(0.000)	(0.000)
Constant	0.0003	0.0003	0.0003	0.0003	0.001***	0.001***	0.003***
	(0.446)	(0.113)	(0.400)	(0.150)	(0.006)	(0.000)	(0.000)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Firm fixed effects	No	No	No	No	No	No	Yes
N	7052	7052	7052	7052	7052	7052	7052
R^2	0.058	0.057	0.059	0.060	0.066	0.081	0.534

Table IA14. Subsidies before and after the departures of provincial technology bureau heads, by subsidy type

This table is a robustness check on Table 10 of the paper which examines R&D subsidies before and after the departures of provincial technology bureau heads. In Table 10 in the paper, we include total R&D subsidies from all seven categories of funding we collected. In this version, we separate the funding sources into funds strongly or weakly related to innovation. Subsidies strongly related to innovation include subsidy types 1, 2, 3, 4, and 6. Funding sources weakly related to innovation include subsidy types 5 and 7. See Section 2A and Table 2 of the paper for definitions and descriptions of the subsidy types. The table's organization is otherwise identical to Table 10 in the paper. Detailed definitions of other control variables are found in the Appendix 1. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (6), and clustered by industry and province are used for regression in Column (7). *p*-values are in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Subsidies strongly related to innovation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales
R&D Efficiency $_{t-1}$	0.002***		0.002***	0.002*	0.002*	0.002***	0.0002
	(0.003)		(0.002)	(0.052)	(0.054)	(0.003)	(0.666)
AETC/Sales $_{t-1}$		0.050**	0.052**	0.075**	0.075**	0.068***	0.075***
		(0.019)	(0.016)	(0.010)	(0.011)	(0.000)	(0.000)
Post Departure			-0.0002	-0.0003	-0.0003	-0.0003	0.0001
			(0.260)	(0.166)	(0.170)	(0.195)	(0.744)
R&D Efficiency $_{t-1}$ ×Post Departure				0.001	0.001	0.001	0.0004
				(0.522)	(0.511)	(0.383)	(0.587)
AETC/Sales $_{t-1}$ ×Post Departure				-0.044*	-0.045*	-0.038*	-0.061***
				(0.090)	(0.087)	(0.052)	(0.000)
SOE $_{t-1}$					-0.001	0.0003	0.0002
					(0.149)	(0.170)	(0.779)
Political Connection $_{t-1}$					0.001	0.001**	0.0004
					(0.134)	(0.013)	(0.246)
Return on Assets $_{t-1}$						-0.004***	-0.005***
						(0.002)	(0.001)
Tobin's Q $_{t-1}$						0.0002***	-0.00004
						(0.000)	(0.527)
Leverage $_{t-1}$						-0.005***	-0.001*
						(0.000)	(0.074)
Constant	0.001	0.001	0.001	0.001	0.001	0.003***	0.014***
	(0.329)	(0.222)	(0.270)	(0.253)	(0.144)	(0.000)	(0.000)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Firm fixed effects	No	No	No	No	No	No	Yes
N	7052	7052	7052	7052	7052	7052	7052
R^2	0.063	0.063	0.067	0.068	0.070	0.093	0.577

Panel B: Subsidies weakly related to innovation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales
R&D Efficiency $_{t-1}$	0.001***		0.001***	0.0004	0.0004	0.0004	0.00004
	(0.008)		(0.002)	(0.113)	(0.131)	(0.192)	(0.909)
AETC/Sales $_{t-1}$		0.009*	0.009*	0.009	0.008	0.008	0.005
		(0.071)	(0.057)	(0.266)	(0.329)	(0.343)	(0.695)
Post Departure			-0.0001	-0.0001*	-0.0001	-0.0001	-0.00001
			(0.322)	(0.094)	(0.105)	(0.106)	(0.909)
R&D Efficiency $_{t-1}$ ×Post Departure				0.001	0.001	0.001	-0.0002
				(0.139)	(0.121)	(0.155)	(0.631)
AETC/Sales $_{t-1}$ ×Post Departure				-0.001	-0.001	0.002	-0.015
				(0.954)	(0.960)	(0.862)	(0.192)
SOE $_{t-1}$					-0.001***	-0.0002	-0.001
					(0.000)	(0.175)	(0.108)
Political Connection $_{t-1}$					0.0002	0.0002	-0.0003*
					(0.171)	(0.216)	(0.075)
Return on Assets $_{t-1}$						-0.001	-0.001
						(0.322)	(0.281)
Tobin's Q $_{t-1}$						0.0001*	-0.0001
						(0.076)	(0.189)
Leverage $_{t-1}$						-0.002***	-0.001*
						(0.000)	(0.081)
Constant	0.0003	0.0003	0.0003	0.0003	0.001*	0.001***	0.001**
	(0.446)	(0.113)	(0.115)	(0.373)	(0.094)	(0.001)	(0.043)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Firm fixed effects	No	No	No	No	No	No	Yes
N	7052	7052	7052	7052	7052	7052	7052
R^2	0.058	0.057	0.059	0.059	0.065	0.080	0.539

Table IA15. Subsidies and future innovation, before and after the 2012 anti-corruption campaign, using 2012 as the single event year

