China Economic Review 43 (2017) 29–46

Contents lists available at ScienceDirect

China Economic Review

Who determines Chinese firms' engagement in corruption: Themselves or neighbors?

Jing You[a], Huihua Nie[b,*]

[a] School of Agricultural Economics and Rural Development, Renmin University of China, No.59, Zhongguancun Ave., Haidian District, Beijing 100872, China
[b] School of Economics, Renmin University of China, 59 Zhongguancun Ave., Haidian District, Beijing 100872, China

ARTICLE INFO

Article history:
Received 16 May 2016
Received in revised form 6 January 2017
Accepted 6 January 2017
Available online 10 January 2017

JEL classification:
D73
D22
C21
O53

Keywords:
Corruption
Spatial model
Copying behavior
Chinese firm

ABSTRACT

We investigate the determinants of firm corruption and highlight contagious diffusion of firm corruption under mutual influences of firms' past corrupt history and between peers. The analysis finds that firms' decision-making on engagement in corruption can be affected vertically by their own past experience of bribing bureaucrats and horizontally by the contagion effects of neighbors' observed malfeasance, while there is substantial regional heterogeneity. Moreover, these horizontal contagion effects are nonlinear depending on the distance between neighbors. We also identify three channels underlying "osmosis" of corruption: firms' geographic networks, information exposure, and local marketization. The strongest contagion effect appears in the eastern region, indicating that petty firm corruption can develop into a systematic phenomenon. More practical anti-corruption policies call for cooperation in design and implementation across administrative areas.

1. Introduction

Corruption is pervasive in transition economies. There are a large number of studies examining the determinants of corruption (see a recent survey in Kis-Katos & Schulze, 2013). Many of these focus on the incentives of bureaucratic corruption (e.g., Armantier & Boly, 2011) or corruption at country level (e.g., Goel & Korhonen, 2011) and at provincial level (e.g., Ko & Zhi, 2013), while only a limited number of studies examine the causes of micro-level corrupt behavior among "victims" such as firms (Chatterjee & Ray, 2012). It is nevertheless worth noting that corruption arises because the government, public officials and firms (or households) are involved in a principal-supervisor-agent relationship in both developing (Mishra, 2005) and developed countries (Brandt & Svendsen, 2013). The agents ("firms") are sources of corruption in the society through their decision-making, especially in transition economies engaged in the construction of democracy and improvement of institutional quality. A white paper from Charney Research, a polling firm, reveals that in 2014, 35% of 2293 firms across different industries and regions in China paid bribes.[1] Answering questions as to why some firms decide to pay bribes while others do not and why some firms would opt to pay more than others will cast new light on the reasons for and the spread of rampant and persistent corruption (Khan, 2008) and indicate implications for effective anti-corruption policy.

* Corresponding author.
E-mail addresses: j.you714@gmail.com (J. You), niehuihua@vip.163.com (H. Nie).

[1] A briefing is available at: http://www.forbes.com/sites/richardlevick/2015/01/21/new-data-bribery-is-often-an-unspoken-rule-in-china/#4fbbdc6645fc [accessed 25 October 2016].

http://dx.doi.org/10.1016/j.chieco.2017.01.002
1043-951X/

Our logic starts from a firm's stance: how it decides the optimal solution to pay or not to pay a bribe in the complex principal-supervisor-agent interactions involving not only bureaucrats and the firms themselves, but also other firms' optimal responses. This paper engages in this endeavor through an analysis of a sample of 9077 firms in China, collected by the World Bank. The empirical analysis uses the time a firm spends with four crucial government departments – taxation, public security, environment, labor and social insurance – to provide an objective measure of the level of firm corruption.

The present study advances the existing literature on the following fronts. First, we add new explanations to firm-level corrupt behavior. In particular, we detect the contagious corrupt influence, where that exists, in corruption-related decision making. We suspect that when making decisions on corruption, firms may not only consider their own characteristics, but also care about other firms' malpractices. This supposition is inspired by the existing literature on bureaucrat corruption: the willingness of a bureaucrat to be corrupt depends on the behavior of other bureaucrats (Shleifer & Vishny, 1993).The more perceived corruption in a society, i.e., more people engaging in corruption, the more an individual is inclined to be corrupt as corruption seems to be justified (Dong, Dulleck, & Torgler, 2012).

We further hypothesize and specify that the extent of firms' corruption efforts could derive from two sources: (1) vertical influence, i.e., its own characteristics, especially its own past experience of corruption from an intertemporal behavioral concern; and/or (2) horizontal influence including either corrupt practices observed in other firms or unobserved corrupt culture and customs within the area. We also suspect that this neighborhood influence on corrupt behavior might be geography and industry specific, considering the very different cultures and customs across China. This contagious influence on the corruption of victims' (or suppliers') behavior has not yet been studied in China, nor in more general literature on determination of corruption.

Second, based on identifying firms' interdependent decision-making on malfeasances, we further investigate underlying mechanisms to discover how firms' engagement in corruption is affected by themselves and/or neighbors' corrupt behavior which is observed and/or unobserved. While there are regional and cross-country studies documenting contagion of corruption (e.g., Goel & Nelson, 2007; Goel & Saunoris, 2014), there is a paucity of firm-level empirical evidence and thus lacks mechanisms of how corruption spillovers. In the present study, we pay particular attention to the role played by dispersal of information, which is through either geographic links or access to a variety of news (e.g., Zhu, Lu, & Shi, 2013 for corruption perceptions in China and Costa, 2013 for a cross-country study), and marketization (e.g., Gong & Zhou, 2015 for China and Iwasaki & Suzuki, 2012 for transition economies). To the best of our knowledge, this is the first firm-level study unveiling not only the contagion effects of corruption, but also the (new) channels of this “osmosis”.

Our findings will shed new light on the general literature on the determinants of firms' behavior and the underlying mechanisms, and help explain why corruption has been rampant in China and even worse than the median compared to other major transition economies (Dollar et al., 2003), especially since the reforms deepened in the 1990s (Wedeman, 2012). The findings are also expected to inform practical bottom-up corruption control policy.

The paper proceeds as follows. Section 2 describes the data. Section 3 presents methodology, with particular attention to appropriate specifications. Section 4 discusses empirical results. Section 5 makes concluding remarks and offers implications for anti-corruption policy.

2. Data

2.1. Data source

We use the World Bank Enterprise Surveys conducted by the World Bank in collaboration with the National Bureau of Statistics of China in 2005. This cross-sectional survey includes 12,400 firms in 30 out of 34 Chinese provinces.[2] We divide the full sample into 3 regions – East, Center, and West – according to the National Bureau of Statistics of China (NBS) (see Table 1).[3] We drop firms who reported unrealistic age and those which supplied no data on geographic locations (longitude and latitude data) which are needed for spatial analysis. The final constructed full sample contains 9077 firms.

The sample shows satisfactory representativeness, covering 29 industries, ranging from the low-value industry (25.3%), bulk-goods industry (74%) and high-value industry (0.7%).[4] According to the real percentage shares owned by different stakeholders, we defined firms' ownership by the largest shareholder. The state shares dominate in 47.1% of sample firms (36% of which state shares are higher than 50%), while 38.5% and 14.4% are private- and foreign-owned firms, respectively. Small and medium sized firms are also represented well. The median number of employees is 300 across sample firms. 23% of firms have under 100 employees, while only 11% employ more than 2000 people. Regarding firm performance, 16.6% of our samples experienced negative or zero net profit in 2005. The median annual net profit per employee was 8939 *yuan* in 2005, which is equivalent to US$ 1091.[5]

2 34 provinces are constituted by 23 provinces, 5 autonomous regions, 4 directly administered municipalities (Beijing, Tianjin, Shanghai and Chongqing) and 2 special administrative regions (Hong Kong and Macau).

3 The classification is also motivated by economic, geographic and cultural differences. For example, the average GDP per capita of sample cities in the coastal region, East, was 13,771 *yuan* in 2005, which was 1.13 and 1.09 times larger than that in landlocked Central and West regions, respectively.

4 The classification follows the World Bank (2006). Low-value industry includes agricultural and sideline food processing; food production; textile, garment, shoe and cap manufacturing. Bulk goods industry includes the production of raw chemical materials and chemical products; non-metal mineral products; smelting and processing of (non)ferrous metals. High-value industry includes pharmaceuticals; medical, electronics and telecoms equipment.

5 Authors' calculation (8939 ÷ 8.19) based on the 2005 market exchange rate (8.19) from the World Bank online database.

Table 1
Geographic distribution of sample firms.
Source: Authors' calculation based on the World Bank Enterprise Survey (cross-refer to Section 2.1).

