

Is a Corruption Crackdown Really Good for the Economy? Firm-Level Evidence from China

Zhiyuan Chen
Renmin University of China

Xin Jin*
University of South Florida

Xu Xu
Stanford University

We study the impact of anticorruption efforts on firm performance, exploiting an unanticipated corruption crackdown in China's Heilongjiang province in 2004. We compare firms in the affected regions with those in other inland regions before and after the crackdown. Our main finding is an overall negative impact of the crackdown on firm productivity and entry rates. Furthermore, these negative impacts are mainly experienced by private and foreign firms, while state-owned firms are mostly unaffected. We present evidence concerning two potential explanations for our findings. First, the corruption crackdown may have limited bribery opportunities that helped private firms operate. Second, the corruption crackdown may have interfered with personal connections between private firms and government officials to a greater extent than institutional connections between state-owned firms and the government. Overall, our findings suggest that corruption crackdowns may not restore efficiency in the economy, but instead lead to worse economic outcomes, at least in the short run (*JEL* L2, M1, O1).

1. Introduction

How do anticorruption efforts affect firm performance? Conventional wisdom holds that corruption misallocates resources and creates market

*Department of Economics, University of South Florida, Tampa, FL, USA. E-mail: xjin@usf.edu. We thank Padmaja Ayyagari, Andrei Barbos, Ruoran Gao, Daniel Grodzicki, Giulia La Mattina, Maria Petrova, Yang Song, Michael Waldman, Shuang Zhang, Boliang Zhu, and Nicolas Ziebarth, Raymond Fisman, the Editor, three anonymous referees, and seminar participants at the University of South Florida, Renmin University (China), the Workshop in Applied and Theoretical Economics at the Central Florida University, the Eastern Economics Association meeting, and the Midwest International Economic Development Conference for helpful comments. Binrui Yang, Kuan Yu Huang, Tong Li, Yi Li, Yong Liao, Fan Ni, Qingzhen Ye, and Jiaojiao Zhao provided excellent research assistance. All remaining errors are our own.

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distortions (Shleifer and Vishny 1993; Goulder et al. 1996; Djankov et al. 2002; Fisman and Svensson 2007). Under this view, anticorruption efforts, especially those targeting corrupt officials, should remove the “grabbing hands of the economy” and improve firm performance. An alternative view is that corruption can “grease the wheels of the economy,” since it speeds up bureaucratic procedures and creates competition for (scarce) government resources (Leff 1964; Lui 1985; Beck and Maher 1986; Vial and Hanoteau 2010). According to this view, eliminating corruption may hurt the firms, especially in regions with weak market institutions. Furthermore, the political connection literature finds positive value of firms’ ties to the government (Fisman 2001; Charumilind et al. 2006; Faccio, 2006; Fan et al. 2008; Acemoglu et al. 2016). Anticorruption efforts may weaken firms’ political connections, thereby affecting firm performance negatively. In sum, the existing literature does not provide a definitive answer to the impact of anticorruption efforts on firm performance.

In this article, we investigate the impact of an anticorruption episode on firm productivity and entry in China. We exploit an unanticipated large-scale corruption crackdown in Heilongjiang province in 2004, triggered by a violent assault on police officers by civilians. The timing of this event allows us to use a rich dataset of large-scale manufacturing firms in China from 1999 to 2007 to examine the impact of a corruption crackdown on firm performance. Unlike most previous studies that focus on financial outcomes such as stock market returns, we explore the impact of a corruption crackdown on firms’ real performance including productivity and entry–exit dynamics.

Using a difference-in-differences approach that compares firms in the affected regions to those in 19 other inland provinces, we find that the corruption crackdown significantly lowered labor productivity—measured as log real value-added per employee—for both existing firms and newly entering firms. When we examine how the effect varies with ownership type, we find that the negative impact was large for private (−20%) and foreign firms (−28%), whereas state-owned firms were largely unaffected. We provide further evidence that the decrease in labor productivity, especially that of private firms, was mostly due to difficulties in securing long-term loans and obtaining land resources for production after the crackdown.

We also find that entry rates in Heilongjiang province after the crackdown was three percentage points lower than in other inland provinces. This decrease is observed both among private and foreign firms, with seven and four percentage point decreases in entry rates, respectively. State-owned firms, in contrast, experienced a one percentage point increase in entry after the crackdown. This is despite the fact that entry barriers (measured by firms’ value-added, sales, fixed capital, and employment) are higher for state-owned firms.

This evidence suggests that corruption crackdowns in a region with weak market institutions have a substantial negative impact on firm performance in the short run.¹ In particular, it reduces firm productivity and entry. Furthermore, the negative effects are mainly experienced by non-state firms (i.e., private and foreign firms), while state-owned firms are largely unaffected. We also find that a crackdown raises entry barriers for all types of firms, suggesting that it removes the “grease of the wheels” that helps firm performance when market institutions are weak.

Our results are robust to different definitions of productivity, various model specifications, sample selection, and different ways of bootstrapping standard errors (SEs) that correct for a small number of clusters and serial correlation. We continually observe a substantial negative impact of the corruption crackdown on private firms’ productivity and entry rates, but there is little effect on state-owned firms. Furthermore, falsification tests find no evidence of pre-trends in labor productivity between Heilongjiang province and other inland regions. The results also hold when we use a continuous measure of crackdown intensity—the number of officials arrested in each prefecture in Heilongjiang province. The effects are unlikely driven by political uncertainty, government dysfunction, China’s entry to the World Trade Organization (WTO), or concurrent events in Heilongjiang province and its nearby regions around the time of the crackdown.

We provide evidence concerning two potential explanations for our findings: (a) limited bribery opportunities and (b) weakened political connections. First, using the 2012 World Bank Enterprise Survey and interviews with entrepreneurs and business insiders inside China, we show that private firms generally rely more on informal payments (the desensitized term for bribing officials) than state-owned firms. Thus, by making bribery riskier, a corruption crackdown should have a larger (negative) impact on private firms than on state-owned firms. Second, we argue that private firms’ personal ties to government officials may be more susceptible to corruption crackdowns than state-owned firms’ institutional connections to the government. Thus, the crackdown is more likely to weaken private firms’ connections than state-owned firms’ connections. To test this possibility, we manually collected the resumes of 2707 top managers in private firms in Heilongjiang province and hand-coded their previous job affiliations to construct a measure of political connection.² We find that private firms with personal connections have lower productivity than state-owned

1. Heilongjiang and the inland regions in China are considered to have weak market institutions. This is measured by the marketization index published by China’s National Economic Research Institute (Fan et al. 2003). For more details about the NERI’s publications, see <http://www.neri.org.cn/English.html>. See Ding et al. (2017) and Lin et al. (2016) for applications of this Index.

2. Previous studies have used past job affiliations of the board members to code political connections for listed firms (e.g., Fan et al. 2008). As far as we know, this paper is the first to provide such a measure for nonlisted firms.

firms after the crackdown, whereas unconnected private firms and state-owned firms do not perform differently.

Our study contributes to a large body of literature on the effect of corruption on firm performance. Previous studies find either positive (Vial and Hanoteau 2010) or negative (Fisman and Svensson 2007) impacts of corruption on firm productivity. Also, focusing on the extensive margin, Klapper et al. (2006) find that regulatory entry barriers have no adverse effect on entry in high-corruption countries.³ This article differs from these studies in two important ways. First, while most previous studies focus on the role of corruption on firm performance, we focus on the effect of anticorruption efforts on firm performance. We find that corruption crackdowns may not restore efficiency in the economy, but instead may lead to even worse economic outcomes. Second, we provide evidence from a natural experiment at sub-national levels concerning how anticorruption efforts affect firm performance at both the intensive margin (i.e., firm productivity) and the extensive margin (i.e., firm entry and exit). Previous studies have not examined both margins simultaneously.

A growing body of literature provides mixed findings regarding the consequences of anticorruption campaigns in China. Various studies have found negative impacts on luxury goods imports (Qian and Wen 2015), financial performance (Kong et al. 2017), and provincial-level GDP growth (Wang 2016), while others find positive impacts on firms' innovation (Xu and Yano, 2017) and market values (Lin et al. 2016; Ding et al. 2017).⁴ Our findings are largely in line with the studies, which find negative impacts.

A recent body of literature looks specifically at an anticorruption regulation in China that mandates resignations of government officials from corporate boards (i.e., the File 18 regulation) (Tang et al. 2016; Fan 2018; Xu 2018; Berkowitz et al. 2019). The main finding in these studies is that the regulation affects firm value negatively, which is consistent with our finding regarding productivity. On the other hand, when the researchers examine the impact of the regulation on financial performance by firms' ownership type, the results are inconclusive. While Fan (2018) and Tang et al. (2016) find a negative impact mainly experienced by private firms, Xu (2018) and Berkowitz et al. (2019) find that both state-owned and private firms are negatively affected although the negative effect concerning

3. Similar studies that examine the relationship between regulation and entry include Scarpetta et al. (2002); Desai et al. (2003); Ovaska and Sobel (2005); Ciccone and Papaioannou (2007); Freytag and Thurik (2007); Bjørnskov and Foss (2008); Dreher and Gassebner (2013) among others. Most studies along this line find a negative relationship between entry regulations and entry. Dreher and Gassebner (2013) find that corruption reduces the negative impact of entry regulation on entry.

4. Lin et al. (2016) find heterogeneous impacts of anticorruption campaigns on stock market valuations among state-owned firms and private firms.

private firms is not statistically significant. Overall, our results are consistent with the finding in [Fan \(2018\)](#) and [Tang et al. \(2016\)](#) that punishing government corruption negatively affects the private sector in China.⁵

There are two main differences between our study and the earlier studies of anticorruption campaigns in China. First, most of the previous studies focus on government-launched anticorruption campaigns involving political motivations such as political purges and appealing to the public for political support. Our empirical strategy, in contrast, exploits an unanticipated large-scale corruption crackdown triggered by an assault on the police, which is thus less politically motivated.⁶ Second, our study employs a comprehensive dataset on manufacturing firms instead of listed firms. Rather than using stock market returns that reflect market expectations, we use direct measures of firm performance (i.e., productivity and entry) as outcome variables.⁷ Moreover, this dataset allows us to analyze firms' entry and exit decisions, which have not been looked at in the previous studies that focused on public-listed firms. Therefore, our study presents a broader picture of the consequences of anticorruption efforts on firm performance.

Our paper also contributes to the study of the value of political connections. Since [Fisman's \(2001\)](#) seminal work on connected firms' stock market response to rumors about the Indonesia President Suharto's health, numerous studies have examined the importance of political connections on firms' financial behaviors on various dimensions. These include studies of lending ([Khwaja and Mian 2005](#); [Charumilind et al. 2006](#); [Claessens et al. 2008](#)), bailouts ([Faccio et al. 2006](#)), and abnormal returns

5. The gradual removal of government officials differs from a corruption crackdown in affecting firms' political connectivity. The former does not necessarily reduce firms' political ties since a firm can remain connected to the removed officials through other venues, or the firm can be connected through other non-board officials who are not affected by the regulation. In contrast, a corruption crackdown terminates the business-government relation when the official is arrested. Moreover, forced resignations from the board in one firm might not deter the official or others from further interacting with her own firm or with other connected firms unless corruption investigations are involved. Furthermore, the File 18 regulation only applies to the listed firms, while our sample includes non-listed firms. Lastly, the literature on the File 18 regulation focuses on firms' financial performances, while our focus is on labor productivity. Despite that, our study differs from the File 18 studies in the nature of the anticorruption events, the outcome measures, and the sample of firms, our results are largely consistent with those found in the File 18 studies.

6. Two other studies have examined corruption crackdowns rather than anticorruption campaigns with different focuses from ours. [Fan et al. \(2008\)](#) examine the effect of cracking down on economic corruption on public listed firms' financial performance. [Di Tella and Schargrodsky \(2003\)](#) study the wage adjustment process during a corruption crackdown in the City of Buenos Aires.