This table investigates the relation between R&D subsidies and future innovation before and after the anti-corruption campaign which stated in 2012. We present results using two measures of future innovation as the dependent variable. In Column (1), the dependent variable is Patents/Sales using U.S. patent data. In Column (2), the dependent variable is Relative Citation Strength using U.S. patent data. Post Campaign is an indicator variable that equals 1 for the years after 2012. All other variables are defined as in Appendix 1. In each regression, we include the lagged dependent variable to control for persistence. Huber-White heteroskedasticity-consistent standard errors clustered by industry and province are used for all regressions. *p*-values are in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)
Dependent Variable	Patents/ Sales (U.S.)	Relative Citation Strength (U.S.)
Patents/Sales (U.S.)$_{t-1}$	-0.047***	
	(0.000)	
Relative Citation Strength (U.S.)$_{t-1}$		-0.104***
		(0.000)
Subsidies/Sales $_{t-1}$	-0.002	-0.597**
	(0.152)	(0.025)
Subsidies/Sales $_{t-1}$×Post Campaign	0.009***	0.913***
	(0.000)	(0.003)
Constant	0.002***	0.020
	(0.001)	(0.841)
Lagged firm controls	Yes	Yes
Year fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes
N	8628	8628
R^2	0.541	0.280

Table IA16. Subsidies before and after the 2012 anti-corruption campaign, using 2012 as the single event year

This table reports panel regression analysis of R&D subsidies before and after the anti-corruption campaign which stated in 2012. Subsidies are measured as the amount of R&D subsidies a firm receives in a given year, divided by its annual revenue in that year. Post Campaign is an indicator variable that equals 1 for the years after 2012. Panel A presents the results pertaining to the full sample; Panel B presents results when splitting the sample into high and low corruption regions. In Panel B, for brevity, only key coefficients are reported. Detailed variable definitions are found in the Appendix 1. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (6) of Panel A, and clustered by industry and province are used for regression in Column (7) of Panel A and Column (1) to (4) of Panel B. *p*-values are in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Full sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales
R&D Efficiency$_{t-1}$	0.003***		0.003***	0.002***	0.002***	0.002**	0.001
	(0.001)		(0.001)	(0.002)	(0.002)	(0.026)	(0.283)
AETC/Sales $_{t-1}$		0.057**	0.059**	0.080***	0.079***	0.084**	0.062***
		(0.031)	(0.025)	(0.000)	(0.000)	(0.015)	(0.001)
R&D Efficiency $_{t-1}$ ×Post Campaign				0.005***	0.006***	0.006**	0.003***
				(0.000)	(0.000)	(0.019)	(0.005)
AETC/Sales $_{t-1}$ ×Post Campaign				-0.044*	-0.046*	-0.061*	-0.070***
				(0.078)	(0.065)	(0.062)	(0.000)
SOE $_{t-1}$					-0.001***	0.0001	-0.002**
					(0.000)	(0.908)	(0.028)
Political Connection $_{t-1}$					0.001***	0.001*	0.0004
					(0.002)	(0.096)	(0.347)
Return on Assets $_{t-1}$						-0.006**	-0.005***
						(0.018)	(0.001)
Tobin's Q $_{t-1}$						0.0003***	-0.0002
						(0.002)	(0.814)
Leverage $_{t-1}$						-0.007***	-0.002**
						(0.000)	(0.018)
Constant	0.001	0.001	0.001	0.001*	0.002***	0.004***	0.007***
	(0.280)	(0.182)	(0.251)	(0.053)	(0.004)	(0.000)	(0.000)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Firm fixed effects	No	No	No	No	No	No	Yes
N	7052	7052	7052	7052	7052	7052	7052
R^2	0.082	0.081	0.085	0.088	0.092	0.122	0.644

Panel B: High versus low corruption regions

	(1)	(2)	(3)	(4)
	High Corruption	High Corruption	Low Corruption	Low Corruption
Dependent Variable	Subsidies/Sales	Subsidies/Sales	Subsidies/Sales	Subsidies/Sales
R&D Efficiency$_{t-1}$	0.002	0.0002	0.002**	0.002*
	(0.115)	(0.829)	(0.029)	(0.093)
AETC/Sales$_{t-1}$	0.069***	0.065**	0.044	0.060
	(0.007)	(0.026)	(0.169)	(0.112)
R&D Efficiency$_{t-1}$ ×Post Campaign		0.005**		0.004
		(0.019)		(0.116)
AETC/Sales$_{t-1}$ ×Post Campaign		-0.115***		-0.043
		(0.000)		(0.209)
Constant	0.008***	0.002	0.009**	0.012**
	(0.000)	(0.517)	(0.038)	(0.032)
Lagged firm controls	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	1408	1408	5644	5644
R^2	0.518	0.545	0.614	0.617

Table IA17. Subsidies and future innovation, before and after staggered provincial inspections by the Central Commission for Discipline Inspection