Region	Province	No. of cities	No. of firms	Share of firms in full sample
East	Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan	58	4512	49.71%
Center	Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan	37	2728	30.05%
West	Sichuan, Chongqing, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, Guangxi, Inner Mongolia	25	1837	20.24%
Total	30	120	9077	100%

Notes: The geographic division complies with the National Bureau of Statistics of China.

2.2. Measuring corruption engagement

Corruption is defined as the proportion of days per year that the firm spends in handling relations with four government departments including taxation, public security, environment, labor and social security. Our measure is motivated by the following considerations. First, we prefer objective indicators to subjective ones. Using data from Indonesian villagers, Olken (2009) reveals that perception of corruption, although containing some real information, is biased as individual ethnic heterogeneity and social participation can result in very different responses from those obtained on more neutral topics. Observing little correlation between perceived corruption and actual corrupt practices, Treisman (2007) also suggests research should be based on actual activities conducted in practice rather than opinion, such as businessmen reporting that they are expected to pay bribes.

Second, our indicator of corruption can be understood as the "time tax" imposed on firms by red tape (Fan, Wang, & Zhu, 2010; World Bank, 2003, p. 8). More time spent with government officials in running a business is associated with administrative hassles, which typically requires firms to deal with a number of bureaucrats across different government departments (such as China in Fan et al., 2010). The four government departments our indicator covers are also relevant. According to the white paper from Charney Research (as cited in Footnote 1), the main purpose of corporation corruption is to operate and remain in the business; 79% of executives said the bribes were made to local government officials, followed by tax collectors at 56% and national officials at 34%. Thus, payments to inspectors or officials are often involved and combined together (Ang, Cheng, & Wu, 2014; Hallward-Driemeier, Wallsten, & Xu, 2006). This is particularly relevant in the Chinse context. Different from lobbying, it is common that Chinese corporation bribes are given naturally in an "insensitive" way typically through social activities, especially under increasingly stricter anti-corruption laws than before. For example, executives may spend the weekend playing cards with the officials and finish payments through gambling losses.[6] Based on three world-wide firm surveys in 48–73 countries in 1997, Kaufmann and Wei (1999) also find that firms paying more bribes are also likely to spend more time with bureaucrats negotiating regulations. Using the World Bank Enterprise Survey for 27 transition economies during 2002–2005, Ayyagari, Demirguc-Kunt, and Maksimovic (2010) demonstrate that the time spent by executives of innovating firms with government officials can predict the amount of their bribe payment. Third, the amount of bribes is highly secret and firms are likely to give biased or untruthful responses (e.g., Clarke, 2011 for African firms), while the "time tax" could be a "safer" and thus precise proxy. In another survey of 5 cities in China, only a few Chinese firms answered direct questions on bribes, while many more firms did supply information on the time spent with officials dealing with business relations (Hallward-Driemeier et al., 2006). Despite the secretive nature of firms' corrupt activities, Reinikka and Svensson (2006) argue that appropriate measurement of micro-level (firms and households) corruption engagement is achievable by certain survey designs. The "time tax" offers an indirect and more "secure" topic which can avoid firms' suspicion of the objective of data collection and so elicit credible answers.[7]

Fourth, our indicator relates to other existing measures in sensible ways. Specifically, we regressed our indicator respectively on the provincial marketization index constructed and used Fan et al. (2010) reflecting quality of local institutions and the provincial ratio of the number of cases of corruption registered in the provincial procurator's office in 2004 over the provincial population measured by 10 thousand people,[8] together with city dummies, industry and ownership dummies. The estimated coefficient of the former is −0.026 at 1% significance level, indicating the better the institutional environment, the lower corruption in terms of time spent with the bureaucrats. As predictable, the estimated coefficient of the latter is 0.013 at the 5%

[6] See various news for anecdotal evidence, for example, http://news.jschina.com.cn/gb/jschina/news/fasong/userobject1ai899203_1.html [in Chinese], accessed 25 October 2016.

[7] It is worth noting that our measure of firms' corruption engagements will be biased if firms can spent on money to reduce time, i.e., bribes and "time taxes" are substitutes as predicted by the "efficient grease" hypothesis of bribes. We argue that in the Chinese context, money and time may be more of complements than substitutes. Theoretically, Kaufmann and Wei (1999) show that in a general equilibrium where the harassment rate is endogenously determined by the corrupt bearcats, firms' effective burden in terms of "time costs" to get the business done relates positively to bribe intake. They also test it empirically by the Global Competitiveness Report (1996 and 1997) covering more than 70 countries. Empirically, due to no data on real bribes, it is impossible to test this in our data. We alternatively use firms' expenditure on entertainment and travel, which has been proved to capture some components of actual bribes by Cai, Fang, and Xu (2011), as another indicator of corruption and compare it to the time measure. As shown by Fig. 3 in Wang and You (2012), the upward slope of the fitted line between them indicate that bribes and time costs might be complements rather than substitutes – as also mentioned in Footnote 6, in the Chinese context, firms may not only have to spend time in learning bureaucrats' traits and accumulate trust, but also bribe in a less perceivable way, for example, bribing by spending time in social activities with bureaucrats. The complementarity between time taxes and actual bribes would contribute to validity of our measure of corruption.

[8] Authors' calculation based on data from Procuratorial Yearbook of China 2005.

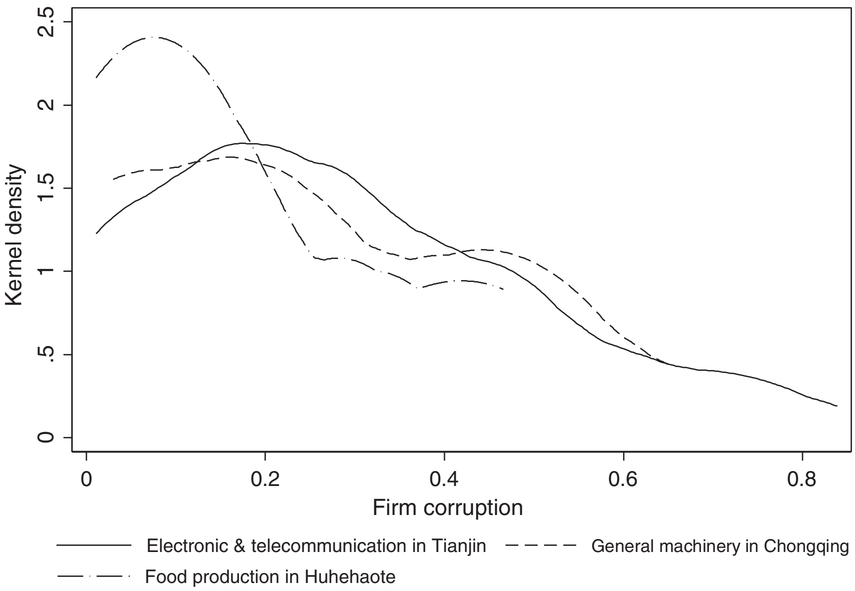

Fig. 1. Distribution of corruption for all firms in selected industry and city Notes: The horizontal axis measures the firm's engagement in corruption, which is the proportion of days spent with government officials over the past year. The vertical axis denotes the kernel density estimate of this indicator of the firm's engagement in corruption. The density is drawn for all firms in the listed industry and the city.
Source: Authors' calculation based on the World Bank Enterprise Survey (cross-refer to Section 2.1).

significance level. Last, we checked robustness of our results in Section 4.2. by using another corruption measure – firms' entertainment and travel costs as Cai et al. (2011).

It is also worth clarifying the interpretation of our indicator in the following two aspects. For one thing, it could be argued that our measure should alternately be interpreted as bureaucratic delay (or broadly the quality of government), which might not be necessarily related to rent seeking. We admit that our measure contains such information given its nature of "time costs in getting things done". However, it is also worth noting that, using the same dataset and measurement of firm corruption engagement as ours, Wang and You (2012) document a positive relationship between Chinese firms' "time tax" and the growth rate of their sales income. As paying "time tax" turn to be profitable for Chinese firms, our corruption measure would potentially capture some components of genuine corrupt activities with bureaucrats. That is, firms may have incentives to use "time" to bribe bearcats in order to gain more profit. As such, our corruption measure would capture aforementioned firms' defense against rent extraction and aggressive rent-seeking, which corresponds to Dong, Wei, and Zhang's (2016) classification of allocation of Chinese entrepreneurial efforts in a "twisted" rent-seeking environment. Moreover, the 90th–10th ratios of our indicator at the industry level within each city lie between 1.4 and 63.3 with the mean (standard deviations) ranging between 13.3 (9.9) and 16 (12.1). Picking up one industry in one city, Fig. 1 illustrates wide spectrum of the "time tax" ranging from nearly zero to 0.8, such as the "electronic and telecommunication equipment" industry in Tianjin, the "general machinery" industry in Chongqing and the "food production" industry in Huhehaote.[9] There should not have been such wide variation within the same industry in the same city if our measure reflects merely "bureaucratic delay in doing businesses" or "quality of government".