7. We are unable to match our dataset to the China Stock Market & Accounting Research (CSMAR) database to benchmark our results to listed firms as there are only 25 listed firms before 2004 in Heilongjiang province in the CSMAR database (11 firms are matched to our data set). We feel the sample size is too small to produce meaningful results.

(Acemoglu et al. 2016). Our study adds to the literature by identifying two new economic consequences of weakening firms' political connections: reduced productivity and lower entry rates.⁸ More importantly, our study provides the first evidence that political connections formed through personal ties are more susceptible to political turmoil than those formed through institutional connections.⁹

The outline for the article is as follows. Section 2 introduces the institutional background of the corruption crackdown in Heilongjiang province, the data, and our empirical strategy. We present our findings in Section 3 and discuss our preferred explanations for our findings in Section 4. Section 5 discusses alternative explanations. Section 6 concludes.

2. Institutional Background and Empirical Strategy

2.1 Heilongjiang Province and the Han Guizhi Crackdown

Heilongjiang province is located in the northeastern tip of China with Russia to the east (Figure 1). It is roughly the size of California with a population of more than 38 million, and a total land area of 175,600 square miles. Heilongjiang and the adjacent Jilin and Liaoning provinces are collectively known as the Three Northeastern Provinces (Dongsansheng). The Dongsansheng region, known as China's Rust Belt, has specialized in heavy machinery manufacturing and oil extraction since the 1950s.

On February 20, 2004, the Chairwomen of the People's Political Consultative Conference (CPPCC) in Heilongjiang province, Han Guizhi, was arrested in a corruption investigation. Unlike the famous anticorruption campaign launched by Chinese President Xi Jinping in 2012, Han's crackdown was triggered by an unanticipated local-level event in which a business owner violently attacked police officers, including taking a police gun. Since snatching police guns by civilians is an extremely serious felony in China, a series of investigations were subsequently carried out (details below). The investigations eventually unveiled notorious office-selling chains (i.e., bribes involving the selling of government positions) in which Han was at the center (Zhu 2008).¹⁰

On the evening of April 5, 2000, after receiving a 110 call (China's emergency line), 4 police officers in Harbin, the provincial capital city of Heilongjiang province, arrived at the East Sea Dragon Palace Bath House to investigate a possible prostitution case. The Bath House's manager, Liu

8. Earle and Gehlbach (2015) also examine firm productivity, but their focus is on how firms benefited from their connections to the political leader after the 2004 Orange Revolution in Ukraine.

9. Some previous work has examined the effect of government ownership on firm performance (Sun and Tong 2003; Allen et al. 2005; Cull and Xu 2005; Calomiris et al. 2010). Our study also contributes to this literature by finding that state ownership can shield firms from the negative impact of corruption crackdowns.

10. Details of the Han Guizhi case are available at <http://m.lymil.com/2014/0914/11680.html>.



Figure 1. Heilongjiang Province and Other Inland Regions in China.

Jinlong, refused to cooperate, assaulted the police with his security force, and shot a police officer after snatching one of the police officers' guns. This serious assault on the police triggered a series of investigations that revealed a long corruption chain in Heilongjiang. Liu, the Bath House's manager, was connected through bribery to Ding Zhiguo, the Vice President of the Agricultural Bank of China, Heilongjiang Branch. Ding, in turn, was bribed by Miao Shengguo, Manager of Mudanjiang Pharmaceutical Company. The investigation of Miao revealed the corruption case of Ma De, the party secretary of Suihua City and the former vice mayor of Mudanjiang City. From 2002 to 2003, more than a hundred government officials in Suihua were investigated. Up to then, the corruption crackdown remained local until Ma De reported Han Guizhi to the authorities in early 2004.

On February 20, 2004, Han Guizhi was arrested for corruption. During Han's investigation, she confessed that she had received bribes that amounted to more than 9.5 million RMB (≈ 1.5 million USD) from more than 67 officials in exchange for government positions. Her confession led to an "earthquake" in the Heilongjiang officialdom. The follow-up investigations in late 2004 involved about 100 additional officials from all over Heilongjiang province. More than 50 senior officials, including at least 30 officials at prefectural-level or above, were charged with corruption and misconduct. Ten out of Heilongjiang's (then) 14 prefectures had their top

leaders (mayors or party secretaries) removed due to this large-scale corruption crackdown.

Using this corruption crackdown to examine the impact of anticorruption efforts on firm performance has several advantages over anticorruption campaigns used in previous studies. First, the unveiling of the large-scale office-selling chain was largely accidental. The law enforcement agency had no intention of investigating official corruption when they opened a case of an assault on the police. There was no evidence that Liu Jinlong was connected either directly or indirectly to high-ranking government officials who might be able to protect him from an investigation. Thus, using this accidental event alleviates concerns that the crackdown was due to weak local economic performance, or other political motives that are correlated with the local business network.¹¹ Second, unlike firm-related corruption cases, office selling should not directly affect firm productivity. In other words, economic factors were unlikely the triggers of the crackdown.¹²

We choose 2004 as the cut-off time for our study since Han was arrested in early 2004, after which the provincial-wide crackdown started. We expect a corruption crackdown targeting government officials to affect firm performance because the Chinese economy heavily depends on business-government relations (Xin and Pearce 1996; Tsang 1998; Liu et al. 2013). In fact, connections to the government are essential for business operations not only in China, but also in other developing countries with weak market institutions, such as Indonesia (Fisman 2001), Uganda (Fisman and Svensson 2007), and Cambodia (Malesky and Samphantharak 2008). Consulting firms in Indonesia provide a means for foreign investors to get connected with the Suharto family (Fisman 2001). In China, firms are protected from safety inspections, pollution fines, etc. if they have an

11. In Appendix Table A1, we test directly whether the crackdown was correlated with economic conditions. To be specific, we check whether the number of officials removed in each prefecture in Heilongjiang in 2004 is correlated with prefecture-level economic growth (measured as GDP per capita) as well as firms' productivity in that prefecture. We find no significant negative correlation. In fact, the coefficients are positive, which means better economic conditions are correlated with more removed officials. This may be due to the fact that Harbin, the capital city of Heilongjiang province, had the most officials removed and Harbin is also a city with better economic conditions.

12. One may argue that Han's opponents could manipulate the investigations that led to the removal of over 100 officials, and they may also have manipulated the business networks behind Han. However, if that were the case, Han should be systematically more connected to private firms, which is unlikely. Our findings using private firms' personal connection data (see Table 8) further rule out this possibility, since if our results were due to manipulation, Han should have been disproportionately connected with private firms whose managers previously worked in SOEs. We further conduct prefectural-level analysis, and use the number of officials arrested in each prefecture during the crackdown as a continuous measure of crackdown intensity to address this concern (see Table 6). It is unlikely that Han's opponents could target Han's networks in each prefecture so precisely that the number of Han's followers arrested perfectly matches the level of economic distress (measured as lower firm productivity) in that jurisdiction.

executive in the C-suite who once held a high-level government position (Fisman and Wang 2015). Therefore, a major disruption in the officialdom resulting from a corruption crackdown is very likely to affect firm performance in Heilongjiang, a region with an underdeveloped economy and weak market institutions.

2.2 Data and Empirical Strategy

We obtained a panel of firms from the Chinese Industrial Enterprise Database that covers 426,702 large-scale enterprises in manufacturing, mining, and utilities from the years 1999 to 2007.¹³ This database was constructed by the National Bureau of Statistics of China and includes all the state-owned enterprises (SOEs) and nonstate-owned enterprises with annual sales above five million RMB.¹⁴ It serves as the main source for the compilation of the Statistical Yearbook of Chinese Economy. We focus on the manufacturing sector since approximately 90% of the firms in our database are manufacturing firms. We exclude firms with missing values for key variables, firms that have changed provinces during our sample period, and firms that only existed in the year 2004.¹⁵ Our final dataset consists of 388,047 firms and 1,556,517 firm-year observations.

Table 1 provides descriptive statistics. We can see that Heilongjiang's economy is relatively closed. From Panel A in Table 1, only 4% of Heilongjiang manufacturing firms are foreign firms, while 19% of manufacturing firms in the coastal regions are foreign. Also, fewer than 9% of all the Heilongjiang firms are export-oriented, while close to 40% of the firms in the coastal region are export-oriented. In addition, Heilongjiang province has a large public sector where 42% of the firms are state-owned

13. This database is proprietary and can be accessed through HuaMei Commercial Information Consulting Corporation (<http://www.allmyinfo.com/eng/services/index1-1.asp>), a large consulting firm in China. The unit of observation is at the firm level instead of at the establishment level. If a firm has multiple establishments, the observation consists of the firm-level aggregates for all the establishments. This dataset is widely used in papers analyzing firm performance in China, especially for the manufacturing sector. Many studies have used this database to investigate macro development (Hsieh and Klenow 2009; Song et al. 2011), firm-level productivity growth (Brandt et al. 2012), international trade (Yu 2015; Dai et al. 2016), and innovation in China (Liu and Qiu 2016; Chen et al. 2017). We followed the procedure in Brandt et al. (2012) to minimize potential measurement errors in calculating labor productivity.

14. See The Standard of the Chinese National Statistical Bureau (1996–2007).

15. In Figure A1, we plot firms' entry, labor productivity, sales, fixed assets (capital), employment, and value-added against time for Heilongjiang and the control provinces. Since the data collection framework changed from a survey to a census in 2004, we observe a spike in the entry rate in 2004. We thus exclude data from 2004 for our entry analysis. We also exclude Tibet since there are only 281 manufacturing firms in Tibet. Firms' migration across provinces may contaminate the treatment effect. However, only 61 firms, or 311 firm-year observations (<0.02%), changed provinces across the years. We thus do not think migration is a big concern and delete these firms for a cleaner set of results. Multiple establishments might also affect the results if a firm has establishments in both the Heilongjiang and other inland regions. This possibility, however, should cause a downward bias in our estimates.

Table 1. Summary Statistics

	Heilongjiang	Inland regions	Coastal China
A. Provincial-level characteristics			
Total number of manuf. Firms	4267	129,345	254,435
Agricultural product (%)	15.4	10.0	4.3
Heavy machinery (%)	23.9	25.3	34.9
Private firms (%)	54.6	62.1	64.2
SOEs (%)	41.5	33.4	17.1
Foreign firms (%)	3.9	4.5	18.7
Export-oriented firms (%)	8.6	19.5	39.1
Entry rate (%)	18.8	20.2	19.4
Exit rate (%)	15.3	14.6	12.5
B. Firm-level characteristics			
Labor productivity (log)	3.42	3.64	3.77
Employment (in 1000)	373.75	315.98	244.15
Sales (in 1000 RMB)	67,591.19	66,073.43	69,411.61
Fixed assets (in 1000 RMB)	32,538.16	27,639.03	18,272.16
Value-added (in 1000 RMB)	17,377.73	20,455.97	17,198.13

Note: Inland regions include the following 19 provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shannxi, Gansu, Qinghai, Ningxia, and Xinjiang. Entry rates are averaged over the years 2000 to 2007. Exit rates are averaged over the years 1999–2006. Provincial FDI are from the Wind database (<http://www.wind.com.cn/en/>). Data on population are from China Statistical Yearbook from 2002 to 2007. All monetary values are deflated to 1999 RMB.

compared to 17% in the coastal area. Heilongjiang also has a slightly lower entry rate and higher exit rate compared to coastal China. As shown in Panel B, Heilongjiang firms have lower labor productivity compared to firms in other inland regions and the coastal area. Heilongjiang firms also have lower value-added and sales, and larger employment and fixed assets.