This table investigates the relation between R&D subsidies and future innovation before and after the staggered provincial inspections by the Central Commission for Discipline Inspection. We present results using two measures of future innovation as the dependent variable. In Column (1), the dependent variable is Patents/Sales using U.S. patent data. In Column (2), the dependent variable is Relative Citation Strength using U.S. patent data. Post inspection is an indicator variable that equals 1 for the years after the inspections by the central government. All other variables are defined as in Appendix 1. In each regression, we include the lagged dependent variable to control for persistence. Huber-White heteroskedasticity-consistent standard errors clustered by industry and province are used for all regressions. *p*-values are in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)
Dependent Variable	Patents/ Sales (U.S.)	Relative Citation Strength (U.S.)
Patents/Sales (U.S.)$_{t-1}$	-0.045***	
	(0.000)	
Relative Citation Strength (U.S.)$_{t-1}$		-0.104***
		(0.000)
Subsidies/Sales $_{t-1}$	-0.001	-0.545**
	(0.278)	(0.031)
Post Inspection	-0.00004	-0.003
	(0.283)	(0.725)
Subsidies/Sales $_{t-1}$×Post Inspection	0.010***	1.041***
	(0.000)	(0.001)
Constant	0.002***	0.019
	(0.001)	(0.854)
Lagged firm controls	Yes	Yes
Year fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes
N	8628	8628
R^2	0.542	0.281

Table IA18. Subsidies before and after staggered provincial inspections by the Central Commission for Discipline Inspection

This table reports panel regression analysis of R&D subsidies before and after the staggered provincial inspections by the Central Commission for Discipline Inspection. Subsidies are measured as the amount of R&D subsidies a firm receives in a given year, divided by its annual revenue in that year. Post Inspection is an indicator variable that equals 1 for the years after the inspections by the central government. Panel A presents the results pertaining to the full sample; Panel B presents results when splitting the sample into high and low corruption regions. In Panel B, for brevity, only key coefficients are reported. Detailed variable definitions are found in the Appendix 1. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (6) of Panel A, and clustered by industry and province are used for regression in Column (7) of Panel A and Column (1) to (4) of Panel B. *p*-values are in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Full sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales
R&D Efficiency$_{t-1}$	0.003***		0.003***	0.003***	0.003***	0.002***	0.001
	(0.001)		(0.001)	(0.000)	(0.000)	(0.000)	(0.370)
AETC/Sales $_{t-1}$		0.057**	0.059**	0.072***	0.071***	0.071***	0.054***
		(0.031)	(0.025)	(0.000)	(0.000)	(0.000)	(0.002)
Post Inspection			-0.001**	-0.001**	-0.001**	-0.001**	-0.001**
			(0.018)	(0.024)	(0.025)	(0.019)	(0.014)
R&D Efficiency $_{t-1}$ ×Post Inspection				0.007***	0.007***	0.007***	0.005***
				(0.000)	(0.000)	(0.000)	(0.003)
AETC/Sales $_{t-1}$ ×Post Inspection				-0.057*	-0.061**	-0.074**	-0.086***
				(0.054)	(0.039)	(0.011)	(0.000)
SOE $_{t-1}$					-0.001***	0.0001	-0.001**
					(0.000)	(0.840)	(0.031)
Political Connection $_{t-1}$					0.001***	0.001***	0.0004
					(0.002)	(0.004)	(0.237)
Return on Assets $_{t-1}$						-0.006***	-0.006***
						(0.001)	(0.001)
Tobin's Q $_{t-1}$						0.000***	-0.0001
						(0.000)	(0.491)
Leverage $_{t-1}$						-0.007***	-0.002**
						(0.000)	(0.034)
Constant	0.001	0.001	0.001***	0.005***	0.005***	0.007***	0.003
	(0.280)	(0.182)	(0.000)	(0.000)	(0.000)	(0.000)	(0.206)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Firm fixed effects	No	No	No	No	No	No	Yes
N	7052	7052	7052	7052	7052	7052	7052
R^2	0.082	0.081	0.086	0.088	0.092	0.122	0.651

Panel B: High versus low corruption regions

	(1)	(2)	(3)	(4)
	High Corruption	High Corruption	Low Corruption	Low Corruption
Dependent Variable	Subsidies/Sales	Subsidies/Sales	Subsidies/Sales	Subsidies/Sales
R&D Efficiency$_{t-1}$	0.002	-0.0003	0.002**	0.002*
	(0.115)	(0.765)	(0.029)	(0.056)
AETC/Sales $_{t-1}$	0.069***	0.057**	0.044	0.053
	(0.007)	(0.044)	(0.169)	(0.131)
Post Inspection		-0.001		-0.001**
		(0.354)		(0.011)
R&D Efficiency $_{t-1}$ ×Post Inspection		0.014***		0.00003
		(0.000)		(0.987)
AETC/Sales $_{t-1}$ ×Post Inspection		-0.117***		-0.079
		(0.000)		(0.117)
Constant	0.008***	0.001	0.009**	0.013**
	(0.000)	(0.798)	(0.038)	(0.036)
Lagged firm controls	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	1408	1408	5644	5644
R^2	0.518	0.553	0.614	0.618

Table IA19. Subsidies before and after the removals of top provincial officials on corruption charges: Adding linear time trend