For another, it could also be argued that our indicator represents simultaneously "helping" and "grabbing" hands for certain firms. The above evidence on wide distributions of our indicator within the industry in the city helps mitigate this concern from the perspective of industries. From the perspective of firm ownership, one may suspect that more time with the government among state enterprises compared to private or foreign firms (which will be shown in Table 2) is because of the nature of their state ownership rather than corruption. In other words, state firms may be more inclined to seek help from or visited more frequently by the government, which is not necessarily corruption. As what we did to industries, we also calculated the 90th–10th ratios of firm corruption within each kind of ownership in each city. They lie between 1.3 and 85 with the mean (standard deviations) ranging between 12.4 (9.6) and 17 (12.6). Fig. 2 further draws distributions of our measure for selected firms who are used in Fig. 1 – i.e., firms being, respectively, in the same industry and the city – but state-owned in terms of a higher-than-half proportion of state shares. Clearly, the distribution spreads widely from nearly zero to more than 0.6. Similar wide distributions also appear if we use the same firms in Fig. 2 but refer to the "time tax" per employee in Fig. 3. Again, if routinely "helping hands" dominate our indicator, the time per employee should not have scattered among firms in the same industry, city and ownership. More evidence can be found from profits. If our indicator were more likely to simply capturing "helping

[9] We drew the distributions for all 29 industries and 120 cities, but illustrated selected ones in Fig. 1. Figs. 2 and 3 are also for those selected firms only. Other graphs will be provided upon request.

Table 2
Determinants of firm corruption (full sample).
Source: Authors' calculation based on the World Bank Enterprise Survey (cross-refer to Section 2.1).

Independent variables	OLS	2SLS-IV	SAR	SAE	SARAR	SARAR
	(1)	(2)	(3)	(4)	(5)	(6)
Influence from neighboring firms						
ρ		0.010 (0.006)*	0.096 (0.050)*		0.075 (0.059)	0.054 (0.063)
Highway						−0.001 (0.001)
Highway × neighbors' corruption						−0.002 (0.003)
Information						0.004 (0.002)**
Information × neighbors' corruption						−0.004 (0.001)***
Marketization						−0.056 (0.026)**
Marketization × neighbors' corruption						0.028 (0.005)***
λ				−0.657 (0.101)***	−0.663 (0.101)***	−0.734 (0.114)***
Influence from firms themselves						
γ	0.027 (0.007)***	0.027 (0.007)***	0.027 (0.007)***	0.027 (0.007)***	0.027 (0.007)***	0.027 (0.007)***
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
City controls	Yes	Yes	Yes	Yes	Yes	Yes
Provincial dummies	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	9077	9077	9077	9077	9077	9077
R^2	0.133	0.133	–	–	–	–
Spatial pseudo R^2	–	–	0.143	0.152	0.135	0.136

Notes: a. Refer to Appendix A for variable definitions.
b. Columns 3–6 are estimated by the GS2SLS. Heteroskedasticity-robust standard errors are in parentheses. *, ** and *** denote 1%, 5% and 10% significance levels. "–" means being not applicable.
c. In Column (2), the two excluded instruments are the second-order spatial lags of firms' current and past corruption. Their estimates are 0.079 and 0.202 at the 1% significance levels in the first-step estimation and the partial R^2 is 0.959. The Angrist-Pischke multivariate F-statistic for overall significance of all instruments in the first step estimation is 35,187.23 with a p-value of 0.000. These exclude the concern over weak instruments. The underidentification (Kleibergen-Paap rank LM) test is also firmly rejected at the 1% significance level (with a χ^2 statistic of 1684.72), indicating that all canonical correlations between the matrices of the endogenous regressor (i.e., the first-order spatial lag of firms' current corruption) and all instruments are significantly different from zero (i.e., satisfying the rank identification). Finally, the Sargan's statistic is 1.408 with a p-value of 0.235, indicating that the instruments are uncorrelated with the 2SLS residuals.

hands" or routine visits, firms with net losses would have suggested more time with the government than those with net profits. For firms in the same industry, city and ownership (in total 29 industries, 120 cities and 3 types of ownerships), we calculated separately the mean of the "time tax" separately for those who earned net profits and for those who incurred net losses. These mean values indeed appear to be higher in the case of losses than that of net profits, but only differ at the second decimals, indicating stories beyond "helping hands" underlying our indicator.

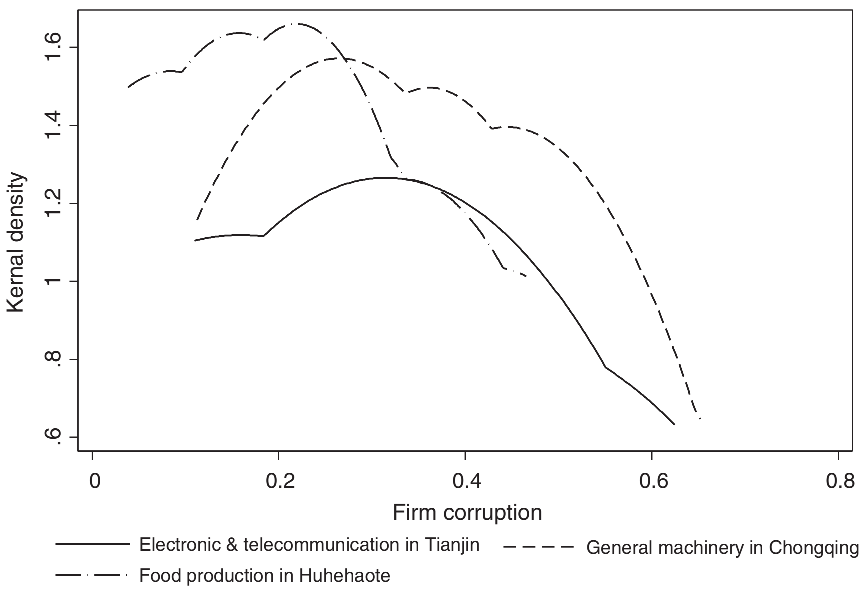

Fig. 2. Distribution of corruption for state-owned firms in selected industry and city Notes: The horizontal and vertical axes are defined as those in Fig. 1. The density is drawn for all state-owned firms in the listed industry and the city. A firm is classified as being state-owned if the proportion of state shares is higher than 50%. Source: Authors' calculation based on the World Bank Enterprise Survey (cross-refer to Section 2.1).

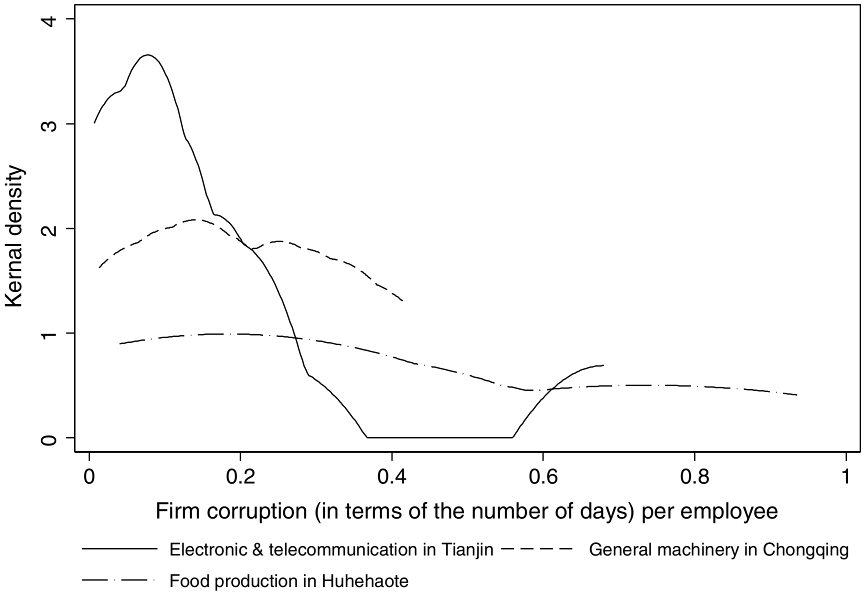

Fig. 3. Distribution of corruption per employee for state-owned firms in selected industry and city Notes: The horizontal axis measures the firm's engagement in corruption divided by its total number of employees. The firm's engagement in corruption is calculated as the proportion of days spent with government officials over the past year. The vertical axis denotes the kernel density estimate of the firm's engagement in corruption per employee. A firm is classified as being state-owned if the proportion of state shares is higher than 50%. The density is drawn for all state-owned firms in the listed industry and the city.
Source: Authors' calculation based on the World Bank Enterprise Survey (cross-refer to Section 2.1).