Table 1 shows that Heilongjiang firms are relatively similar to firms in other inland provinces but different from those in the coastal areas of China. Therefore, we use firms in the 19 inland provinces as the control group in our main analysis. Firms in these 20 provinces represent 34% of all the firms in the original database.

Our empirical strategy relies on a difference-in-difference comparison of firms in Heilongjiang with firms in other inland provinces, before and after the crackdown. To address the common trend issue, we directly test for pre-existing trends in the robustness check section (Section 3.3). In addition, we construct a continuous measure of crackdown intensity at the prefecture-level to further address concerns involving unobserved confounders and potential concurrent events around the time of the crackdown (Section 3.3). We also employ matching to improve the difference-in-difference estimation for labor productivity.¹⁶

16. Using the nearest-neighbor matching algorithm, as in Abadie et al. (2004), for each Heilongjiang firm in 2004, we draw five matches from the inland provinces based on

Another empirical challenge in our estimation is obtaining correct SEs. Because we only have a small number of clusters at the province level (20 in total), we bootstrap SEs at the province level using the wild cluster bootstrap approach following [Cameron et al. \(2008\)](#) and [Cameron and Miller \(2015\)](#). The wild cluster bootstrap approach deals with the problem of over-rejection of the null hypothesis in the presence of a small number of clusters.¹⁷

3. The Effect of the Corruption Crackdown on Firm Performance

3.1 Labor Productivity

To estimate the effect of the crackdown on firm productivity, we use the following specification to take advantage of the panel data structure:

$$Y_{it} = \beta_1 \text{Heilongjiang}_i \times \text{Post2004}_t + \beta_2 X_{it} + \alpha_i + \tau_t + \lambda_{jt} + \epsilon_{it}, \quad (1)$$

where Y_{it} is firm i 's labor productivity in year t . We define labor productivity as the log of real value-added per employee.¹⁸ Heilongjiang_i is an indicator variable that equals one if firm i is in Heilongjiang province; Post2004_t is an indicator variable that equals one if the year is after 2004; X_{it} is a vector of controls including the firm's ownership type and log total sales in year t ; α_i is time-invariant firm characteristics; τ_t are year dummies; and λ_{jt} are industry dummies.

Since the wild cluster bootstrap approach is not compatible with panel data ([Cameron and Miller 2015](#)), we first use a standard difference-in-difference specification and treat our data as repeated cross-sections by adding province dummies in [equation \(1\)](#). To control for firm-fixed effects, we then estimate [equation \(1\)](#) using demeaned data with the wild cluster bootstrap approach. The results are reported in [Table 2](#). The demeaned estimators in columns 2 and 4 are comparable with the fixed-effect estimators in [Appendix Table C1](#) that use the standard clustering approach at the province level.

We start with the effect of the corruption crackdown on the full set of firms. Column 1 in [Table 2](#) indicates that labor productivity declined by

industry, assets, employees, and sales. The results are qualitatively unchanged compared to the results in [Table 2](#). See [Appendix Table A2](#) for details concerning the matched sample. Other studies that use this method include [Matsa and Miller \(2013\)](#).

17. We report the results using the standard clusters at the province level in [Appendix Tables C1](#) through C6.

18. As this measure of labor productivity may pick up changes in capital investment, we also use two other control function approaches to compute total factor productivity: the OP method ([Olley and Pakes 1996](#)) (at 10% and 5% depreciation) and the LP method ([Levinsohn and Petrin 2003](#)). [Appendix B](#) provides more details on the two estimation strategies for total factor productivity. See [Appendix Tables A3](#) for results using the OP and the LP methods. The results are qualitatively unchanged compared to the results using the simple labor productivity measure. We thus adopt the most straightforward measure of productivity. Other studies that use this productivity measure include [Bernard et al. \(2003\)](#) and [Klapper et al. \(2006\)](#).

Table 2. The Effect of a Corruption Crackdown on Firm's Labor Productivity

	All firms		Existing firms		New firms
	(1)	(2) Demean	(3)	(4) Demean	
Heilongjiang X After 2004	-0.106*	-0.166***	-0.142***	-0.158***	-0.098*
	(0.057)	(0.059)	(0.051)	(0.056)	(0.058)
Province fixed effect	X		X		X
Year fixed effect	X	X	X	X	X
Industry fixed effect	X	X	X	X	X
Firm characteristics	X	X	X	X	X
Observations	489,729	489,729	222,643	222,643	88,389
Number of firms	132,854	132,854	36,654	36,654	88,389
R^2	0.261	0.168	0.224	0.205	0.147

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered at province and firm levels in columns (1), (3), and (5) and at province level in columns (2) and (4). SEs are bootstrapped at the province level using the wild cluster bootstrap method. Samples in columns (2) and (4) are demeaned to capture the panel data structure in the original data set. The samples in columns (1) and (2) include all large-scale manufacturing firms from years 1999 to 2007. The samples in columns (3) and (4) include firms that enter before 2004 and exit after 2004. The sample in column (5) includes firms in their entering year after 1999. Firm characteristics include firm's ownership type (i.e., private, state, or foreign owned) and assets (log). *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

11% among Heilongjiang firms relative to firms in other inland provinces after 2004 ($p < 0.1$). As shown in column 2, after controlling for firms' time-invariant characteristics by demeaning the data, the point estimate becomes -0.166 and is statistically significant at 0.01 level. That is, labor productivity after 2004 declined by a substantial 17% among Heilongjiang firms compared to firms in other provinces.

Columns 3 and 4 show the impact of the crackdown on existing firms. We define existing firms as those that entered before 2004 and exit after 2004, so that the firms are in the sample for at least three years. Again, we find a substantial negative effect of the crackdown on labor productivity. To be specific, column 4 shows that firms in Heilongjiang have a 16% lower productivity compared to firms in other inland provinces after the crackdown. This effect is significant at the 0.01 level.

To examine the impact of the crackdown on firms' productivity among the newly entering firms, we estimate equation (1) after adding province dummies. To be specific, we consider the following specification:

$$Y_{it} = \beta_1 \text{Heilongjiang}_i \times \text{Post2004}_t + \beta_2 X_{it} + \gamma_s + \tau_t + \lambda_{jt} + \epsilon_{it}, \quad (2)$$

where γ_s is the province dummies.

The results are reported in column 5 of Table 2. We find that newly entering firms in Heilongjiang province after the crackdown had a 10% lower productivity compared with newly entering firms in other inland provinces.

We next examine how the effects of the corruption crackdown vary with ownership type. Marketization in China and the privatization of

SOEs make it challenging to define a firms' ownership type. We employ the classification adopted by Guariglia et al. (2011) that is based on the firms' majority share of paid-in-capital.¹⁹ In our sample, 75,584 firms have one or more ownership type changes during the sample period, which accounts for 7% of the firm-year observations. We exclude firms with ownership type changes from our sample in the analyses related to ownership type.²⁰

In Table 3, we re-estimate equations (1) and (2) for private, state-owned (i.e., the SOEs), and foreign firms separately. We find that the negative impact of the crackdown was mainly experienced by private and foreign firms. In particular, after the crackdown, existing private firms in Heilongjiang province experienced a 20% decline in labor productivity (column 2) relative to firms in other provinces. The decrease in labor productivity among existing foreign firms was a substantial 28% (column 8). Both estimates are statistically significant at the 0.01 level. In contrast, the crackdown had no statistically significant impact on the SOEs' labor productivity. The point estimates for the existing SOEs are, in fact, positive (column 5). Focusing on firms' productivity in the entry years in columns 3, 6, and 9, we again see strong negative effects: a 13% decrease for private firms (column 3) and a 32% decrease for foreign firms (column 9). In contrast, the newly entered SOEs' productivity in Heilongjiang did not differ from that in other provinces (column 6).

To further explore how the crackdown depresses labor productivity in private versus state-owned firms, we gathered additional evidence on firms' financial performance and local land provisions for industry use. The rationale is that both capital and land are important production resources.

With regard to firms' financial performance, we find that private firms have lower profits and higher leverage after the crackdown (see Appendix Table A5). The increase in private firms' leverage is due to increases in debt, especially short-term debt. These results suggest that private firms face difficulties raising long-term debt—a preferred method of debt financing (Flannery 1986; He and Xiong 2012), while the debt financing environment for the SOEs did not change. Differences in firms' debt

19. There are six categories of ownership type: state-owned, collective investors, private legal entities, private individuals, foreign-owned, Hong Kong-Macao-Taiwan (HKMT) owned. We further combine state-owned and collective investors as state-owned firms; private legal entities and individuals as private firms; foreign and HKMT owned as foreign firms. Other studies using paid-in-capital to classify ownership type include Ayyagari et al. (2010) and Dollar and Wei (2007).

20. Appendix Table A4 reports the effect of the crackdown on firms' ownership changes. After the crackdown, the SOE reforms did not slowdown in Heilongjiang (column 1). Interestingly, there was an increase in private to state-owned conversion after the crackdown (column 2). Overall, the crackdown increases ownership type changes of all kinds in Heilongjiang (column 3). However, we do not find any differences in the probability of changing ownership types between Heilongjiang firms and firms in the inland provinces before the crackdown.

Table 3. The Effect of a Corruption Crackdown on Firm's Labor Productivity by Firm's Ownership Types

	Private			State			Foreign		
	Existing firms		New firms	Existing firms		New firms	Existing firms		New firms
	(1)	(2) Demean	(3)	(4)	(5) Demean	(6)	(7)	(8) Demean	(9)
Heilongjiang X After 2004	-0.202*** (0.072)	-0.199*** (0.071)	-0.125* (0.065)	-0.018 (0.038)	0.027 (0.061)	0.095 (0.074)	-0.214*** (0.076)	-0.277*** (0.099)	-0.320*** (0.114)
Mean of dependent variable	3.96		3.71	3.10		2.75	4.22		3.81
Province fixed effect	X		X	X		X	X		X
Year fixed effect	X	X	X	X	X	X	X	X	X
Industry fixed effect	X	X	X	X	X	X	X	X	X
Firm characteristics	X	X	X	X	X	X	X	X	X
Observations	96,877	96,877	62,800	30,709	30,709	9121	9268	9268	3109
Number of firms	17,281	17,281	62,800	4815	4815	9121	1507	1507	3109
R ²	0.203	0.240	0.129	0.191	0.137	0.189	0.243	0.108	0.178

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered at province and firm levels in columns (1), (4), and (7) and at province level in columns (2), (3), (5), (6), (8), and (9). SEs are bootstrapped at province level using the wild cluster bootstrap method. Samples in columns (2), (5), and (8) are demeaned to capture the panel data structure in the original data set. Samples restricted to firms with no ownership changes during their sampling periods. The samples in columns (1), (2), (4), (5), (7), and (8) include firms enter before 2004 and exit after 2004. The samples in columns (3), (6), and (9) include firms in their entering year after 1999. Firm characteristics include assets (log). ***p < 0.01, **p < 0.05, *p < 0.1.

financing options may lead to differences in productivity after the crackdown.

With regard to land provisions for industry use, existing literature shows that local Chinese leaders use negotiated land transfers, often at discounted prices, to attract investment to their jurisdiction, and in this way, stimulate local economic growth and improve their own political prospects (e.g., Jin and Xu 2019; Tao et al. 2010). Negotiated land transfers are used to distribute industrial land (*gongye yongdi*) at low or even zero cost, whereas commercial land (*shangzhu yongdi*) transactions usually occur through auctions, bidding, and listings at much higher market prices. As land sales through auctions, bidding, and listings reflect marketized land transactions, we use the ratio of negotiated land area sales to auction/bid/listing area sales to measure the willingness of the local government to provide cheap land for industry use. We find that the corruption crackdown discouraged officials in Heilongjiang cities from providing cheap land for industry use (see Appendix Table A6). This finding suggests that insufficient production resources (e.g., land) may have contributed to the lower productivity in Heilongjiang province after the crackdown.