This table is a robustness check to Table 9 of the paper which analyses subsidies before and after the removals of top provincial officials on corruption charges. In column (1)-(7), we include a linear time trend to address the concern that the difference in R&D subsidy allocation before and after the removals of top provincial officials on corruption charges could be due to a general time trend, for example a general improvement in subsidy allocation. In column (8), we include firm-specific linear trend in subsidies before the removals of top provincial officials (Trend control) to control the potential difference in firm-specific subsidy trends before the removals which might have influence on the estimation, and include interactions of control variables and the post removal dummy variable (Controls×Post Removal) to control for potential systematic changes in the influence of our control variables on subsidies after the removals of top provincial officials. Trend control is the triple interaction of firm fixed effects, pre-removal dummy variable and linear time trend. Pre-removal dummy variable equals one if the year of observation is before the removal year. Detailed variable definitions are found in the Appendix 1 of the paper. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (6), and clustered by industry and province are used for regression in Column (7) and (8). *p*-values are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales
R&D Efficiency$_{t-1}$	0.003***		0.003***	0.003***	0.003***	0.003***	0.001	0.00003
	(0.001)		(0.001)	(0.000)	(0.000)	(0.000)	(0.111)	(0.963)
AETC/Sales $_{t-1}$		0.057**	0.059**	0.066***	0.064***	0.062***	0.052***	0.040**
		(0.031)	(0.026)	(0.000)	(0.000)	(0.000)	(0.002)	(0.047)
Post Removal			0.001	0.0001	0.0001	0.0003	0.0001	0.004
			(0.342)	(0.893)	(0.874)	(0.639)	(0.756)	(0.296)
R&D Efficiency $_{t-1}$ ×Post Removal				0.006*	0.006*	0.007*	0.010***	0.018***
				(0.098)	(0.099)	(0.069)	(0.001)	(0.000)
AETC/Sales $_{t-1}$ ×Post Removal				-0.078*	-0.085*	-0.077*	-0.061*	-0.095*
				(0.090)	(0.064)	(0.090)	(0.088)	(0.077)
Linear time trend	0.0004***	0.0004***	0.0004***	0.0004***	0.0004***	0.0003***	0.0002***	--
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	
SOE $_{t-1}$					-0.001***	0.00003	-0.001*	0.003***
					(0.000)	(0.903)	(0.068)	(0.003)
Political Connection $_{t-1}$					0.001***	0.001***	0.0002	0.0002
					(0.001)	(0.004)	(0.505)	(0.704)
Return on Assets$_{t-1}$						-0.005***	-0.005***	-0.003**
						(0.002)	(0.003)	(0.043)
Tobin's Q $_{t-1}$						0.0003***	-0.00002	0.000002
						(0.000)	(0.701)	(0.976)
Leverage $_{t-1}$						-0.007***	-0.002**	-0.00003
						(0.000)	(0.030)	(0.979)
Constant	-0.763***	-0.714***	-0.728***	-0.841***	-0.744***	-0.570***	-0.294***	0.009***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Firm fixed effects	No	No	No	No	No	No	Yes	Yes
Year fixed effects	No	No	No	No	No	No	No	Yes

Trend control	No	No	No	No	No	No	No	Yes
Controls×Post Removal	No	No	No	No	No	No	No	Yes
N	7052	7052	7052	7052	7052	7052	7052	7052
R^2	0.081	0.080	0.084	0.084	0.089	0.119	0.641	0.768

Table IA20. Subsidies before and after the departures of provincial technology bureau heads: Adding linear time trend

This table presents robustness checks to Table 10 of the paper, which analyzes R&D subsidies around the departures of provincial technology bureau heads. In column (1)-(7), we add a linear time trend to remove general time-related changes in R&D subsidies. In column (8), we include firm-specific linear trend in subsidies before official departures (Trend control) to control the potential difference in firm-specific subsidy trends before the departures which might have influence on the estimation, and include interactions of control variables and the post departure dummy variable (Controls ×Post Departure) to control for potential systematic changes in the influence of our control variables on subsidies after official departures. Trend control is the triple interaction of firm fixed effects, pre-departure dummy variable and linear time trend. Pre-departure dummy variable equals one if the year of observation is before the departure year. Variable definitions are identical to those in the paper and can be found in Appendix 1 of the paper. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (6), and clustered by industry and province are used for regression in Column (7) to (8). *p*-values are in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. *p*-values are reported in parentheses.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales	Subsidies /Sales
R&D Efficiency $_{t-1}$	0.003***		0.003***	0.002***	0.002***	0.002***	-0.001	-0.001
	(0.001)		(0.001)	(0.004)	(0.004)	(0.008)	(0.405)	(0.558)
AETC/Sales $_{t-1}$		0.057**	0.059**	0.086***	0.084***	0.078***	0.086***	0.060*
		(0.031)	(0.025)	(0.000)	(0.000)	(0.000)	(0.000)	(0.055)
Post Departure			-0.0004**	-0.001**	-0.001**	-0.001**	-0.0001	0.012***
			(0.036)	(0.027)	(0.033)	(0.038)	(0.698)	(0.000)
R&D Efficiency $_{t-1}$ ×Post Departure				0.002*	0.002*	0.002*	0.002*	0.002*
				(0.069)	(0.059)	(0.089)	(0.062)	(0.097)
AETC/Sales $_{t-1}$ ×Post Departure				-0.050**	-0.050**	-0.041*	-0.082***	-0.072*
				(0.045)	(0.043)	(0.095)	(0.000)	(0.073)
Linear time trend	0.0004***	0.0004***	0.0004***	0.0004***	0.0004***	0.0003***	0.0002***	--
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	
SOE $_{t-1}$					-0.001***	0.00003	0.0004	0.001
					(0.000)	(0.897)	(0.599)	(0.335)
Political Connection $_{t-1}$					0.001***	0.001***	-0.0003	0.001
					(0.002)	(0.004)	(0.509)	(0.212)
Return on Assets $_{t-1}$						-0.005***	-0.005***	-0.005*
						(0.002)	(0.004)	(0.068)
Tobin's Q $_{t-1}$						0.0003***	-0.00003	0.0001
						(0.000)	(0.604)	(0.659)
Leverage $_{t-1}$						-0.007***	-0.003***	-0.001
						(0.000)	(0.002)	(0.615)
Constant	-0.763***	-0.714***	-0.806***	-0.805***	-0.707***	-0.653***	-0.340***	0.015***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Firm fixed effects	No	No	No	No	No	No	Yes	Yes
Year fixed effects	No	No	No	No	No	No	No	Yes