Together, even for quite "homogeneous" firms in terms of their location, industry, ownership and size, there may well be some other activities causing huge differences in time spent with the government. Our measure could capture some real components of corruption.[10]

2.3. Descriptive statistics

The average time spent with government departments is 58 days (0.16 × 365 days) in 2005, while most firms spend a little less: 44 days (0.12 × 365 days) as the median.[11] Corruption is committed unequally across firms. The bottom 5% of samples in the distribution of corruption spent 5 days a year handling the relationship with government departments. By contrast, the top 5% spent 170 days (nearly six months) dealing with government departments.

We grouped 29 industries into three groups conforming to the World Bank's classification to facilitate comparison of firm corruption. Across three groups, Fig. 4 documents the highest average firm corruption in the bulk-goods industry (0.16), which is followed by the low-value industry (0.13). Similar to Section 2.2, all three industrial groups exhibit long tails at the higher end of the distribution of firm corruption. The within-industry 90th–10th ratios of firm corruption are 16, 21 and 23 respectively in bulk-goods, high-tech and agricultural industries. Again, this indicates that even firms who are in the same industry confronting common regulations and institutions spend distinct time with local officials. There must be some factors beyond routine regulatory requirements underlying firms' diversified efforts in dealing with governments. Together with aforementioned profitability that could be brought about by spending more time with the government officials, it thus can be inferred that our corruption indicator captures some real component of corrupt activities.

Fig. 5 shows that corruption tends to be "clustered" in adjacent areas suggesting geographical distinction. Provinces are 10% less corrupt in the East than the West.[12] This may reflect Wei's (2000) finding that a "naturally more open" region in terms of larger size of economy and better geographic locations facilitating logistics might have devoted more resources to building good governance and, hence, display lower corruption.

[10] If firms are more likely to report the time close to a particular time than the true value, the mode of the measurement errors would not be zero. As such the variable of corruption engagement encounters a problem of nonclassical measurement errors in addition to classical ones. The question on time is not very sensitive to firms in terms of giving them an impression of collecting data on their engagement in corruption. Therefore, the nonclassical measurement errors might not be prominent. Our spatial model specification in the next section can also help mitigate classical measurement errors. That having been said, Hu and Schennach (2008) develop a nonparametric method to directly deal with this nonclassical problem, which is worth implementation in the future.

[11] Unfortunately, the questionnaire does not ask more disaggregated time, say hours or minutes in a called-in day. Thus, our measure should be treated as an upper bound of genuine corruption.

[12] We also checked regional differences by using alternative proxies for corruption such as the ratio of provincial registered cases of corruption in the procurator's office in 2004 over the provincial population and the ratio of the litigation costs during the judicial proceeding over the total value of the object of contract. A similar pattern but with wider difference is revealed: provinces are 16% less corrupt in the East than in the West, under the former indicator; and 45% under the latter indicator.

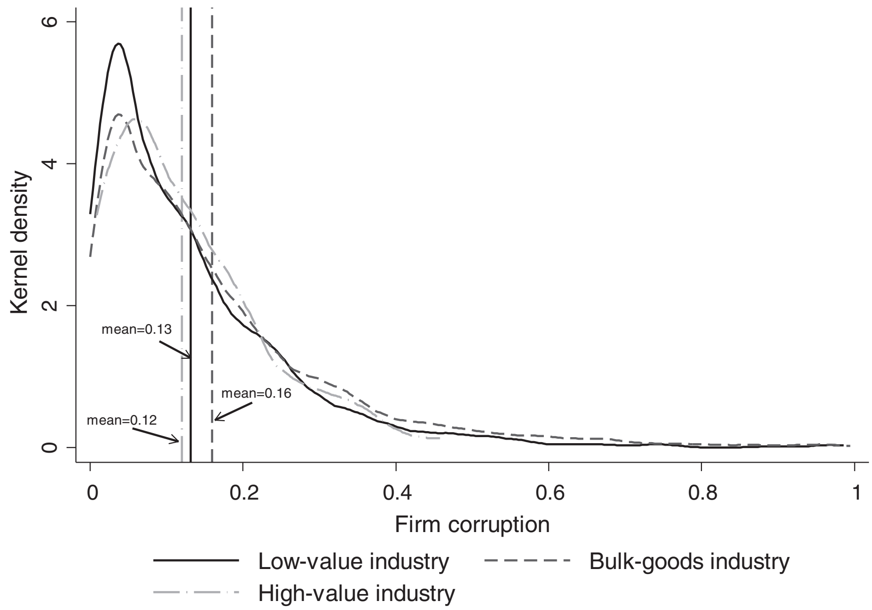

Fig. 4. Distribution of firms' corruption engagement, by industry Notes: The horizontal and vertical axes are defined as those in Fig. 1. The density is drawn for all firms in each industry.
Source: Authors' calculation based on the World Bank Enterprise Survey (2005).

An interesting observation is that in both more and less corrupt regions, corruption is likely to diffuse across cities and even provinces. This lends support to our conjecture that firms might take into account their neighbors' corrupt practice in their own decision-making process. The co-movements among a certain group of firms might spread corruption from what was originally quite a small group to many others and hence, shape pervasive corruption in the whole region.

3. Methodology

The theme of this paper is to empirically identify and distinguish different (and possibly contagious) influences on firms' corrupt behavior. Inspired by the existing literature, we conjecture that the firms' current decision on corrupt practice could be affected by (vertically) their past experience of corruption (e.g., Sah, 2007)[13] and/or (horizontally) by other firms (e.g., Becker, Egger, & Seidel, 2009).[14] Furthermore, we gauge two alternative varieties of this (horizontal) "influence from neighbors". For one thing, as predicted by Andvig and Moene's (1990) theoretical model, individuals' propensities to replicate malfeasances increase with higher frequency of corruption as they see themselves partially forced to commit these acts. Firm *i* may choose to engage in corruption as it observes an increased number of firms benefiting from corrupt practices. Although in many cases *i* may not be able to spot easily neighbors' malfeasance, it can perceive the historical inertia of institutions (Goel & Nelson, 2010) and play dynamic strategic complementarities (Tirole, 1996). As such, the composition of (rather than simply the distance per se from) the surrounding corruption may induce the firm's own engagement in corruption, which is similar to a "neighborhood effect" where composition of neighbors matters in one's own decision making (Topa & Zenou, 2015). For another, the unobserved characteristics and/or omitted variables may also force or entice firms to act collectively, such as culture (Licht, Goldschmidt, & Schwartz, 2007), veiled bureaucrats' incentives and extraction under China's decentralized authoritarian rule (Birney, 2014) and fiscal decentralization found to depress local corruption in China (Dong & Torgler, 2013).

3.1. The spatial model specification

Taking into account all three kinds of influences, we write the most flexible model specification to model the firm's corrupt behavior, a spatial lag model with autoregressive disturbances (SARAR), as follows:

$$\mathbf{c} = \rho\mathbf{Wc} + \gamma\mathbf{c}_p + \mathbf{X}_f\boldsymbol{\beta}_1 + \mathbf{X}_c\boldsymbol{\beta}_2 + \mathbf{D}_p + \boldsymbol{\varepsilon} \quad (1)$$

[13] Sah (2007) demonstrates that an individual's current perceived corruption is shaped by the realities of the past, which in turn influences its current and future actions.
[14] By using a cross-section of 123 countries, Becker et al. (2009) find that reduction in corruption in one country due to institutional changes can affect neighboring countries.