3.2 Entry and Exit

In the previous subsection, we examined the effect of the corruption crackdown on firms' labor productivity at the intensive margin. We now turn our focus to the extensive margin, that is, entry and exit decisions. Following Klapper et al. (2006), we calculate entry and exit rates at four-digit industry levels. There are 754 four-digit industries in our sample.

We estimate equation (2) using province-year-industry-level entry or exit rates as the dependent variable, where we include cell-level average log sales, year dummies, and province dummies as controls. The results are reported in Table 4. After the crackdown, the Heilongjiang industries experienced a 0.027 lower entry rate compared to industries in other provinces (column 1). This represents about a 16% decrease in the mean entry rate. On the other hand, the crackdown had no impact on the exit rate (column 2) in Heilongjiang compared to firms in other provinces.

When we divide our sample by ownership type, we find that private and foreign firms experienced entry rate declines of 0.072 and 0.037, respectively. On the other hand, the crackdown increased the entry rate of state-owned firms in Heilongjiang relative to SOEs in other inland provinces after the crackdown.²¹

Entry decisions are mainly determined by entry costs and expected returns. We examine the impact of the crackdown on entry costs in Table 5. If the crackdown increased entry costs so that only large firms could enter, we should observe an increase in firm size, that is, entry

21. We find no impact of the crackdown on private firms' and SOEs' exits, and decreases in exit rates among foreign firms. These results are available upon request.

Table 4. The Effect of a Corruption Crackdown on Firm Entry and Exit

	Entry	Exit	Entry by firm type		
	All (1)	All (2)	Private (3)	State (4)	Foreign (5)
Heilongjiang X After 2004	-0.027*** (0.010)	-0.003 (0.008)	-0.072*** (0.026)	0.014* (0.009)	-0.037*** (0.013)
Mean of dependent var.	0.173	0.157	0.261	0.110	0.192
Province fixed effect	X	X	X	X	X
Year fixed effect	X	X	X	X	X
Firm characteristics	X	X	X	X	X
Observations	41,669	41,679	29,531	22,378	7348
R^2	0.094	0.078	0.154	0.042	0.083

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered and bootstrapped at province level using the wild cluster bootstrap method. Entry and exit rates are calculated for each year-province-industry (four-digit)-ownership type cell. Firm characteristics include cell-level average log assets. Entry year is defined as the first year in sample after the year 1999. Exit year is defined as the last year in sample before the year 2007. Data in 2004 are excluded. Samples in columns (3), (4), and (5) are restricted to firms with no ownership changes during their sampling years. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Table 5. The Effect of a Corruption Crackdown on New Firms' Size as a Measure of Entry Barriers by Firm's Ownership Type

	Log (sale) (1)	Log (vad) (2)	Log (asset) (3)	Log (labor) (4)
Panel A: private firms				
Heilongjiang X After 2004	0.134* (0.072)	-0.022 (0.090)	-0.027 (0.057)	0.103** (0.046)
Observations	65,163	62,800	65,163	65,163
R^2	0.092	0.072	0.055	0.114
Panel B: state firms				
Heilongjiang X After 2004	0.704*** (0.000)	0.470** (0.202)	0.848*** (0.000)	0.345* (0.187)
Observations	9630	9121	9630	9630
R^2	0.229	0.193	0.093	0.110
Panel C: foreign Firms				
Heilongjiang X After 2004	0.119 (0.113)	-0.141 (0.109)	0.655*** (0.000)	0.137 (0.107)
Observations	3309	3109	3309	3309
R^2	0.094	0.086	0.131	0.151

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered and bootstrapped at province level using the wild cluster bootstrap method. Each regression includes a time trend, province fixed effect, and industry fixed effect. Samples include firms in their entering year after 1999 with no ownership changes in their sampling years. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

barriers. Panel B shows that entry barriers for SOEs are higher from the standpoint of various measures. Newly entering SOEs' value-added and employment increased by 48% and 35%, respectively, while sales and assets increased by a substantial 72% and 85%, respectively. In contrast, we observe only moderate increases in sales and employment among private firms, and in assets among foreign firms. These patterns suggest that entry barriers are higher after the crackdown, which is consistent with the crackdown removing the grease-of-the-wheels effect of corruption.

3.3 Robustness Checks

3.3.1 Pre-existing Trend. The validity of our difference-in-difference estimator relies on the assumption of a common trend in firm performance across Heilongjiang province and other inland provinces. To examine the possibility of pre-existing trends, we create placebo treatments for every year from 1999 to 2007 by interacting the indicator for Heilongjiang province with each year dummy. We plot the resulting coefficients in [Figure 2](#) with confidence intervals from the wild cluster bootstrapping method using demeaned data. We also report the estimations in [Appendix Table A7](#). Overall, we find no significant differences in pre-trends before 2004 in firms' labor productivity. We address the issues with entry below.

3.3.2 Crackdown Intensity. Since our identification is based on a corruption crackdown in one province in 2004, our results are subject to other events around 2004 that could have affected firm performance in Heilongjiang province relative to firms in other provinces. To further explore the effect of the corruption crackdown, we investigated archival data and Chinese news reports to identify the number of high-level officials arrested in each prefecture in Heilongjiang during the crackdown.²² This measure avoids the problem of a small number of clusters in the provincial-level DID design, as well as potential biases caused by concurrent events in Heilongjiang around 2004. It also addresses concerns of a political purge as discussed in footnote 10. The results are reported in [Table 6](#). Columns 1 and 5 show that existing private (foreign) firms experienced an 8.3% (8.5%) decrease in labor productivity when one additional official was arrested in the prefecture where the firms were located. On the other hand, the SOEs were unaffected by the number of officials arrested

22. We focus on arrested officials at prefectural-level and above, as only high-level officials were identified in the news reports. To obtain the number of officials arrested in each prefecture, we first assign arrested officials at the prefecture-level to their corresponding jurisdictions before the arrests. For provincial-level officials, we assign them to the prefecture where they were promoted from or born in, since previous job affiliation and hometown connections are regarded as good proxies of political connections ([Fisman et al. 2020](#)). Following this procedure, we assigned 36 arrested officials at the prefectural-level and above to 12 prefectures (out of 14) in Heilongjiang to construct a continuous measure of prefecture-level crackdown intensity. Unaffected prefectures in Heilongjiang and in other control provinces are coded as zero officials arrested.

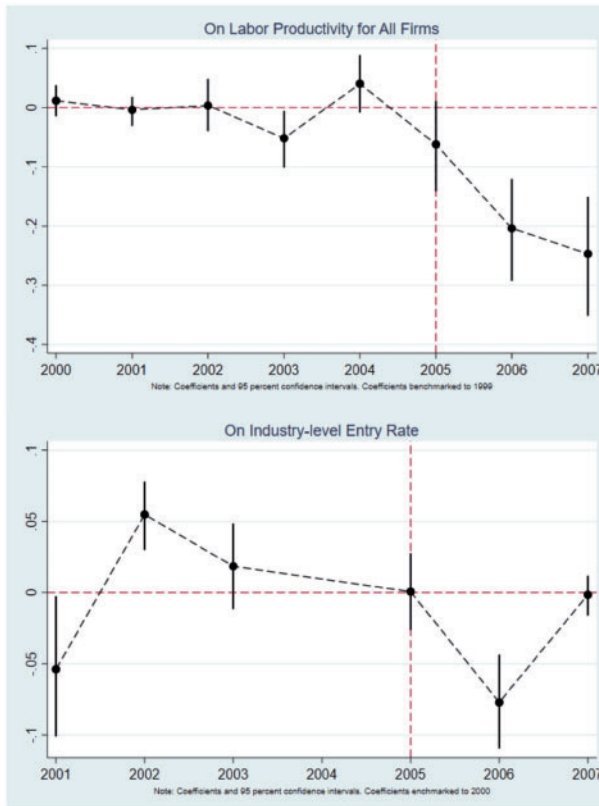


Figure 2. Pre-existing Trends Analysis.

Note: Each graph represents coefficient from a regression of outcome variables on interactions of Heilongjiang with year dummies where 2004 is the outbreak year. All estimates are benchmarked to effects in the beginning year. SEs are clustered at the province level using the wild cluster bootstrap method.

(columns 3 and 4), which is consistent with our findings using the provincial-level treatment.

3.3.3 Entry Measures. Our database contains SOEs of all sizes, but only non-SOEs with annual sales higher than five million RMB. Given this, using in-sample entry and exit can be problematic. The issue is that, if the crackdown prevents small nonstate firms from growing large enough (in sales) to be included in our sample, then there will be a bias concerning how the crackdown affects different types of firms. To address this issue, we apply the same 5 million size cutoff to all firms by excluding SOEs with <5 million annual sales. The results are consistent with the findings in the full sample regarding entry (Appendix Table A8). We also find consistent results on productivity in the truncated sample compared with the results in the full sample (Appendix Table A9). Nevertheless, we cannot rule out

Table 6. Number of Arrested Officials at the Prefectural Level and Firms' Labor Productivity by Ownership Type

	Private		Foreign	
	Existing firms (1)	New firms (2)	Existing firms (5)	New firms (6)
No. of corrupt X after 2004	-0.083*** (0.020)	-0.025 (0.084)	-0.085** (0.038)	-0.102 (0.149)
No. of corrupt		0.124 (0.082)		0.160 (0.308)
Firm fixed effect	X		X	
Province fixed effect		X		X
Year fixed effect	X	X	X	X
Industry fixed effect	X	X	X	X
Firm Characteristics	X	X	X	X
Observations	92,854	62,232	9003	3093
Number of firms	16,673	62,232	1471	3093
F^2	0.241	0.130	0.108	0.183

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered and bootstrapped at city level. Samples restricted to firms with no ownership changes during their sampling periods. The samples in columns (1), (3), and (5) include firms enter before 2004 and exit after 2004. The samples in columns (2), (4), and (6) include firms in their entering year after 1999. Firm characteristics include log assets. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

the possibility that our findings concerning entry dynamics are at least partially the result of sample selection. Thus, the findings on entry and entry barriers should be interpreted with caution.

4. Our Preferred Explanations

In this section, we explore two possible explanations for our finding that the corruption crackdown negatively affected the performance of private firms but not state-owned firms.

4.1 Limiting Bribery Opportunities

A corruption crackdown may hurt private firms more than state-owned firms if the private firms rely on bribing local officials more often to obtain government resources and government permissions. To test this possibility, we draw on the 2012 World Bank China Enterprise Survey. Summary statistics from this survey are reported in Table 7. The table shows that almost all the surveyed firms report making informal payments when applying for government contracts. For example, close to 90% of the private as well as the state-owned firms report making informal payments when applying for basic infrastructure services such as electricity, water, and phone lines. Nevertheless, bribery is more common among private firms than state-owned firms. While 32% of the private firms report making

Table 7. Business Operations and Informal Payment in China by Firms' Ownership Types

Services	Private firms		State-owned firms		Foreign firms	
	Firm applied (%)	Bribed if applied (%)	Firm applied (%)	Bribed if applied (%)	Firm applied (%)	Bribed if applied (%)
Electricity, water, phone	18%	89%	16%	88%	12%	50%
Construction permit	7%	32%	4%	0%	18%	17%
Tax inspection	78%	23%	27%	21%	85%	21%
Government contract	15%	99%	6%	100%	24%	100%
Overall likelihood of informal payment	32%		22%		24%	

Source: The 2012 World Bank Enterprise Survey. Information is based on respondents' recall of events over the past 2 years. The survey covers 2700 firms in 25 cities and 10 provinces (Anhui, Hebei, Henan, Hubei, Liaoning, Sichuan, Guangdong, Jiangsu, Zhejiang, and Shandong) and 2 municipalities (Beijing and Shanghai). We restrict our sample to 998 firms in 9 cities and 6 inland provinces (Anhui, Hebei, Henan, Hubei, Liaoning, and Sichuan).

informal payments of some sort to “get things done,” only 22% of the state-owned firms report making such payments (t -stat: 1.5; p -value: 0.06). In addition, interviews with entrepreneurs and business insiders in China suggest that it is very common for private business owners, who personally own their firms, to bribe government officials. But, leaders of state-owned firms do this less often, according to our interviews, because they have less incentive to bribe their colleagues since the firms are owned by the state.²³ Since private businesses are more likely to bribe government officials, a corruption crackdown may have a larger (negative) impact on private firms. This is because many of the corrupt officials will be removed, making it more difficult for privately owned firms to “get things done.”