Trend control	No	No	No	No	No	No	No	Yes
Controls ×Post Departure	No	No	No	No	No	No	No	Yes
N	7052	7052	7052	7052	7052	7052	7052	7052
R^2	0.081	0.080	0.084	0.085	0.090	0.119	0.593	0.685

Table IA21. Difference-in-differences analysis: Subsidies (million RMB) before and after the removals of top provincial officials on corruption charges

This table is a robustness check to Table 7 of the paper, which conducts a difference-in-difference analysis before and after the removals of top principal officials on corruption charges. In Table 7 in the paper, subsidies are scaled by sales. In this version, we use un-scaled subsidies (measures in millions RMB) for analysis. Methodology and format of this table are otherwise identical to Table 7 in the paper. Detailed variable definitions are found in the Appendix 1 in the paper. *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels in a two-tailed test, respectively.

Panel A: Pre-Trend Test: Annual growth in Subsidies (million RMB)

	Event Year -3	Event Year -2	Event Year -1
High R&D Efficiency	0.100	0.368	0.556
Low R&D Efficiency	0.045	0.563	0.380
t-test	0.343	-0.884	0.903
	Event Year -3	Event Year -2	Event Year -1
High AETC	0.311	0.499	0.305
Low AETC	0.367	0.168	0.386
t-test	-0.157	0.998	-0.292

Panel B: Difference-in-differences in Subsidies (million RMB) for firms with high and low R&D efficiency

	Before	After	After - Before	*t*-stat
High R&D Efficiency	4.909	9.525	4.616	4.939***
Low R&D Efficiency	6.034	7.398	1.364	1.944*
High - Low	-1.125	2.127	3.252	2.779***

Panel C: Difference-in-differences in Subsidies (million RMB) for firms with high and low AETC

	Before	After	After - Before	*t*-stat
High AETC	5.837	6.589	0.752	0.859
Low AETC	5.693	9.449	3.756	2.713***
High - Low	0.144	-2.860	-3.004	-1.833*

Table IA22. Difference-in-differences analysis: Subsidies (million RMB) before and after the departures of provincial technology bureau heads

This table is a robustness check to Table 8 of the paper which conducts a difference-in-difference analysis of subsidies before and after the departures of provincial technology bureau heads. In Table 8 in the paper, R&D subsidies are scaled by sales. In this version, we use un-scaled R&D subsidies (measured in millions RMB) as the dependent variable. The table's methodology, organization, and data definitions are otherwise identical to Table 8 in the paper. Detailed variable definitions are found in the Appendix 1 in the paper. *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels in a two-tailed test, respectively.

Panel A: Pre-trend annual growth in Subsidies (million RMB)

	Event Year -3	Event Year -2	Event Year -1
High R&D Efficiency	0.097	0.309	0.399
Low R&D Efficiency	0.316	0.621	0.067
t-test	-0.600	-0.768	1.219
	Event Year -3	Event Year -2	Event Year -1
High AETC	0.520	0.497	0.381
Low AETC	0.316	0.283	0.570
t-test	0.655	0.744	-0.865

Panel B: Difference-in-differences in Subsidies (million RMB) for firms with high and low R&D efficiency

	Before	After	After - Before	*t*-stat
High R&D Efficiency	3.204	9.564	6.360	3.327***
Low R&D Efficiency	2.748	6.150	3.402	2.051**
High - Low	0.456	3.414	2.958	1.169

Panel C: Difference-in-differences in Subsidies (million RMB) for firms with high and low AETC

	Before	After	After - Before	t-stat
High AETC	4.775	8.830	4.055	3.262***
Low AETC	3.514	12.037	8.523	4.266***
High - Low	1.261	-3.207	-4.468	-1.899*