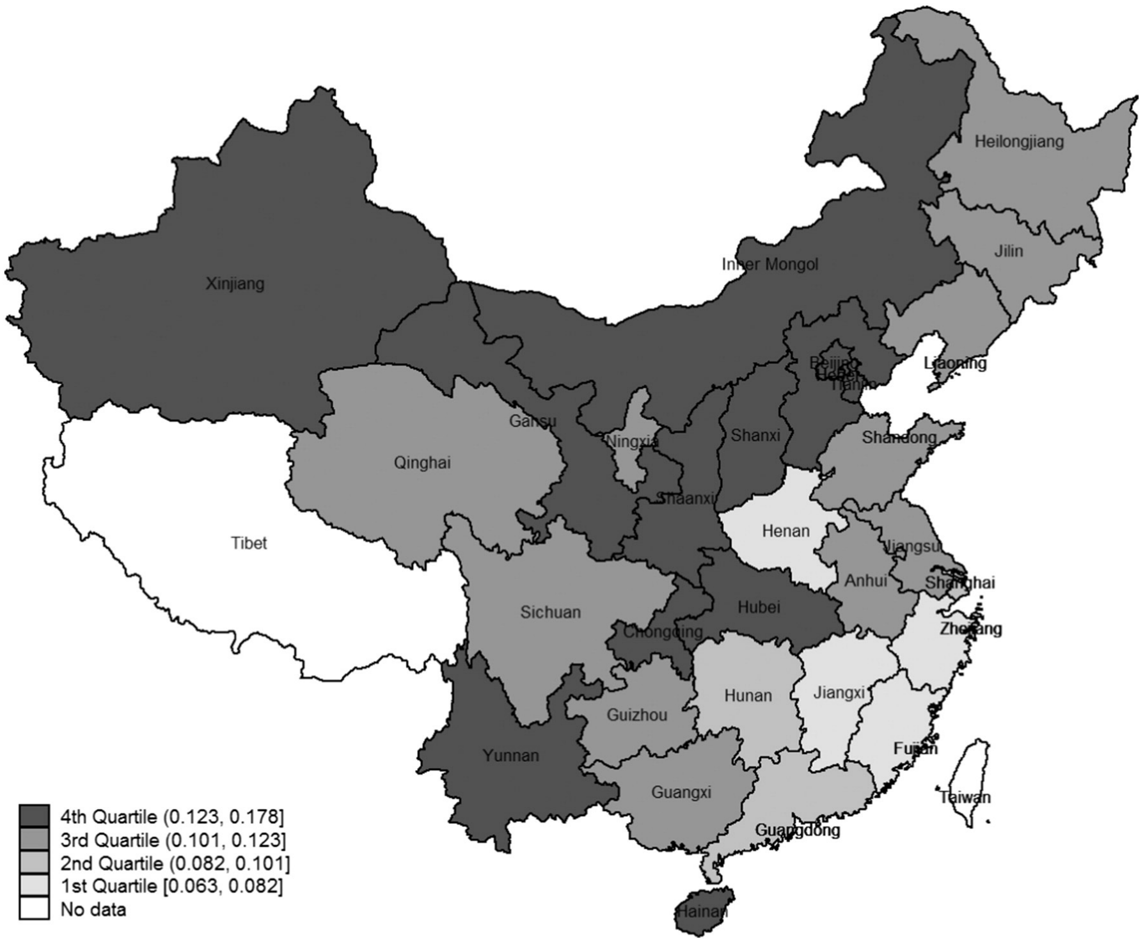

Fig. 5. Geographic distribution of firms' corruption engagement, by province Notes: The provincial median level of corruption is the median of firms' engagement in corruption within the province. The firm's engagement in corruption is the proportion of days spent with government officials over the past year. Quartiles are calculated based on the provincial median corruption.
Source: Authors' calculation based on the World Bank Enterprise Survey (cross-refer to Section 2.1).

$$\boldsymbol{\varepsilon} = \lambda \mathbf{W}\boldsymbol{\varepsilon} + \mathbf{u} \tag{2}$$

where $\mathbf{c}$ is a vector including the level of firms' current corruption; $\mathbf{c}_p$ is a measure of firms' past corrupt activities; $\mathbf{W}$ denotes the spatial weight matrix to be discussed later; the unobserved correlate of firm corruption $\boldsymbol{\varepsilon}$ is composed of the spatially weighted error $\mathbf{W}\boldsymbol{\varepsilon}$ which is to be explained later and the random disturbance $\mathbf{u} \sim N(0, \sigma^2 \mathbf{I}_n)$; the vector $\mathbf{X}_f$ incorporates firm-level observed characteristics that are susceptible to determine its engagement in corrupt activities; $\mathbf{X}_c$ controls for the city-level determinants, which are logarithmic per capita GDP and population; $\mathbf{D}_p$ contains a set of provincial dummies capturing other unspecified regional influence or heterogeneity and thus, helps to purge local diffusion of corruption measured by the spatial term, especially when our spatial term picks up mainly inter-city osmosis by construction of $\mathbf{W}$.[15]

More specifically, firms' past experience of corruption ($\mathbf{c}_p$), providing the source of the impact of "themselves" on firms' current corrupt behavior, is proxied by a dummy variable taking the value of one if the firm sought help from "government or senior leaders who were able to help solve the issue…were there any disputes, different interpretations between your company and the

[15] Ideally one may add city fixed effects to controlling for as many as possible confounding factors. We controlled for provincial rather than city dummies out of three considerations. First, given the spatial estimation strategy (i.e., 2SGSLS), including 119 city dummy variables as opposed to province dummy variables will cause over-identification and multi-collinearity in instruments in GS2SLS – 17,000 instruments have to be omitted, This not only makes the GS2SLS estimation impossible as the matrix including all instruments cannot be identified, but also strains the interpretation of the estimates. Second, given the construction of the spatial terms $\mathbf{Wc}$ and $\mathbf{W}\boldsymbol{\varepsilon}$, some components of within-city dispersion of corruption and city-level heterogeneity have been incorporated in either observed or unobserved spatial influence. Third, given the M-shape of bureaucratic hierarchy in China, local governments, in particular, the provincial governments, have discretion over various local affaires (Xu, 2011), even over whether and to what extent to implement which laws (Birney, 2014). Thus, provincial heterogeneity may be more prominent than inter-city variations within the same province.

government in the past 3 years".[16] Of all sample firms, 5.5% (499 firms) said there were indeed some government officials or senior leaders who were able to help them solve problems. Among those firms, 95% (474 firms) used these channels when facing difficulties in dealing with government-related issues in the past 3 years. Of those who used informal channels, 77% (365 firms) were "happy with the result". The "helping hand" in the past suggests expected returns for Chinese firms and thus, firms would have incentives to commit corruption in the future.

Two kinds of influences from "neighbors" are defined by two spatial components: $\mathbf{Wc}$ and $\mathbf{W\varepsilon}$. Specifically, the elements in the spatial weight matrix, w_{ij}, are exogenous and orthogonal spatial weights between firms i and j with $i,j=1,2,\ldots,N$.[17] The off-diagonal elements (w_{ij} with $i \neq j$) could be either zero, meaning that the firm i is not j's neighbor, or non-zero, meaning that the firm i is j's neighbor and its behavior imposes influence on j. Firms are not neighboring with themselves, i.e., zero diagonal elements of when $i=j$. More specifically, firms i and j are labeled "neighbors" if the distance between them is less than a threshold θ.

$$w_{ij} = \begin{cases} \frac{1}{d_{ij}^{\alpha}} & \text{if } d_{ij} \le \theta \\ 0 & \text{if } d_{ij} > \theta \text{ or } i = j \end{cases} \tag{3}$$

where d_{ij} is the actual distance between i and j in kilometers. If i and j are contiguous, the corruption influences imposed by i on j diminishes when d_{ij} increases. α measures the speed of decay of corruption influence. $w_{ij}=0$ if i and j are located further than θ. We then row-standardize the spatial weight matrix $\mathbf{W}$, which makes the elements in each row add up to one. Row standardization addresses the issue raised by Plümper and Neumayer (2010) that the potential influence might become proportionally smaller for those who have a larger number of neighbors. Empirically we set $\alpha=1$ and $\theta=200$ km, considering the moderate distance between cities in China.[18] The impact of neighbors' observed corrupt behavior would be transmitted to the firm i through the spatial weighted average $\mathbf{Wc}$ and reflected by the estimated ρ. The unobserved influence from "neighbors" enters into i's decision through the spatial weighted error term $\mathbf{W\varepsilon}$ and is reflected by the estimated λ.

In addition to the above contagiously behavioral influences, we specify five kinds of corruption determinants in $\mathbf{X}_f$ motivated by the existing literature, in order to reveal comprehensively the determinants of Chinese firms' decision-making on corruption and to help mitigate the omitted variable problem. First, according to the hypothesis of firms' motivations of profit maximization (Svensson, 2003), we included net profit per employee, capital stock calculated by the sum of reinvestment per employee and sunk cost of capital stock proxied by fixed assets per employee. Second, considering the local government's predation (Bardhan & Mookherjee, 2006), we controlled for a dummy variable taking the value of one if the firm belongs to natural resources industries, that are more likely to be hassled or extorted, and the contract intensity which we have calculated according to Nunn's (2007) measure for each industry. Third, taking into account the antithetical relationship between corruption and competition predicted by the theoretical model (Emerson, 2006), we controlled for the number of competitors in the same industry within the same city. Forth, we also included to control for legal institution as theory predicts firm corruption under low judicial efficiency (Damania, Fredriksson, & Mani, 2004).[19] Finally, we controlled for firms' various characteristics (including the ownership structure, age, size, etc.) as Laffont and Tirole's (1991) canonical model suggests that firms' different and private types and efforts result in unknown costs in corrupt activities.