4.2 Weakening Political Connections: Personal Versus Institutional

Another channel through which a corruption crackdown may affect firm performance is weakened political connections. It is likely that private firms' connections to individual officials are more susceptible to a corruption crackdown than state-owned firms' connections. To test this possibility, we manually coded private firms' personal connections using their top leaders' past job affiliations.²⁴ We collected the resumes of 2707 top

23. Note that SOEs may be more corrupt in terms of taking State's properties for private use, but private firms are likely more corrupt in terms of bribing government officials. Our results are in line with recent findings in Fang et al. (2018) that private firms spend more on perks given to government officials than SOEs after a major political turnover of government officials in a firm's city.

24. We searched all the private firms in Heilongjiang that existed before 2004 in the National Enterprise Credit Information Publicity System of China. Our procedure consisted of matching firms by firm names and their legal person's names since there are frequently

managers or shareholders in 675 private firms in Heilongjiang. Following [Fan et al. \(2008\)](#) and [Fisman and Wang \(2015\)](#), a private firm is considered politically connected if at least one of its top managers once worked in a government administrative position (e.g., mayors or party secretaries), a legislative position in the National People's Congress (NPC) or in the CPPCC, a state-affiliated association, or a SOE. We consider all state-owned firms as "institutionally connected" by default through their government ownership ([Calomiris et al. 2010](#)).

Note that we are using the term "political connection" loosely. In the Chinese context, political connections can be established through many different channels, including hiring executives with prior political experiences and/or government affiliations, offering "perks" to government officials, through government ownership or princeling ownership and many more (e.g., [Fan et al. 2008, 2018](#); [Calomiris et al. 2010](#); [Chen and Kung 2018](#);). Strictly speaking, our measure only captures the personal connections formed through previous job affiliations. The "unconnected" firms in our sample may include firms with other types of connections that we are unable to identify. This measurement error likely leads to a downward bias. Thus, our estimates should be interpreted as a lower bound of the true effect of political connections.

In [Table 8](#), we first compare connected and unconnected private firms in Heilongjiang province with SOEs in the same province (column 1) before and after the crackdown. We find that connected private firms had a statistically significant 26% lower productivity than the SOEs after the crackdown, while unconnected private firms did not perform differently compared to the SOEs. Column 2 focuses on different types of private connections. We find that private firms with top managers who previously worked in government administrative positions, the NPC, the CPPCC, or state-affiliated associations were unaffected by the crackdown. But the productivity of private firms with top managers who previously worked in SOEs decreased by 36% relative to the SOEs after the crackdown. As a robustness check, we also include all other unidentified private firms in Heilongjiang and code them as non-connected firms. These results shown in columns 3 and 4 are similar.

The findings in [Table 8](#) suggest that different types of political connections result in different outcomes during a corruption crackdown. The literature on political connections identifies two broad types of connections—personal ties and institutional ties. As [Calomiris et al. \(2010\)](#) point out, institutional ties, such as those formed through government ownership, can substitute for personal ties as a source of political

multiple firms with the same name. In [Table A10](#), we present sample level comparisons for the key variables between the searchable firms (i.e., private firms in Heilongjiang with legal persons' names) and non-searchable firms (private firms in Heilongjiang without legal persons' names). The searchable firms are larger in size, but not different from the non-searchable firms in terms of labor productivity and profitability.

Table 8. Productivity and Political Connections in Heilongjiang: Personal Connections versus Institutional Connections

Dependent variable:	Searchable firms		All firms	
	(1)	(2)	(3)	(4)
Log labor productivity				
POE Con X After 2004	-0.256** (0.126)		-0.213* (0.118)	
POE Uncon X After 2004	-0.099 (0.078)	-0.099 (0.078)	0.015 (0.042)	0.014 (0.042)
POE Govt X After 2004		0.063 (0.134)		0.047 (0.114)
POE Renda X After 2004		-0.048 (0.284)		-0.015 (0.269)
POE Enterp X After 2004		-0.362** (0.154)		-0.307** (0.149)
Year fixed effect	X	X	X	X
Industry fixed effect	X	X	X	X
Firm characteristics	X	X	X	X
Observations	5779	5779	15,187	15,187
Number of num	1574	1574	4103	4103
R ²	0.091	0.091	0.091	0.091

Notes: Samples in columns (1) and (2) include private firms with information on legal person and all state-owned firms in Heilongjiang from 1999 to 2007. Samples in (3) and (4) include all private and state-owned firms in Heilongjiang. SEs are clustered at firm level. POE Govt equals to 1 if at least one of the top leaders in a private firm used to hold government positions. POE Renda equals to 1 if at least one of the top leaders in a private firm used to hold positions in the People's Congress, the CPPCC, or any national nongovernment associations. POE Enterp equals to 1 if at least one of top leaders in a private firm used to work in an SOE. POE Con equals to 1 if a private firm has any of the aforementioned connections. POE Noncon equals to 1 if a private firm has none of the aforementioned connections. The omitted category is the SOEs. Firm characteristics include assets (log). *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

connections. Our findings suggest that a corruption crackdown negatively affects firms with personal connections (to either the removed officials or other unremoved officials), but leaves those firms with institutional connections unaffected.

Before investigating differences between personal connections and institutional connections, the case of Qiqihar Jiecheng Commercial and Trade Co., Ltd. provides a concrete example of the value of private firms' personal connections to government officials and the vulnerability of this type of connections during a corruption crackdown. The CEO of this private firm in the City of Qiqihar, Heilongjiang, Liu Jie, obtained the Qiqihar Bus Terminal Building in 2000 through his personal connection to Wang Xiaoci, the former Vice Chief of the Bureau of Transportation in Heilongjiang province. To complete this transaction, Wang Xiaoci directed Bada Road and Bridge Company, an SOE owned by the Bureau of Transportation, to purchase the Building for 4.5 million RMB ($\approx 638,000$ USD) and resell it to Liu for 1 million RMB ($\approx 142,000$ USD). Wang was later scrutinized in an investigation related to the Han Guizhi case, and found guilty of 63 corruption incidents totaling more than 3

million RMB ($\approx 438,000$ USD) in illegal income.²⁵ From this case, we can see that this type of personal connection can quickly lose its value during a corruption crackdown.

A corruption crackdown affects not only the firms connected to the removed officials but also firms connected to other officials since the crackdown will deter surviving officials from engaging in illegal behaviors.²⁶ On the other hand, state-owned firms do not rely nearly as much on personal connections, since they are endowed with institutional connections through government ownership (Calomiris et al. 2010). Local governments or the central governments are the largest shareholders of the state-owned firms. They receive shareholder bonuses, dividends, and other benefits from the state-owned firms, in addition to the taxes imposed on state-owned firms. Interviews with business insiders indicate that state-owned firms are responsible for financing government public welfare programs, such as the Poverty Reduction Programs (fupin), and provide other financial or practical support when needed. For example, in the aforementioned case, Wang manipulated the sale through an SOE owned by the Bureau of Transportation. In return, the government subsidizes state-owned firms heavily. Thus, even when government officials are replaced during a corruption crackdown, the new officials still have numerous reasons for supporting state-owned firms.

Private firms are not endowed with the type of automatic support that state-owned firms have. Thus, when their personal connections to government officials are removed or weakened due to a corruption crackdown, they suffer more than state-owned firms. This is especially true in markets with weak institutions, since there are no efficient market forces to facilitate resource allocation, and the rebuilding of personal connections is costly for private firms.²⁷

25. *Cai Jing* Magazine (in Chinese) published an article on January 10, 2005 detailing the corruption investigation on Wang Xiaoci. The complete report (in Chinese) can be accessed at <http://misc.caijing.com.cn/chargeFullNews.jsp?id=110061782&time=2005-01-10&cl=106>.

26. For example, Wang (2019) finds that China's recent anticorruption investigations (2012–2017) had a “chilling effect” on bureaucrats' productivity. The bureaucrats reduced activities such as selling land for development projects, collecting revenue, and enforcing environmental regulations during the anticorruption campaign. Fan et al. (2008) also find that the announcement of a corruption investigation has a negative impact on connected firms' corporate financing decisions, even if the firms are not directly involved in the corruption cases. Fang et al. (2018) find that after an anticorruption campaign or arrests of municipal leaders, firms' spending on perks to government officials decreases.

27. Our results do not suggest that state-owned firms are more efficiently operated than the private firms, but that the state-owned firms' endowed institutional connections likely protect them from the adverse impacts of a corruption crackdown. In fact, we show in Table 3 that private firms are more efficient than state-owned firms in terms of labor productivity. For studies focused on state-owned firms' efficiency, see Cao et al. (2019).

Note that the political connection channel is different from the bribery channel, since the former is a long-term reciprocal relationship, whereas the latter can involve ad hoc “undesirable” exchanges. In fact, firms’ political connections formed through previous job affiliations can protect firms from being solicited for bribes, ad hoc taxes, and other types of informal payments to government officials (Hou 2019).

5. Alternative Explanations

In this section, we discuss possible alternative explanations for our findings. Two related explanations for the reduction in labor productivity in Heilongjiang province after the crackdown are dysfunctional local governments and political uncertainty. We feel these mechanisms are unlikely to be the drivers of our findings for the following reasons. First, if government dysfunction is the main mechanism, we should observe all firms exhibiting declining labor productivity, especially the state-owned firms since the government is heavily involved in the operations of state-owned firms. However, we find no change in state-owned firms’ labor productivity and increased entry after the crackdown. Second, we find no evidence that existing firms face higher political uncertainty since there is no decline in existing firms’ capital intensity after controlling for employment. Table 9 shows that existing private firms’ capital intensity did not change after the crackdown, while SOEs and the foreign firms’ capital intensities even increased (columns 1 and 3 through 6). These results indicate that these firms are intensifying their investment in fixed assets, which is inconsistent with a higher degree of political uncertainty. We do, however, find an increase in the uncertainty faced by new private firms, since the crackdown resulted in a decrease in their capital intensity (column 2).

Another potential explanation is that Heilongjiang firms were affected by China’s entry into the WTO. One might argue that, compared with private firms in other provinces, private firms in Heilongjiang have less access to free markets so that they were worse off after the WTO entry. We do not believe this is the correct explanation for our findings for several reasons. First, China joined the WTO in December 2001. The existing literature (e.g., David et al. 2013; Brandt et al. 2017) considers 2002 as the post-treatment year for analyses of the WTO effect, which is 2 years before the corruption crackdown in Heilongjiang. As shown in the falsification test (Figure 2), there is not a statistically significant difference between Heilongjiang and other provinces in existing firms’ labor productivity between 2002 and 2005.