Table IA23. Panel regressions: Subsidies (million RMB) before and after the removals of top provincial officials on corruption charges

This table is a robustness check to Table 9 of the paper which reports panel regression analysis of R&D subsidies (scaled by sales) before and after the removals of top principal officials on corruption charges. In Table 9 in the paper, R&D subsidies are scaled by sales. In this version, we use un-scaled R&D subsidies (measured in millions RMB) as the dependent variable. The table's organization and data definitions are otherwise identical to Table 9 in the paper. Detailed variable definitions are found in the Appendix 1. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (6) of Panel A, and clustered by industry and province are used for regression in Column (7) of Panel A and Column (1) to (4) of Panel B. *p*-values are in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. *p*-values are reported in parentheses.

Panel A: Full sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Subsidies (mil. RMB)	Subsidies (mil. RMB)	Subsidies (mil. RMB)	Subsidies (mil. RMB)	Subsidies (mil. RMB)	Subsidies (mil. RMB)	Subsidies (mil. RMB)
R&D Efficiency $_{t-1}$	1.118**		1.391*	1.391*	0.987	1.294*	0.544
	(0.012)		(0.095)	(0.064)	(0.182)	(0.074)	(0.370)
AETC (mil. RMB) $_{t-1}$		0.236***	0.237***	0.243***	0.224***	0.227***	0.039*
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.060)
Post Removal			0.633	0.652	-1.184*	0.446	-0.524
			(0.323)	(0.402)	(0.094)	(0.550)	(0.323)
R&D Efficiency $_{t-1}$ ×Post Removal				0.119	1.424	1.628	9.015*
				(0.985)	(0.821)	(0.792)	(0.085)
AETC (mil. RMB) $_{t-1}$ ×Post Removal				-0.110*	-0.111*	-0.099*	-0.080*
				(0.074)	(0.066)	(0.093)	(0.085)
SOE $_{t-1}$					5.026***	3.764***	-1.174
					(0.000)	(0.000)	(0.134)
Political Connection $_{t-1}$					1.290***	1.281***	1.154***
					(0.000)	(0.000)	(0.007)
Return on Assets$_{t-1}$						24.480***	0.264
						(0.000)	(0.886)
Tobin's Q $_{t-1}$						-0.807***	-0.283***
						(0.000)	(0.000)
Leverage $_{t-1}$						7.250***	1.200
						(0.000)	(0.178)
Constant	3.614***	4.339***	4.250***	4.294***	-0.083	-1.326	8.570***
	(0.004)	(0.002)	(0.003)	(0.000)	(0.903)	(0.111)	(0.000)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Firm fixed effects	No	No	No	No	No	No	Yes
N	7052	7052	7052	7052	7052	7052	7052
R^2	0.060	0.095	0.095	0.096	0.127	0.167	0.708

Panel B: High versus low corruption regions

	(1)	(2)	(3)	(4)
	High Corruption	High Corruption	Low Corruption	Low Corruption
Dependent Variable	Subsidies (mil. RMB)	Subsidies (mil. RMB)	Subsidies (mil. RMB)	Subsidies (mil. RMB)
R&D Efficiency $_{t-1}$	0.009	0.337	0.901*	0.695
	(0.994)	(0.813)	(0.056)	(0.475)
AETC (mil. RMB) $_{t-1}$	0.102***	0.104**	-0.023	0.022
	(0.003)	(0.021)	(0.494)	(0.667)
Post Removal		1.092		-0.522
		(0.139)		(0.413)
R&D Efficiency $_{t-1}$ ×Post Removal		12.326*		11.702
		(0.067)		(0.177)
AETC (mil. RMB) $_{t-1}$ ×Post Removal		-0.192**		-0.052
		(0.017)		(0.417)
Constant	2.736**	4.022	15.967	0.929
	(0.015)	(0.324)	(0.491)	(0.321)
Lagged firm controls	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	1408	1408	5644	5644
R^2	0.621	0.622	0.721	0.729

Table IA24. Panel Regressions: Subsidies (million RMB) before and after the departures of provincial technology bureau heads