3.2. Mechanisms underlying spatial diffusion of corruption

We also inserted additional regressors to Eq. (1) to approximate three possible channels through which corruption could be osmotic – the density of highway (km per capita), the number of varieties of newspaper, an overall marketization index compiled from Fan et al. (2010) reflecting local institutions (including development of products and factors markets, the relationship between the government and markets, development of the non-state sector, market intermediaries, and commercial legal environment),[20] all at the provincial level, and their interactions with the influence from neighbors (i.e., spatial lag term of corruption, $\mathbf{Wc}$). Highway links geographically different cities and thus, may facilitate copying neighbors' behavior. Transmission of information is proxied by newspaper and is expected to affect firms' decision making if they do care about what neighbors are doing, while a more market-oriented business climate may attenuate the need to do so. On the other hand, intense and quick information-flow (higher transparency) may also discourage firms from following their neighbors' corrupt activities because of higher risk of detection. Therefore, Eq. (1) is rewritten by:

$$\mathbf{c} = \rho\mathbf{Wc} + \gamma\mathbf{c}_p + \mathbf{X}_f\beta_1 + \mathbf{X}_c\beta_2 + \mathbf{D}_p + \mathbf{S}_p\beta_3 + \mathbf{S}_p\mathbf{Wc}\beta_4 + \boldsymbol{\varepsilon} \tag{3}$$

[16] It is admittedly that this variable can only capture part of the genuine corruption, if any, as not all "help" should necessarily be "corruption". Unfortunately, there is no dependent variable (i.e., time spent with the government) in past years due to only one cross section of the dataset. This variable is the best available we can extract from the dataset. However, when using other indicators to proxy firms' corrupt behavior, i.e., the costs of "eating, drinking and entertainment" in Section 4.2, we are able to use firms costs of these activities in the last year to represent $\mathbf{c}_p$ and thus, checking the robustness of our proxy for firms' past corruption as well.

[17] Note that it is not possible to identify firms' GIS as they are anonymous. There are no data on firms' longitudes or latitudes. We identify firms' location through the cities' latitudes and longitudes according to the names of sample cities. Therefore, firms in the same city are classified as "neighbors".

[18] Section 4.2 discusses robustness of results to other values of α and θ.

[19] See Table A1 in Appendix A for detailed definition of marketization index.

[20] See Table A1 in Appendix A for detailed definition of marketization index.

where $\boldsymbol{\varepsilon}$ has the same SAR structure as Eq. (2); the vector $\mathbf{S}_p$ includes three channels at the provincial level;[21] and their interaction terms neighboring corruption is expressed by $\mathbf{S}_p\mathbf{Wc}$.

3.3. Identification

The Eq. (1) is first estimated by the standard ordinary least square (OLS) under the assumption of homoscedasticity. As warned by Manski (1993), one's own behavior and his/her reference group's (i.e., surrounding firms') acts may be simultaneous. It is not easy to distinguish similar behavior from different sources. It could stem from similar propensities to behave between the individual and the reference group (i.e., pure endogenous effects), similar exogenous contexts such as same administration and culture (i.e., the exogenous (contextual) effects), or common characteristics shared jointly by the individual and the reference group (i.e., correlated effects). This “reflection problem”, in the language of Manski (1993), is prominent when the attributes defining the reference group is “functionally dependent and statistically independent” with those affecting the firm's own outcomes. The Eqs. (1)–(3) use geographical distance to define the reference group. The empirical literature on the neighborhood effects has widely used it as a proxy to the social sphere (e.g., Aizer & Currie, 2004 and a review by Topa & Zenou, 2015), but it is likely to incur the above “reflection problem”. Manski (1993) suggests collecting rich data. Ideally one can identify the reference group by knowing how firms form the reference group through their actual social or information interactions (e.g., Conley & Udry, 2010), for example, the firm's upstream and downstream firms or business partners. Unfortunately, our dataset does not contain such information.[22]

We first use the two-stage least square instrumental variable (2SLS-IV) approach to address the endogenous $\mathbf{Wc}$ in Eq. (1). In spatial models, the excluded instruments for the spatially correlated firm corruption are usually higher order spatial lags of dependent and independent variables. Here we use the second order spatial lags of firms' current and past corruption ($\mathbf{W}^2\mathbf{c}$ and $\mathbf{W}^2\mathbf{c}_p$) and other characteristics ($\mathbf{W}^2\mathbf{X}$), as suggested by Fingleton and Le Gallo (2008), as the excluded instruments controlling for the “contextual” and “correlated effects”. The argument underlying this choice is that, either at present or in the past, the reference group's (i.e., the $\mathbf{Wc}$'s) neighboring firms' propensities to be corrupt and other observed characteristics can directly affect corrupt acts of those in this group, but are not directly affect the firm i's behavior due to geographical disconnection. As such, those attributes of the reference group (i.e., the excluded instruments) “moderately” relate to factors determining i's engagement in corruption, satisfying Manski's (1993) criterion of valid inferences. Further, in Eqs. (2) and (3), the disturbances $\boldsymbol{\varepsilon}$ are also spatially correlated and thus are correlated with $\mathbf{Wc}$, further controlling for the “contextual effects” and being a proxy for neighbor fixed effects. However, such an SARAR specification brings in heteroskedasticity, making both OLS and IV estimators inconsistent. Therefore, we also adopt the generalized spatial two-stage least square (GS2SLS) method originally introduced and generalized by Kelejian and Prucha (2010), in order to obtain consistent and efficient estimators in the presence of heteroskedasticity even after controlling for spatial diffusion.[23]

It should be noted that the magnitude of the estimates in Eqs. (1)–(3) cannot be interpreted directly as the marginal effects due to the spatial diffusion process of corruption. Based on the estimates of Eqs. (1)–(2), we further calculate two kinds of marginal effects in the spirit of Elhorst (2014), namely the average direct marginal effect (ADME) when only one firm changes a time and each firm changes sequentially, and the average total marginal effect (ATME) when all firms change simultaneously. See Appendix B for formulae.

4. Empirical results

We begin with estimating a specification without any forms of spatial diffusion, i.e., Column 1 of Table 2, and then, control gradually for the spatial lag term measuring copying behavior across neighboring firms because of their neighbors' observed corrupt practice in Columns 2–3 of Table 2 (known as the spatial autoregressive model, i.e., SAR), the spatial error term measuring the unobserved influence affecting simultaneously the firm and its neighbors in Column 4 (known as the spatial autoregressive error model, i.e., SAE) and last, the most general specification as Column 5 including both spatial impacts as Eqs. (1) and (2) (known as the spatial autoregressive model with a spatial autoregressive error term, i.e., SARAR). See Appendix C for comparison of different specifications and justification of using SARAR as our main regression.

4.1. Estimating determinants of corruption and identifying the underlying mechanisms

For the full sample, the positive and significant IV estimator of $\hat{\rho}$ in Column 2 of Table 2 indicates the existence of copying behavior from neighboring firms' corrupt practice. Corruption in this way diffuses from one to all other firms within the system through observed corrupt behavior practiced by neighboring firms. The overall level of corruption in a country would, in turn,

[21] Ideally one may control for the city-level variation, for example, the average values within the neighboring cities. It matters directly how information is transmitted between neighboring firms and also could be larger than that of the province. Nevertheless, it is not possible to do so given data limitations on the city-level information.

[22] We will, however, restrict firms within the same industry and geographic distance on the assumption that a firm might interact more with other firms in the same industry than those in other industries. Section 4 will discuss the results.

[23] There are four steps in estimation. First, consistent ρ, γ, and β are estimated by instrumental variables as those in the 2SLS-IV. Second, estimate λ and the standard deviation of residuals σ by GMM where the moment conditions explicitly allow for heteroskedastic innovations. Third, use the estimated λ and σ to transform the data and obtain more efficient estimates of ρ, γ, and β. Fourth, use those efficient estimated ρ, γ, and β to obtain an efficient GMM estimator of λ. Arraiz, Drukker, Kelejian, and Prucha (2010) demonstrate that the GS2SLS estimators are consistent under heteroskedastic disturbances and large sample.

Table 3
Decomposition of average marginal effects.
Source: Authors' calculation based on the World Bank Enterprise Survey (cross-refer to Section 2.1).