Second, in our analysis of political connections (Table 8), we use Heilongjiang firms only and look at different types of political connections. Thus, even if WTO entry influenced Heilongjiang firms differently compared with firms in other provinces, it does not explain our results

Table 9. The Effect of a Corruption Crackdown on Firms' Capital Intensity by Firms' Ownership Types

	Private		State		Foreign	
	(1) Existing	(2) New	(3) Existing	(4) New	(5) Existing	(6) New
Heilongjiang X After 2004	-0.028 (0.022)	-0.188*** (0.073)	0.120*** (0.043)	0.389*** (0.000)	0.127** (0.049)	0.482*** (0.000)
Province fixed effect		X		X		X
Year fixed effect	X	X	X	X	X	X
Industry fixed effect	X	X	X	X	X	X
Observations	98,747	64,525	32,346	9490	9540	3287
Number of firms	17,281	64,525	4819	9490	1507	3287
R^2	0.111	0.086	0.087	0.074	0.008	0.230

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shannxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered at province and firm levels in columns (1), (3), and (5) and are clustered at province level in columns (2), (4), and (6). SEs are bootstrapped at province level using the wild cluster bootstrap method. The sample in columns (1), (3), and (5) are demeaned to capture the panel data structure in the original dataset. Samples restricted to firms with no ownership changes during their sampling periods. The sample in columns (1), (3), and (5) include firms enter before 2004 and exit after 2004. The sample in column (2), (4), and (6) include firms in their entering year after 1999. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

concerning differences across connected versus unconnected firms within Heilongjiang.

Third, our control group in the DID analysis excludes firms in the export-oriented coastal provinces. One might suspect that entering the WTO would affect firms in Heilongjiang differently compared with firms in other inland provinces in terms of export and hence productivity. We directly test for this possibility and find, as shown in columns 2, 4, and 6 in Table 10, that Heilongjiang firms' exports are not affected differently by the crackdown relative to firms in other inland provinces. In addition, among private and state-owned firms, export intensity (export value over total sales) does not differ between Heilongjiang firms and other inland firms after the crackdown. If anything, the crackdown in Heilongjiang helped foreign firms in terms of exports. We thus do not believe that the WTO is a plausible explanation for our findings.

We also provide evidence concerning two other policy and political-related events in the Northeastern region around 2004 that might affect our results. The first is a pilot Value-added Tax Reform initiated by the central government on July 1, 2004. This reform applied to all three Northeastern provinces. We have repeated our analyses using only these three Northeastern provinces, and we again find a strong negative impact of the corruption crackdown on Heilongjiang firms' productivity and entry rates, especially among private sector firms (see Appendix Tables C7–C9). The second event is a series of nuclear tests in North Korea that started in October 2006. North Korea shares borders with the

Table 10. Corruption Crackdown and Exporting Behaviors

	Private firms		State-owned firms		Foreign firms	
	(1) Intensity	(2) Dummy	(3) Intensity	(4) Dummy	(5) Intensity	(6) Dummy
Heilongjiang X After 2004	-0.003 (0.004)	-0.036 (0.085)	0.000 (0.002)	-0.023 (0.086)	0.040*** (0.000)	-0.007 (0.012)
Year fixed effect	X	X	X	X	X	X
Industry fixed effect	X	X	X	X	X	X
Observations	255,546	255,546	97,130	97,130	17,233	17,233
R^2	0.006	0.036	0.003	0.009	0.022	0.038

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered at province and firm level and are bootstrapped at province level using the wild cluster bootstrap method. The samples are demeaned to capture the panel data structure in the original dataset. Each regression includes a time trend and industry fixed effect. Samples restricted to firms with no ownership changes during their sampling periods. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Northeastern region. One could argue that these tests might have caused increased exit and reduced entry rates in this region. As North Korea is directly adjacent to Jilin and Liaoning, but not to Heilongjiang, we should observe a stronger negative impact on Ji-Liao regions relative to Heilongjiang if this argument were correct. But, we instead find the opposite in our three-province analysis. Furthermore, the beginning of these nuclear tests was towards the end of our sample period. We thus do not think this event is a plausible explanation for our findings.

6. Conclusion

This article examines the consequences of a large-scale corruption crackdown in Heilongjiang province in China around the year 2004. The unanticipated nature of this event allows us to examine the impact of a corruption crackdown on firms' productivity and entry rates at sub-national levels. Using a comprehensive database on Chinese manufacturing firms, we compare Heilongjiang firms' performance to firms in other inland provinces before and after the crackdown. We find that the crackdown had a substantial negative impact on Heilongjiang firms' labor productivity and entry rates. More interestingly, private and foreign firms suffer the most, while the SOEs were unaffected.

The above findings are likely due to the idea that private firms are more likely to bribe government officials for access to resources and permissions, and therefore a crackdown targeting corrupt officials should affect private firms more than state-owned firms. Furthermore, our results are consistent with the view that political connections are valuable for firms given weak market institutions, and therefore a corruption crackdown

may weaken private firms' political ties and hurt firm performance. The corruption crackdown also raises entry barriers for all types of firms, suggesting that it removes the "grease of the wheels" that helps firms given weak market institutions. When we examine our results against alternative explanations, we find that the decreased labor productivity and entry rates cannot be explained by government dysfunction, political uncertainty, WTO entry, or other reforms and events in Heilongjiang province and nearby regions around the time of the crackdown.

The finding that the corruption crackdown negatively affected the economy carries important implications for the consequences of anticorruption efforts in markets with weak institutions. It calls attention to an often-overlooked fact that, although corruption is not a first-best equilibrium (Fisman and Svensson 2007), corruption crackdowns may not restore the economy to a corruption-free equilibrium, but instead lead to worse economic outcomes at least in the short run.

Note that our results may not apply to economies with strong market institutions. We can imagine that a corruption crackdown would have very different impacts on firms in regions with more developed market institutions, as suggested in Lin et al. (2016). Acemoglu et al. (2016) also find that political connections have no impact on firms in the US during normal times but a significant impact on firm performance during the financial crisis. Nevertheless, an analysis of a plausible exogenous event of this sort in a more developed coastal region in China is beyond the scope of this article.

The effect of the corruption crackdown on the actual levels of corruption remains unclear since we do not have direct measures of corruption levels. It is unlikely, however, that one corruption crackdown would change the norm concerning corruption fundamentally. There is a difference between the anticorruption effort that we focus on in this article—a single corruption crackdown—and the large-scale and long-term anticorruption campaign launched by the Chinese president, Xi Jinping. Xi's long-term anticorruption campaign might be able to change social norms toward corruption. This may explain the positive consequences of Xi's anticorruption campaign on stock market valuations (e.g., Ding et al. 2017).

Although we are unable to infer the long-term effects of anticorruption efforts on firm performance, due to data limitations, we find strong negative impacts of a corruption crackdown on firm performance in the short-run (3 years). We contend that an abrupt and short-lived corruption crackdown is unlikely to change social norms toward corruption because there are no institutional improvements to limit corrupt behaviors. Future work is needed to examine the long-term consequences of anticorruption efforts on firm performance.

Appendix A

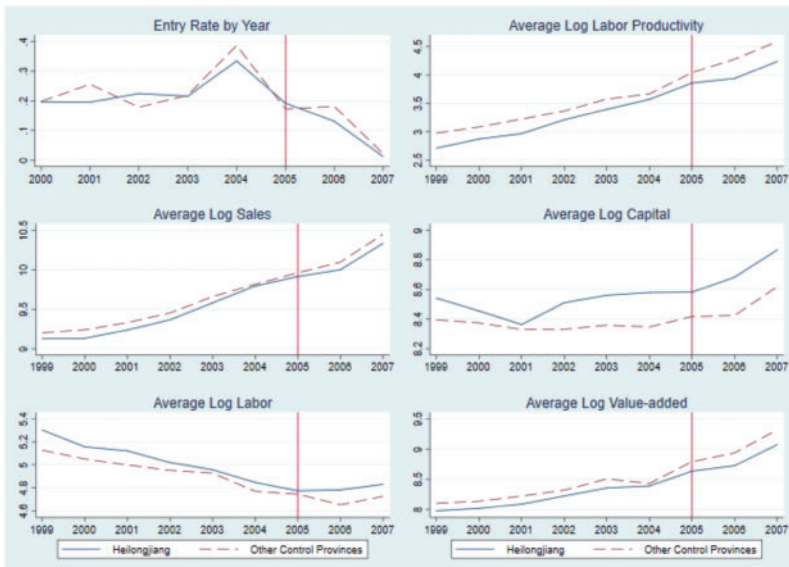


Figure A1. Common Trend on Key Dependent and Control Variables.

Table A1. Economic Growth and Anticorruption

Dependent Var	(1)	(2)
No. of officials removed		
GDP per capital	0.000 (0.000)	
Log labor productivity		0.140 (0.086)
Constant	2.643*** (0.720)	4.437*** (0.327)
Observations	12	1652
R^2	0.027	0.002

Robust SEs in parentheses. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Table A2. The Effect of a Corruption Crackdown on Firm's Labor Productivity, Matched Sample

	Labor productivity	TFP-OP method 10%	TFP-OP method 5%	TFP-LP method
	(1)	(2)	(3)	(4)
Heilongjiang X After 2004	-0.182*** (0.035)	-0.245*** (0.026)	-0.245*** (0.026)	-0.259*** (0.027)
Firm fixed effect	X	X	X	X
Year fixed effect	X	X	X	X
Industry fixed effect	X	X	X	X
Firm characteristics	X	X	X	X
Observations	46,175	20,915	20,915	20,915
Number of firms	9066	3537	3537	3537
R^2	0.191	0.166	0.167	0.145

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered at province level. The samples include firms in Heilongjiang in 2004 with their five closest matched firms drawn from the other 19 inland provinces. Firm characteristics include firm's ownership type (i.e., private, state, or foreign owned) and assets (log). *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Table A3. The Effect of a Corruption Crackdown on Firm's Total Factor Product

	OP method, 10% depr		OP method, 5% depr		LP estimation	
	Existing (1)	New (2)	Existing (3)	New (4)	Existing (5)	New (6)
Heilongjiang X After 2004	-0.230*** (0.028)	0.109** (0.048)	-0.230*** (0.028)	0.109** (0.048)	-0.247*** (0.030)	0.133** (0.050)
Province fixed effect		X		X		X
Firm fixed effect	X		X		X	
Year fixed effect	X	X	X	X	X	X
Industry fixed effect	X	X	X	X	X	X
Firm characteristics	X	X	X	X	X	X
Observations	122,028	21,566	122,028	21,566	122,028	21,566
Number of firms	18,943	21,566	18,943	21,566	18,943	21,566
R^2	0.198	0.216	0.200	0.219	0.176	0.212

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered at province level. The samples in columns (1) and (2) include all large-scale manufacturing firms from years 1999 to 2007. The samples in columns (3) and (4) include firms that enter before 2004 and exit after 2004. The sample in columns (5) and (6) include firms in their entering year after 1999. Firm characteristics include firm's ownership type (i.e., private, state, or foreign owned) and assets (log). *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Table A4. The Effect of a Corruption Crackdown on Firm's Ownership Type Change

	SOE to POE (1)	POE to SOE (2)	All change (3)
Heilongjiang X After 2004	0.005 (0.004)	0.011*** (0.004)	0.014* (0.008)
Firm fixed effect	X	X	X
Year fixed effect	X	X	X
Industry fixed effect	X	X	X
Observations	506,288	506,288	506,288
Number of firms	133,613	133,616	133,619
R^2	0.275	0.216	0.043

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include other 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered and bootstrapped at province level using the wild cluster bootstrap method. Samples in columns are demeaned to capture the panel data structure in the original data set. Firm characteristics include firm's assets (log). SOE stands for State-owned Enterprises. POE stands for private firms. FOE stands for foreign firms. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Table A5. Pre-trend Analysis with Wild Cluster Bootstrap Method

	On labor productivity (1)	On entry rate (2)
Heilongjiang X 2000	0.012 (0.016)	
Heilongjiang X 2001	-0.004 (0.014)	-0.054* (0.028)
Heilongjiang X 2002	0.004 (0.014)	0.055*** (0.000)
Heilongjiang X 2003	-0.052* (0.030)	0.018 (0.018)
Heilongjiang X 2004	0.040 (0.033)	
Heilongjiang X 2005	-0.062 (0.050)	0.001 (0.007)
Heilongjiang X 2006	-0.204*** (0.073)	-0.077*** (0.027)
Heilongjiang X 2007	-0.247*** (0.088)	-0.002 (0.007)
Year fixed effects	X	X
Province fixed effect		X
Observations	489,729	47,613
R^2	0.166	0.278