This table is a robustness check to Table 10 of the paper which reports panel regression results of R&D subsidies (million RMB) before and after the departures of provincial technology bureau heads. In Table 10 in the paper, R&D subsidies are scaled by sales. In this version, we use un-scaled R&D subsidies (measured in millions RMB) as the dependent variable. The table's methodology, organization, and data definitions are otherwise identical to Table 10 in the paper. Detailed definitions of other control variables are found in the Appendix 1. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (6) of Panel A, and clustered by industry and province are used for regression in Column (7) of Panel A and Column (1) to (4) of Panel B. *p*-values are in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Full sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Subsidies (mil. RMB)	Subsidies (mil. RMB)	Subsidies (mil. RMB)	Subsidies (mil. RMB)	Subsidies (mil. RMB)	Subsidies (mil. RMB)	Subsidies (mil. RMB)
R&D Efficiency $_{t-1}$	1.118**		1.394*	1.235*	1.321*	1.085**	-0.497
	(0.012)		(0.094)	(0.080)	(0.077)	(0.021)	(0.531)
AETC (mil. RMB) $_{t-1}$		0.236***	0.237***	0.294***	0.277***	0.301***	0.110***
		(0.000)	(0.000)	(0.005)	(0.002)	(0.001)	(0.000)
Post Departure			0.228	0.206	0.188	-0.262	0.074
			(0.367)	(0.584)	(0.430)	(0.542)	(0.746)
R&D Efficiency $_{t-1}$ ×Post Departure				0.341	-0.859	0.281	1.866*
				(0.834)	(0.644)	(0.871)	(0.094)
AETC (mil. RMB) $_{t-1}$ ×Post Departure				-0.107**	-0.109**	-0.112**	-0.036*
				(0.024)	(0.044)	(0.024)	(0.082)
SOE $_{t-1}$					4.983***	4.116**	3.722***
					(0.006)	(0.011)	(0.000)
Political Connection $_{t-1}$					1.377	1.049	0.318
					(0.133)	(0.202)	(0.470)
Return on Assets $_{t-1}$						24.154***	1.051
						(0.006)	(0.585)
Tobin's Q $_{t-1}$						-0.682***	-0.253***
						(0.005)	(0.002)
Leverage $_{t-1}$						6.425**	3.518***
						(0.015)	(0.000)
Constant	3.614***	4.339***	4.199***	3.394***	0.420	-0.745	10.897***
	(0.004)	(0.002)	(0.003)	(0.007)	(0.700)	(0.649)	(0.000)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No
Firm fixed effects	No	No	No	No	No	No	Yes
N	7052	7052	7052	7052	7052	7052	7052
R^2	0.060	0.095	0.095	0.096	0.133	0.147	0.677

Panel B: High versus low corruption regions

	(1)	(2)	(3)	(4)
	High Corruption	High Corruption	Low Corruption	Low Corruption
Dependent Variable	Subsidies (mil. RMB)	Subsidies (mil. RMB)	Subsidies (mil. RMB)	Subsidies (mil. RMB)
R&D Efficiency $_{t-1}$	-0.567	-0.663	1.091*	1.500*
	(0.696)	(0.710)	(0.096)	(0.089)
AETC (mil. RMB) $_{t-1}$	0.107***	0.222***	0.034	0.051
	(0.009)	(0.000)	(0.147)	(0.152)
Post Departure		-0.111		0.146
		(0.840)		(0.657)
R&D Efficiency $_{t-1}$ ×Post Departure		-0.685		-0.954
		(0.797)		(0.350)
AETC (mil. RMB) $_{t-1}$ ×Post Departure		-0.123**		-0.030
		(0.035)		(0.449)
Constant	34.508***	17.338***	-0.695	-1.247
	(0.000)	(0.000)	(0.577)	(0.310)
Lagged firm controls	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
N	1383	1383	5669	5669
R^2	0.617	0.627	0.730	0.731

Table IA25. Subsidies and future innovation: before and after the removals of top provincial officials on corruption charges, using alternative patent measures

This table is robustness check to Table 4, Panel A in the paper, which investigates the relation between R&D subsidies and future innovation before and after the removals of top provincial officials on corruption charges. In Table 4 Panel A of the paper, the dependent variable is U.S. Patents/Sales. Here, we use two alternative measures of patents. In Panel A, we use an un-scaled version of patents. Specifically, the dependent variable is the natural logarithm of (1 plus) the number of US invention patent applications filed by a firm in a given year that were ultimately approved by Dec 31, 2017. In Panel B, we scale the number of U.S. patents by firm assets instead of by sales. The number of U.S. patents is again the number of U.S. invention patent applications filed by a firm in a given year that were ultimately approved by Dec 31, 2017. In each regression, we include the lagged dependent variable to control for persistence. Detailed definitions of other variables are found in the Appendix 1. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (4), and clustered by industry and province are used for regression in Column (5). *p*-values are in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Future U.S. patents （Ln(Patents+1)）

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Ln(Patents+1) (U.S.)	Ln(Patents+1) (U.S.)	Ln(Patents+1) (U.S.)	Ln(Patents+1) (U.S.)	Ln(Patents+1) (U.S.)
Ln(Patents+1) (U.S.)$_{t-1}$	0.658***	0.657***	0.646***	0.636***	0.055***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Subsidies/Sales $_{t-1}$	1.460**	1.178***	1.275***	1.172***	0.199
	(0.012)	(0.001)	(0.001)	(0.002)	(0.676)
Post Removal		-0.025**	-0.025**	-0.017	-0.029**
		(0.032)	(0.028)	(0.228)	(0.022)
Subsidies/Sales $_{t-1}$×Post Removal		1.861**	1.833**	1.627*	2.626***
		(0.041)	(0.044)	(0.075)	(0.005)
Constant	0.013*	0.014	-0.464***	-0.526***	-0.072
	(0.071)	(0.280)	(0.000)	(0.000)	(0.722)
Lagged firm controls	No	No	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	No
Province fixed effects	No	No	No	Yes	No
Firm fixed effects	No	No	No	No	Yes
N	8628	8628	8628	8628	8628
R^2	0.349	0.349	0.354	0.358	0.592