Independent variables	Full			East			Center			West		
	ATME= (1)	ADME (2)	+AIME (3)	ATME= (4)	ADME (5)	+AIME (6)	ATME= (7)	ADME (8)	+AIME (9)	ATME= (10)	ADME (11)	+AIME (12)
Channels												
Highway	−0.003	−0.001	−0.002	1.584	0.272	1.312	0.008	0.007	0.001	−0.006	−0.006	0
Information	0.008	0.004	0.004	0.114	0.020	0.094	0.003	0.002	0.001	0.002	0.002	0
marketization	−0.114	−0.056	−0.058	−2.252	−0.386	1.866	−0.053	−0.045	−0.008	−0.038	−0.039	0.001
Influence from firms themselves												
γ	0.055	0.027	0.028	0.204	0.035	0.169	0.026	0.022	0.004	0.018	0.019	−0.001

Notes: Refer to Appendix A for variable definitions. Full results are available upon request from the authors.

escalate as a result of contagion of corruption. However, the GS2SLS estimator of $\hat{\rho}$ first rises dramatically in Column 3 of Table 2 under SAR and then, decreases and loses statistical significance when the unobserved spatial influence is also controlled for in Columns 5–6 of Table 2.[24] These observations raise the conjecture that the standard IV estimator conveys shaky evidence of contagion of observed corruption. In the SAE specification (Column 4 of Table 2), the negative $\hat{\lambda}$ implies that the unobservables surrounding the firm i help to confine its corrupt acts at the 1% significance level. Putting $\hat{\rho}$ and $\hat{\lambda}$ together, it seems that there would not be a deluge of corruption due to its contagion effects. We will return to this point with disaggregated analyses for regions and industries.

A statistically significant and positive $\hat{\gamma}$ in all specifications points to path dependence of corrupt acts: firms' current engagement in corruption hinges on "themselves", i.e., their past corrupt experiences. We also replaced the indicator of past corrupt experiences by another proxy – whether the firm were "happy with the results" after seeking help from senior leaders – and re-estimated Table 2. The results reaffirm path-dependent corruption: the estimated coefficients of this alternative proxy are 0.025–0.026 at the 1% significance level.

Column 6 of Table 2 concentrates on three channels stated in Section 2 underlying diffusion of corruption. Comparing Column 6 with 3–5, $\hat{\rho}$ loses statistical significance and becomes smaller. Meanwhile, $\hat{\lambda}$ becomes larger in the absolute term. These changes imply that the channels absorb, to some extent, observed and unobserved spatial diffusions of corruption. Our results manifest the important roles of (local) information networks and marketization. The positive estimator of the varieties of publications (0.004) at the 5% significance level suggests that controlling for the existing corruption committed by neighbors, receiving more local information lures firms into committing more corrupt acts. The negative interaction term between information networks and observed surrounding corruption (−0.004) at the 1% significance level suggests that, given the current exposure to information (or the level of transparency), the firm would limit its malfeasances if neighbors were more corrupt.

Putting them together, the "net" impact of information networks (Column 1 of Table 3) is corruption-increasing with the marginal effect of one more publication per 10 thousand people being 0.8 percentage points (3 days), implying that firms' care about local information and thus their inclination to copy their neighbors' corrupt behavior exceeds their concern about potential risks raised by more transparency. Marketization can be a powerful anti-corruption instrument given its significant and negative estimator (−0.056), but the positive interaction term (0.028) indicates that this effect could be eroded if the surrounding firms are corrupt. The magnitude of "net" marginal impact of marketization is still negative and large (−0.114 in Column 1 of Table 3, equivalent to 42 days/year) because one firm's smaller effort in corruption as a result of marketization spills over in the presence of positive $\hat{\rho}$.

To better understand the driving forces of the above results for the full sample, we use the SARAR specification (i.e., Column 6 of Table 2) to estimate separately 3 regions. Table 4 reports the results. The spatial goodness-of-fit is in general acceptable, indicating satisfactory explanatory power of the SARAR specification for the disaggregated analyses as well.

Different estimates of $\hat{\rho}$, $\hat{\lambda}$ and $\hat{\gamma}$ in Table 4 suggest considerable regional heterogeneity in firms' corrupt behavior. In the Eastern region, firms' decision-making on corruption is affected by both "themselves" and "neighbors". Past experiences in bribing bureaucrats raise the firm's current corruption level at the 1% significance level (0.036 in Column 1 of Table 4). As neighbors become more corrupt, the firm would also be more corrupt, whereas it is insensitive to other unobserved factors shaping the local corrupt environment, which is indicated by the significant and positive $\hat{\rho}$ and insignificant $\hat{\lambda}$. More fatally, the larger-than-one magnitude of the observed influence from "neighbors" (1.15 in Column 1 of Table 4) means that a commensurate increase in the level of one firm's corruption can provoke multiplicative engagement in corruption in nearby firms through copying behavior. The "race-to-the-bottom" in terms of rampant corrupt practices would arise as a consequence of co-movement among neighboring firms. This phenomenon would posit considerable barriers to the effort of reducing corruption and the effect of any anti-corruption policy which only regulates some of the firms in certain areas. As an upshot of a series of copying behavior, the whole country would experience ever-aggregating corruption even if only a few firms in the system paid bribes. Petty corruption would ultimately

[24] We also used the categorical corruption variable defined as quintiles or quartiles of our (continuous) firm corruption to re-estimate Column 6 of Table 2. $\hat{\rho}$ is still insignificant but with smaller magnitude of 0.021 or 0.003, indicating that firms may gradually become more corrupt rather than experiencing sudden behavioral changes.

Table 4
Determinants of firm corruption (by region).
Source: Authors' calculation based on the World Bank Enterprise Survey (cross-refer to Section 2.1).

Independent variable	East	Center	West
	(1)	(2)	(3)
Influence from neighbors			
ρ	1.150 (0.192)***	0.131 (0.026)***	0.786 (0.617)
Highway	0.276 (0.007)***	0.007 (0.004)*	−0.006 (0.001)***
Highway × neighbors' corruption	−0.008 (0.003)***	−0.025 (0.014)*	0.001 (0.011)
Information	0.020 (0.001)***	0.002 (0.002)	0.002 (0.002)
Information × neighbors' corruption	−0.008 (0.001)***	−0.001 (0.005)	−0.009 (0.022)
Marketization	−0.392 (0.005)***	−0.045 (0.021)**	−0.039 (0.024)*
Marketization × neighbors' corruption	0.056 (0.007)***	0.052 (0.051)	−0.126 (0.267)
λ	−0.097 (0.208)	−0.659 (0.104)***	1.035 (0.253)***
Influence from firms themselves			
γ	0.036 (0.012)***	0.022 (0.009)**	0.019 (0.014)
Firm controls	Yes	Yes	Yes
City controls	Yes	Yes	Yes
Provincial dummy	Yes	Yes	Yes
No. of obs.	4512	2728	1837

Notes: a. Refer to Appendix A for variable definitions.
b. θ = 200 km, α = 1. Standard errors are in the parentheses.
c. *, ** and *** denote 1%, 5% and 10% significance levels in turn.

become rampant and persistent. In the presence of multiplicative copying behavior, the total impact of a correlate on corruption, either positive or negative, is larger than its direct impact in absolute terms. For example, the total marginal impact of a firm's own corruption in the past (0.204 in Column 4 of Table 3) is 4.8 times larger than the direct marginal impact (0.035 in Column 5 of Table 3).

Of three channels underlying diffusion of corruption, information and marketization in the East (Column 1 of Table 4) play similar roles as in the full sample. Moreover, the positive estimate of density of highway and its negative interaction with surrounding corruption indicate that, similar to information, geographical networks between firms would push up the level of corruption, but the more corrupt acts committed by neighbors, the less this corruption-increasing impact.[25] As shown in Column 4 of Table 3, the "net" marginal effects of information and highway are still corruption-increasing with the magnitude of the former (0.114) being much less than that of the latter (1.584).

As East, observed corruption in Central region from neighbors also offers a lure for firms (Column 2 of Table 4). Nevertheless, these less-than-one estimates of the contagion effect of corruption point to convergence of firm corruption should one firm in the region starts to be more corrupt either because of its past corrupt experiences (0.022 in Column 2 of Table 4) or other reasons. As the full sample and the bulk-good industry in the East, the remaining unobserved factors surrounding the firm after controlling for three channels underlying diffusion of corruption negatively relates to the firm's corrupt behavior, especially in the low-value industry, as indicated by the significantly negative $\hat{\lambda}$. Of three channels, only density of highway positively relates to corruption with a smaller magnitude in more corrupt environment (Column 2 of Table 4). Its "net" marginal impact on corruption is positive but trivial (0.008 in Column 7 of Table 4). It seems that firms in the West do not follow their corrupt neighbors given insignificant $\hat{\rho}$ in Column 3 of Table 4. On the contrary, they respond positively to unobserved corrupt surroundings by conducting malfeasances, as $\hat{\lambda}$ is 1.035 at the 1% significance level. The three channels function differently across industries in the West. Both geographic networks and marketization reduce corruption independent on the existing surrounding corruption level (Column 3 of Table 4), while the marginal impact of the former is trivial (−0.006) compared with that of the latter (−0.038 in Column 10 of Table 3). Given slower development progress and a higher average corruption level in the West, it is not surprising to observe the smallest benefit of marketization there (−0.038) compared with East (−2.252) and Central (−0.053) in Columns 4, 7 and 10 of Table 3.