Note: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered and bootstrapped at province level using the wild cluster bootstrap method. Sample in columns (1) is demeaned to capture the panel data structure in the original data set. Entry rates are calculated for each year-province-industry (four-digit)-ownership type cell. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Table A6. The Effect of a Corruption Crackdown on Firms' Financial Performance by Firm's Ownership Type

	Log (total profit)		Total debt/asset		Short/total debt	
	(1) Existing	(2) New	(3) Existing	(4) New	(5) Existing	(6) New
Panel A: private firms						
Heilongjiang X After 2004	-0.140* (0.084)	-0.210 (0.162)	0.012*** (0.000)	0.049*** (0.000)	0.013 (0.008)	0.044*** (0.000)
Observations	79,761	50,004	99,352	65,162	98,619	63,806
Number of firms	16,758	50,004	17,284	65,162	17,261	63,806
R^2	0.137	0.069	0.002	0.038	0.002	0.024
Panel B: state firms						
Heilongjiang X After 2004	-0.053 (0.054)	-0.177 (0.213)	-0.012 (0.010)	-0.010 (0.020)	0.007 (0.005)	0.015 (0.010)
Observations	19,363	5868	32,460	9629	32,371	9533
Number of firms	4119	5868	4819	9629	4817	9533
R^2	0.062	0.113	0.024	0.007	0.007	0.056
Panel C: foreign firms						
Heilongjiang X After 2004	0.126* (0.073)	0.083 (0.233)	0.009 (0.010)	-0.102*** (0.036)	0.053*** (0.000)	0.088*** (0.031)
Observations	6931	1940	9568	3308	9532	3263
Number of firms	1448	1940	1507	3308	1507	3263
R^2	0.044	0.093	0.011	0.038	0.019	0.030

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shannxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered at province and firm level in columns (1), (3), and (5) and are clustered at province level in columns (2), (4), and (6). SEs are bootstrapped at province level using the wild cluster bootstrap method. The samples in columns (1), (3), and (5) are demeaned to capture the panel data structure in the original dataset. Each regression includes a time trend and industry fixed effect. Columns (2), (4), and (6) also include province fixed effect. Samples in columns (1), (3), and (5) include firms enter before 2004 and exit after 2004 with no ownership changes in their sampling years. Samples in columns (2), (4), and (6) include firms in their entering year after 1999. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Table A7. Industry Land Provision and Corruption Crackdown

	(1)	(2)	(3)	(4)	(5)
Heilongjiang X After 2004	-1.484*** (0.527)	-1.206*** (0.428)	-1.402*** (0.498)	-1.401*** (0.498)	-1.961*** (0.697)
Log GDP per capita	-0.260 (1.476)	-0.920 (5.031)	-0.510 (4.514)	-0.584 (7.755)	0.396 (2.622)
Log FDI		-0.171 (0.155)	-0.189 (0.141)	-0.190 (0.129)	-0.168 (0.146)
Industry share of GDP			-0.039 (0.032)	-0.040 (0.032)	-0.034 (0.037)
Log investment				0.093 (0.507)	
Log real estate					-1.345 (0.910)
Year fixed effect	X	X	X	X	X
Prefecture fixed effect	X	X	X	X	X
Observations	964	846	846	845	840
Number of prefecture	205	203	203	203	203
R^2	0.042	0.049	0.051	0.051	0.063

Note: Land sale data from the Chinese Land and Resource Statistical Yearbooks 2003 to 2007. Land transaction data prior to 2003 is not available. Prefectures in Heilongjiang province are affected by the anticorruption campaign outbursts in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered at province and prefecture level and are bootstrapped at province level using the wild cluster bootstrap method. The samples are demeaned to capture the panel data structure in the original dataset. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Table A8. The Effect of a Corruption Crackdown on Entry Rate by Firm's Ownership Type, Sales Larger than 5 m

	Private (1)	State (2)	Foreign (3)
Heilongjiang X After 2004	-0.061*** (0.022)	0.017** (0.007)	0.002 (0.034)
Mean of dependent variable	0.219	0.121	0.178
Province fixed effect	X	X	X
Year fixed effect	X	X	X
Firm characteristics	X	X	X
Observations	27,196	15,993	6783
R^2	0.159	0.043	0.084

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered and bootstrapped at province level using the wild cluster bootstrap. Entry and exit rates are calculated for each year-province-industry (four-digit)-ownership type cell. Columns (2) and (4) control for cell-level average log assets. Entry year is defined as the first year in sample after the year 1999. Data in 2004 are excluded. Samples restricted to firms with annual sales >5 million and with no ownership changes in their sampling periods. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Table A9. The Effect of a Corruption Crackdown on Firm's Labor Productivity by Firm's Ownership Type, Sales Larger than 5 m

	Private			State			Foreign		
	Existing firms		New firms	Existing firms		New firms	Existing firms		New firms
	(1)	(2) Demean	(3)	(4)	(5) Demean	(6)	(7)	(8) Demean	(9)
Heilongjiang X After 2004	-0.182*** (0.065)	-0.189*** (0.067)	-0.153** (0.059)	0.046 (0.041)	0.021 (0.028)	-0.114 (0.076)	-0.171*** (0.061)	-0.266*** (0.095)	-0.362*** (0.129)
Province fixed effect	X		X	X		X	X		X
Year fixed effect	X	X	X	X	X	X	X	X	X
Industry fixed effect	X	X	X	X	X	X	X	X	X
Firm characteristics	X	X	X	X	X	X	X	X	X
Observations	82,944	82,944	56,336	19,828	19,828	56,339	8,550	8,550	2865
Number of firms	14,700	14,700	56,336	2,999	2,999	5,639	1,374	1,374	2865
R ²	0.206	0.244	0.127	0.195	0.170	0.167	0.238	0.110	0.183

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered at province and firm levels in columns (1), (4), and (7) and at province level in columns (2), (3), (5), (6), (8), and (9). SEs are bootstrapped at province level using the wild cluster bootstrap method. Samples in columns (2), (5), and (8) are demeaned to capture the panel data structure in the original data set. Samples restricted to firms with annual sales greater than 5 million and with no ownership changes in their sampling periods. The samples in columns (1), (2), (4), (5), (7), and (8) include firms enter before 2004 and exit after 2004. The samples in columns (3), (6), and (9) include firms in their entering year after 1999. Firm characteristics include assets (log). ***, **, * $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A10. Mean Comparison for Heilongjiang Firms, 1999 to 2004

	Non-searchable (1)	Searchable (2)	Connected (3)	Nonconnected (4)
Labor productivity	57.09 (188.18)	60.27 (100.43)	55.06 (68.70)	61.32 (105.73)
Profit (in 1000 RMB)	1090.21 (7404.36)	929.92 (21,604.19)	-137.60 (49,765.48)	1145.32 (8190.03)
Sale (in 1000 RMB)	35,912.24 (120,964.05)	69,253.21*** (158,816.31)	106,843.19 (233,174.17)	61,668.29*** (138,354.10)
Labor (in 1000)	263.01 (717.54)	400.16*** (777.72)	506.70 (1010.85)	378.66 (721.62)
Capital (in 1000 RMB)	20,401.43 (81,127.60)	38,600.63*** (92,687.14)	59,805.40 (130,626.20)	34,321.92*** (82,569.34)
Value-added (in 1000 RMB)	8653.26 (27,063.42)	17,555.19*** (34,730.17)	21,998.47 (39,356.49)	16,658.62 (33,713.90)
Total asset (in 1000 RMB)	65,517.56 (307,512.38)	114,455.63*** (282,408.68)	201,204.29 (441,493.85)	96,951.44*** (234,942.23)
Total debt (in 1000 RMB)	43,706.66 (229,188.24)	70,247.97 (187,396.31)	124,795.56 (314,562.07)	59,241.33*** (147,546.01)
Firm age	16 (11.52)	18*** (12.51)	19 (12.91)	18 (12.45)
No. of Firms	1829	405	68	337

Note. Searchable firms are those with firm name and legal person's name. Nonsearchable firms are those with legal person's name missing. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Appendix B

Notes on Productivity Estimation

B.1 Setup

We assume that the firm has following Cobb–Douglas production technology:

$$y_{it} = \exp(\omega_{it})k_{it}^{\alpha}l_{it}^{\beta} \quad (\text{B1})$$

where i represents firm and t represents the time. y_{it} is the firm's value-added, k_{it} is the capital stock, l_{it} is the labor input, and $\exp(\omega_{it})$ is the total factor productivity. The productivity is known by the firm while unobservable to the econometrician.

B.2 Productivity Measures

B.2.1 Labor Productivity. A commonly used measure for the firm's production efficiency is the labor productivity, which is defined as follow

$$lp_{it} = \frac{y_{it}}{l_{it}} \quad (\text{B2})$$

According to this definition, productivity is the value-added per worker. Though it is not the actual total factor productivity, this measurement

is used in the literature on international trade (e.g., Bernard et al., 2003). If we assume that the production function is as in (B1), then it is obvious that the labor productivity measure contains information of the production efficiency $\exp(\omega_{it})$ as well as the firm's capital intensity (capital stock per unit of labor). In particular, when $\alpha + \beta = 1$, that is, the production technology is of constant return to scale, labor productivity can be expressed as follows:

$$lp_{it} = \exp(\omega_{it}) \left(\frac{k_{it}}{l_{it}} \right)^\alpha \quad (\text{B3})$$

Next, we briefly explain the estimation method we implemented to obtain the total factor productivity.

B.3 Control Function Approach to Estimate ω_{it}

In industrial organization literature, ω_{it} can be backed out using control function approaches. The two most popular approaches are OP (Olley and Pakes, 1996) method and LP (Levinsohn and Petrin, 2003) methodology. We introduce them briefly as below.

B.3.1 OP Method

The problem facing the econometrician is the identification of α and β . Because firms make capital and labor choices by their own productivities, the OLS estimators for α and β are potentially biased because the productivity would be contained in the error term if not being controlled. More specifically, the bias will be upward because more productive firms will invest more in capital and employ more workers. Olley and Pakes (1996) propose to use the firm's capital investment to control for the firm's productivity. Under some mild assumptions, the firm's capital investment can be written as:

$$i_{it} = i(\omega_{it}, k_{it-1}, a_{it}) \quad (\text{B4})$$

where i_{it} represents the firm's capital investment and a_{it} is the firm's age. Moreover, the capital investment is increasing in the firm's productivity conditional on firm's previous capital stock and age. Therefore we can write the firm's productivity as

$$\omega_{it} = i^{-1}(i_{it}, k_{it-1}, a_{it}) \quad (\text{B5})$$

OP uses a two-step procedure to estimate the productivity. In the first step, the firm's productivity is controlled using a polynomial function of i_{it} , k_{it-1} , and a_{it} . The first-step estimation uses the logged form of the production and can identify the labor coefficient β . The productivity process is assumed to be following a first-order Markov process:

$$\omega_{it+1} = \rho\omega_{it} + \xi_{it+1} \quad (\text{B6})$$

where ξ_{it+1} is the i.i.d error term. From the first-stage estimation, the productivity can be expressed as a function of the data and the remaining parameters to be identified. The moment conditions used to identify this parameter is thus given by:

$$E\left(\xi_{it+1} \otimes \begin{pmatrix} 1 \\ l_{it} \\ k_{it} \end{pmatrix}\right) = 0 \quad (\text{B7})$$

B.3.2 LP Approach

OP method requires the investment to be positive. In application, this can cause the loss of a large portion of the sample. Levinsohn and Petrin (2003) suggest using the material input to control for the productivity. LP approach follows the logic of OP closely. The only difference is that in the first-stage estimation, the control function of productivity is based on the firm's static choice of materials. Specifically, the firm's first-order condition is of the material is:

$$m_{it} = m(\omega_{it}, k_{it}, a_{it}) \quad (\text{B8})$$

Using an estimation procedure similar to OP, the productivity can be backed out. The advantage of LP method is that the data on intermediates are usually available and are usually positive.