Panel B: Future U.S. patents （Patents/Assets）

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Patents/Assets (U.S.)	Patents/Assets (U.S.)	Patents/Assets (U.S.)	Patents/Assets (U.S.)	Patents/Assets (U.S.)
Patents/Assets (U.S.) $_{t-1}$	0.520***	0.520***	0.517***	0.510***	-0.015
	(0.000)	(0.000)	(0.000)	(0.000)	(0.242)
Subsidies/Sales $_{t-1}$	0.002***	0.001***	0.001***	0.001***	0.001
	(0.005)	(0.000)	(0.004)	(0.008)	(0.330)
Post Removal		-0.00003**	-0.00003**	-0.00002	-0.00003**
		(0.012)	(0.017)	(0.138)	(0.045)
Subsidies/Sales $_{t-1}$×Post Removal		0.003**	0.003**	0.002**	0.003***
		(0.014)	(0.012)	(0.020)	(0.004)
Constant	0.00001	0.00001	-0.0001	-0.0001	0.001***
	(0.167)	(0.310)	(0.558)	(0.335)	(0.000)
Lagged firm controls	No	No	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	No
Province fixed effects	No	No	No	Yes	No
Firm fixed effects	No	No	No	No	Yes
N	8628	8628	8628	8628	8628
R^2	0.256	0.257	0.258	0.263	0.537

Table IA26. Subsidies and future innovation: before and after the departures of provincial technology bureau heads, using alternative patent measures

This table is a robustness check to Table 5 Panel A of the paper, which investigates the relation between R&D subsidies and future innovation, before and after the departures of provincial technology bureau heads. In Table 5 Panel A of the paper, the dependent variable is U.S. Patents/Sales. Here, we use two alternative measures of patents. In Panel A, we use an un-scaled version of patents. Specifically, the dependent variable is the natural logarithm of (1 plus) the number of U.S. invention patent applications filed by a firm in a given year that were ultimately approved by Dec 31, 2017. In Panel B, we scale the number of U.S. patents by firm assets instead of by sales. The number of U.S. patents is again the number of U.S. invention patent applications filed by a firm in a given year that were ultimately approved by Dec 31, 2017. In each regression, we include the lagged dependent variable to control for persistence. Detailed definitions of other variables are found in the Appendix 1. Huber-White heteroskedasticity-consistent standard errors clustered by firm are used for regressions in Column (1) to (4), and clustered by industry and province are used for regression in Column (5). *p*-values are in parentheses. *, **, *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Future U.S. patents （Ln(Patents+1)）

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Ln(Patents+1) (U.S.)	Ln(Patents+1) (U.S.)	Ln(Patents+1) (U.S.)	Ln(Patents+1) (U.S.)	Ln(Patents+1) (U.S.)
Ln(Patents+1) $(U.S.)_{t-1}$	0.658***	0.657***	0.646***	0.636***	0.057***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Subsidies/Sales $_{t-1}$	1.460**	-0.062	0.039	-0.056	-0.546
	(0.012)	(0.900)	(0.938)	(0.913)	(0.353)
Post Departure		-0.003	-0.002	-0.003	0.008
		(0.710)	(0.810)	(0.665)	(0.292)
Subsidies/Sales $_{t-1}$×Post Departure		2.788***	2.742***	2.657***	2.129***
		(0.000)	(0.000)	(0.000)	(0.002)
Constant	0.013*	0.015	-0.463***	-0.515***	-0.075
	(0.071)	(0.277)	(0.000)	(0.000)	(0.712)
Lagged firm controls	No	No	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	No
Province fixed effects	No	No	No	Yes	No
Firm fixed effects	No	No	No	No	Yes
N	8628	8628	8628	8628	8628
R^2	0.349	0.350	0.355	0.359	0.592

Panel B: Future US patents （Patents/Assets）

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Patents/Assets (U.S.)	Patents/Assets (U.S.)	Patents/Assets (U.S.)	Patents/Assets (U.S.)	Patents/Assets (U.S.)
Patents/Assets (U.S.) $_{t-1}$	0.520***	0.520***	0.517***	0.510***	-0.014
	(0.000)	(0.000)	(0.000)	(0.000)	(0.254)
Subsidies/Sales $_{t-1}$	0.002***	0.001	0.0002	0.0001	0.0001
	(0.005)	(0.397)	(0.698)	(0.809)	(0.822)
Post Departure		-0.000004	-0.000004	-0.00001	0.00001
		(0.627)	(0.632)	(0.539)	(0.495)
Subsidies/Sales $_{t-1}$×Post Departure		0.002***	0.002***	0.002***	0.002*
		(0.001)	(0.001)	(0.001)	(0.053)
Constant	0. 00001	0.00002	-0.0001	-0.0001	0.001***
	(0.167)	(0.295)	(0.565)	(0.382)	(0.000)
Lagged firm controls	No	No	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	Yes	No
Province fixed effects	No	No	No	Yes	No
Firm fixed effects	No	No	No	No	Yes
N	8628	8628	8628	8628	8628
R^2	0.256	0.257	0.259	0.263	0.537