Appendix C

Additional Tables

Table C1. The Effect of a Corruption Crackdown on Firm's Labor Productivity, Standard Clustering

	All firms		Existing firms		New firms	
	(1)	(2)	(3)	(4)	(5)	(6)
Heilongjiang X After 2004	-0.169*** (0.035)	-0.168*** (0.034)	-0.159*** (0.033)	-0.158*** (0.033)	-0.092* (0.047)	-0.098* (0.049)
Province fixed effect					X	X
Firm fixed effect	X	X	X	X		
Year fixed effect	X	X	X	X	X	X
Industry fixed effect		X		X		X
Firm characteristics		X		X		X
Observations	489,729	489,729	222,643	222,643	88,389	88,389
Number of firms	132,854	132,854	36,654	36,654	88,389	88,389
F^2	0.168	0.170	0.203	0.206	0.093	0.148

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shannxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered at province level. The samples in columns (1) and (2) include all large-scale manufacturing firms from years 1999 to 2007. The samples in columns (3) and (4) include firms that enter before 2004 and exit after 2004. The sample in columns (5) and (6) include firms in their entering year after 1999. Firm characteristics include firm's ownership type (i.e., private, state, or foreign owned) and assets (log). *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Table C2. The Effect of a Corruption Crackdown on Firm's Labor Productivity by Firm's Ownership Types, Standard Clustering

	Private		State		Foreign	
	Existing (1)	New (2)	Existing (3)	New (4)	Existing (5)	New (6)
Heilongjiang X After 2004	-0.200*** (0.032)	-0.124** (0.051)	0.029 (0.043)	0.097 (0.069)	-0.279*** (0.045)	-0.315*** (0.042)
Province fixed effect		X		X		X
Firm fixed effect	X		X		X	
Year fixed effect	X	X	X	X	X	X
Industry fixed effect	X	X	X	X	X	X
Firm characteristics	X	X	X	X	X	X
Observations	96,877	62,800	30,709	9121	9268	3109
Number of firms	17,281	62,800	4815	9121	1507	3109
R^2	0.241	0.130	0.139	0.189	0.109	0.182

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered at province level. Samples restricted to firms with no ownership changes during their sampling periods. The samples in columns (1), (3), and (5) include firms enter before 2004 and exit after 2004. The samples in columns (2), (4), and (6) include firms in their entering year after 1999. Firm characteristics include assets (log). *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Table C3. The Effect of a Corruption Crackdown on Firm Entry and Exit, Standard Clustering

	Entry	Exit	Entry by Firm Type		
	All (1)	All (2)	Private (3)	State (4)	Foreign (5)
Heilongjiang X After 2004	-0.027*** (0.009)	-0.003 (0.011)	-0.072*** (0.012)	0.014* (0.008)	-0.037*** (0.011)
Mean of dependent var.	0.174	0.159	0.261	0.110	0.192
Province fixed effect	X	X	X	X	X
Year fixed effect	X	X	X	X	X
Firm characteristics	X	X	X	X	X
Observations	41,669	41,679	29,531	22,378	7348
R^2	0.094	0.078	0.154	0.042	0.083

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered at province level. Entry and exit rates are calculated for each year-province-industry (four-digit)-ownership type cell. Firm characteristics include cell-level average log assets. Entry year is defined as the first year in sample after the year 1999. Exit year is defined as the last year in sample before the year 2007. Data in 2004 are excluded. Samples in columns (3), (4), and (5) are restricted to firms with no ownership changes during their sampling years. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Table C4. The Effect of a Corruption Crackdown on New Firms' Size by Firm's Ownership Type, Standard Clustering

	Log (sale) (1)	Log (vad) (2)	Log (asset) (3)	Log (labor) (4)
Panel A: private firms				
Heilongjiang X After 2004	0.134* (0.067)	-0.022 (0.068)	-0.027 (0.050)	0.102** (0.036)
Observations	65,163	62,800	65,163	65,163
R ²	0.092	0.072	0.055	0.115
Panel B: state firms				
Heilongjiang X After 2004	0.704*** (0.112)	0.469*** (0.111)	0.852*** (0.146)	0.341** (0.137)
Observations	9630	9121	9630	9630
R ²	0.229	0.193	0.094	0.112
Panel C: foreign firms				
Heilongjiang X After 2004	0.120 (0.085)	-0.138 (0.083)	0.654*** (0.123)	0.136* (0.078)
Observations	3309	3109	3309	3309
R ²	0.094	0.087	0.131	0.152

Notes: Firms in Heilongjiang province are affected by the anticorruption campaign outbursts in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered at province level. Each regression includes a time trend, province fixed effect, and industry fixed effect. Sample includes firms in their entering year after 1999 with no ownership changes in their sampling years. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Table C5. The Effect of a Corruption Crackdown on Firms' Financial Performance by Firm's Ownership Type, Standard Clustering

	Log (total profit)		Total debt/asset		Short/total debt	
	(1) Existing	(2) New	(3) Existing	(4) New	(5) Existing	(6) New
Panel A: Private Firms						
Heilongjiang X After 2004	-0.145* (0.074)	-0.216** (0.109)	0.012*** (0.004)	0.043*** (0.016)	0.013* (0.007)	0.045*** (0.014)
Observations	79,761	50,004	99,352	65,162	98,619	63,806
Number of firms	16,758	50,004	17,284	65,162	17,261	63,806
R ²	0.146	0.074	0.002	0.040	0.002	0.024
Panel B: state firms						
Heilongjiang X After 2004	-0.054 (0.055)	-0.115 (0.436)	-0.012 (0.008)	0.002 (0.066)	0.007 (0.005)	0.014 (0.039)
Observations	19,363	5868	32,460	9629	32,371	9533
Number of firms	4119	5868	4819	9629	4817	9533
R ²	0.071	0.164	0.024	0.040	0.007	0.061
Panel C: foreign firms						
Heilongjiang X After 2004	0.147** (0.055)	-0.366 (0.551)	0.009 (0.007)	-0.139** (0.066)	0.053*** (0.004)	0.068 (0.050)
Observations	6931	1940	9568	3308	9532	3263
Number of firms	1448	1940	1507	3308	1507	3263
R ²	0.048	0.124	0.011	0.042	0.019	0.027

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered at province level. Each regression includes a time trend and industry fixed effect. Columns (2), (4), and (6) also include province fixed effect. Samples in columns (1), (3), and (5) include firms enter before 2004 and exit after 2004 with no ownership changes in their sampling years. Samples in columns (2), (4), and (6) include firms in their entering year after 1999. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Table C6. The Effect of a Corruption Crackdown on Firms' Capital Intensity by Firms' Ownership Types, Standard Clustering

	Private		State		Foreign	
	(1) Existing	(2) New	(3) Existing	(4) New	(5) Existing	(6) New
Heilongjiang X After 2004	-0.028 (0.020)	-0.187*** (0.031)	0.121*** (0.022)	0.397*** (0.052)	0.127*** (0.039)	0.482*** (0.083)
Province fixed effect		X		X		X
Firm fixed effect	X		X		X	
Year fixed effect	X	X	X	X	X	X
Industry fixed effect	X	X	X	X	X	X
Observations	98,747	64,525	32,346	9490	9540	3287
Number of firms	17,281	64,525	4819	9490	1507	3287
R^2	0.112	0.089	0.087	0.081	0.008	0.230

Notes: Firms in Heilongjiang province are affected by the corruption crackdown in 2004. The control regions include the following 19 inland provinces: Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, and Xinjiang. SEs are clustered at province level. Samples restricted to firms with no ownership changes during their sampling periods. The sample in columns (1), (3), and (5) include firms enter before 2004 and exit after 2004. The sample in column (2), (4), and (6) include firms in their entering year after 1999. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Table C7. The Effect of a Corruption Crackdown on Firm's Labor Productivity, Three Provinces

	All firms		Existing firms		New firms	
	(1)	(2)	(3)	(4)	(5)	(6)
Heilongjiang X After 2004	-0.141*** (0.008)	-0.140*** (0.009)	-0.151*** (0.013)	-0.150*** (0.015)	-0.127** (0.019)	-0.122** (0.028)
Firm characteristics		X		X		X
Year fixed effect	X	X	X	X	X	X
Industry fixed effect		X		X		X
Firm fixed effect	X	X	X	X		
Observations	90,110	90,110	41,848	41,848	17,872	17,872
Number of firms	25,034	25,034	6979	6979	17,872	17,872
R^2	0.142	0.144	0.169	0.172	0.096	0.148

Notes: Firms in Heilongjiang province is affected by the anticorruption campaign outbursts in 2004. Control regions include Jilin and Liaoning. SEs are clustered at province level. Firm characteristics include firm's ownership type (i.e., private, state, or foreign owned) and total sales (log) in columns (2), (4), and (6). The samples in columns (1) and (2) include all large-scale manufacturing firms in Heilongjiang, Jilin, and Liaoning provinces from years 1999 to 2007. The samples in columns (3) and (4) include firms that enter before 2004 and exit after 2004. The sample in columns (5) and (6) include firms in their entering year after 1999. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Table C8. The Effect of a Corruption Crackdown on Firm's Labor Productivity by Firm's Ownership Type, Three Provinces

	Private		State		Foreign	
	Existing (1)	New (2)	Existing (3)	New (4)	Existing (5)	New (6)
Heilongjiang X After 2004	-0.207** (0.024)	-0.133 (0.061)	-0.009 (0.105)	-0.038 (0.045)	-0.225*** (0.020)	-0.241 (0.086)
Firm characteristics	X	X	X	X	X	X
Year fixed effect	X	X	X	X	X	X
Industry fixed effect	X	X	X	X	X	X
Firm fixed effect	X		X		X	
Observations	16,079	11,796	5598	1886	3942	1175
Number of firms	2894	11,796	908	1886	636	1175
R^2	0.207	0.128	0.146	0.218	0.103	0.152

Notes: Firms in Heilongjiang province is affected by the anticorruption campaign outbursts in 2004. Control regions include Jilin and Liaoning. SEs are clustered at province level. Firm characteristics include total sales (log). Samples restricted to firms with no ownership changes during their sampling periods. The samples in columns (1), (3), and (5) include firms enter before 2004 and exit after 2004. The samples in columns (2), (4), and (5) include firms in their entering year after 1999. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

Table C9. The Effect of a Corruption Crackdown on Firm Entry and Exit, Three Provinces

	Entry	Exit	Entry		
	All (1)	All (2)	Private (1)	State (2)	Foreign (3)
Heilongjiang X After 2004	-0.039* (0.012)	0.002 (0.021)	-0.089*** (0.008)	0.002 (0.009)	-0.044 (0.015)
Mean of dependent var.	0.367	0.338	0.365	0.347	0.314
Firm characteristics	X	X	X	X	X
Year fixed effect	X	X	X	X	X
Observations	7218	7191	5106	3967	2093
R^2	0.103	0.065	0.157	0.031	0.102

Notes: Firms in Heilongjiang province is affected by the anticorruption campaign outbursts in 2004. Control regions include Jilin and Liaoning. SEs are clustered at province level. Entry and exit rates are calculated for each year-province-industry (four-digit)-ownership type cell. Firm characteristics include cell-level average log assets. Entry year is defined as the first year in sample after the year 1999. Exit year is defined as the last year in sample before the year 2007. Data in 2004 are excluded. Samples in columns (3), (4), and (5) are restricted to firms with no ownership changes during their sampling years. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

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