Putting three region-specific $\hat{\rho}$s together, it could be inferred that there are multiple corruption regimes (equilibria) in China. There might be a steady-state corruption level in Central and a high or ever-increasing corruption level in East. This corroborates the predictions of Blackburn's (2012) theoretical model on "an intermediate development regime" which is characterized by multiple equilibria with varying incidences of corruption across or within countries under endogenous determination of corruption.

Among other control variables, private and foreign shares relate robustly to less corruption and a firm consistently malpractices more if it is exposed to extortion of resource rent, that is, belonging to the natural resource industry, has long history, large size, and well-educated managers. Exporting goods also incurs more corrupt practice, which, however, is driven solely by land-locked western areas. Faced with high taxation, firms in East may find it worthwhile to bribe officials to help them evade substantial taxes, especially those in the bulk-goods industry when re-estimating Column 1 of Table 4 for firms in the bulk-goods industry only.[26]

[25] Estimating Column 1 of Table 4 for each industry within East shows that these effects are driven by firms in the bulk-goods industry rather than those in the low-value industry. The results for each industry within each region are available upon request from the authors.
[26] Full results are available upon request from the authors.

Table 5
Sensitivity to normative assumptions of spatial influence.
Source: Authors' calculation based on the World Bank Enterprise Survey (cross-refer to Section 2.1).

Independent variables	(1)	(2)	(3)
Influence from neighboring firms			
ρ	0.005 (0.020)	0.018 (0.007)***	0.402 (0.219)*
Highway	−0.008 (0.054)	0.066 (0.003)***	−0.791 (0.001)***
Highway × neighbors' corruption	−0.001 (0.001)	−0.004 (0.002)**	−0.006 (0.003)*
Information	−0.129 (0.016)***	−0.100 (0.001)***	−0.414 (0.002)***
Information × neighbors' corruption	−0.001 (0.0003)**	−0.005 (0.001)***	−0.004 (0.005)
Marketization	1.201 (0.147)***	1.779 (0.005)***	3.852 (0.017)***
Marketization × neighbors' corruption	0.005 (0.002)***	0.029 (0.005)***	0.030 (0.032)
λ	−0.109 (0.038)***	−0.430 (0.170)**	−3.302 (1.472)**
Influence from firms themselves			
γ	0.174 (0.069)**	0.027 (0.007)***	0.026 (0.007)***
Firm controls	Yes	Yes	Yes
City controls	Yes	Yes	Yes
Provincial dummies	Yes	Yes	Yes
No. of obs.	9077	9077	9077

Notes: a. Refer to Appendix A for variable definitions.
b. Column (1) uses firms' natural logarithmic entertainment and travel costs per employee to proxy corruption and assumes $\theta = 200$ km and $\alpha = 1$. Column (2) assumes $\theta = 800$ km and $\alpha = 1$. Column (3) assumes $\theta = 800$ km and $\alpha = 2$. Standard errors are in the parentheses.
c. *, ** and *** denote 1%, 5% and 10% significance levels in turn. Heteroskedasticity-robust standard errors are in the parentheses.

4.2. Robustness checks

The above results might be sensitive to (i) the measurement of firms' corruption engagement, (ii) the definition of "neighbors" who are presumed to affect the firm's behavior (i.e., θ), and (iii) the speed of diffusion among neighbors controlled by α. This subsection investigates these issues separately.[27]

First, considering contention in measuring corruption engagement, we use another indicator to proxy firm corruption – firms' entertainment and travel costs as Cai et al. (2011). They find that some components of firms' expenditure on entertainment, travel, eating and drinking are genuine bribes. As shown in Column 1 of Table 5, the results are broadly consistent with our main findings based on Column 6 of Table 2, including positive but insignificant "osmosis" of observed corruption and statistically significant and negative influence of unobserved ambient factors on the firm's own malfeasances. The main deviations from Sections 4.1 and 4.2 lie in the reverse signs of information and marketization. Corruption is negatively (positively) related to the varieties of newspaper (marketization). This may be caused by our measurement of corruption engagement. As warned by Cai et al. (2011), the entertainment and travel costs contain not only genuine components of corruption, but also managerial expenditure that is necessary to expanding businesses. If the latter dominates the former, firms may weigh their peers' real business activities more than corruption and one should not be surprised to observe that information flows and marketization raise entertainment and travel costs.

Second, if using a larger cut-off at 800 km in Column 6 of Table 2 to define a broader range of neighbors considered by firms in their decision-making (i.e., *global* copying behavior) – which is likely to happen along with intensified domestic market integration, influence from observing neighbors' malfeasance ($\hat{\rho}$) becomes weakened but statistically significant (0.018 in Column 2 of Table 5). We also experimented with cut-offs at 400 km and 600 km holding $\alpha = 1$ in Column 6 of Table 2. $\hat{\rho}$ is 0.025 at the 5% significance level and 0.012 under 400 km and 600 km, respectively.[28] Together with insignificant $\hat{\rho}$ under 200 km, we argue that there is non-linear relationship between the contagion effect of observed corruption and distance to neighbors: the contagion effect of corruption would emerge if a corrupt neighbor locates at certain medium distance and dissipate at longer distance. Such a tendency can also be observed at the regional level. After re-estimating Column 6 of Table 2 at the regional level with the larger cut-off at 800 km, compared with Table 5, $\hat{\rho}$ reduces to 0.047 in both East and Centre and gains statistical significance in West (0.048), all at 1% significant levels. The non-linear relationship between the contagion effect of corruption and distance implies that firms' decision making on corrupt acts is insensitive to their close neighbors' corrupt behavior, possibly because of their concern with high risk of detection, but they are tempted to copy corrupt practice which is committed by some more distant neighbors and thus does not necessarily intensify detection. This copying behavior would eventually disappear if the corrupt neighbor locates too far away to convey enough incentives to the firm's decision-making.

Third, keeping the distance cut-off constant (e.g., at 800 km in Column 3 of Table 5), the unobserved negative influence imposed by surrounding firms on the firm's own corruption remains negative and statistically significant under higher speed of

[27] Given that our dataset is only one cross section, we cannot provide more robustness tests for the causality from neighboring firms' engagement in corruption to the firm's own engagement, such as the difference-in-difference method cancelling out the impact of other determinants. Such additional tests would be very useful once the data with time differences are available.
[28] Full estimation results are not reported due to limited space.

decaying influence of corruption ($\alpha=2$). Comparing Columns 2 and 3 of Table 5, increasing the speed only enlarges the magnitude of $\hat{\lambda}$ in absolute terms. This is predictable as the magnitude of unobserved influence at the same distance becomes smaller under $\alpha=2$ (larger denominators of spatial weights). Its estimated coefficient has to increase to let these unobservables exhibit similar influence as that under $\alpha=1$.

5. Conclusion

This study identifies the contagion effect of firm corruption and new channels underlying firms' corrupt behavior by using a nationally representative micro dataset in China. Firms' current corrupt activities are joint outcomes of their (vertical) past experiences in bribing bureaucrats and the (horizontal) influence of other surrounding firms' observed corrupt behavior, through the channels of geographical and information linkages and marketization, and *unobserved* neighborhood factors such as culture, customs and local bureaucrats' characteristics. Firms' copying behavior, together with their path-dependence on corrupt practice, raises the aggregated level of corruption. Moreover, firms' incentives to copy their neighbors' malfeasances first increase and then decrease as the distance to neighbors lengthens. Nevertheless, it is worth noting that the magnitude of these influences may be an upper bound of genuine spread of corruption given our measurement of corruption in days rather than in more precise time within the called-in days.

This study has also tested traditional theories of corruption determination. The driving factors of the level of the firm's corruption include expected profits, opportunity costs, economic and resource rents, manager appointed by the government, inter-provincial sales, export, and firm age and size, while the deterrents are private ownership and intensified local competition.

Therefore, a more effective anti-corruption policy may not only consider traditional determinants of corruption (as found in this paper) which explain part of firms' corrupt behavior stemming from themselves, but also take into account the behavioral responses, i.e., the effect of corruption activities imposed by neighbors. The existence of path-dependence and copying behavior in firm corruption invites cooperation and coordination in designing and implementing anti-corruption policy across regions rather than independent actions. The present study could be improved further should panel data be available, as firms' fixed effects (i.e., unobserved effects of "themselves" in addition to the observed ones identified in this paper) can be disentangled.

Acknowledgements

We thank the participants of Organizational Economics Seminar at Renmin University of China held in October 2013, the Annual Meeting of the European Public Choice Society held on 3-6 April 2014 at the University of Cambridge, and the 2nd Annual International Workshop on Economic Analysis of Institutions held on 17-18 May 2014 at Xiamen University for their insightful comments. We are also grateful to two anonymous referees for their helpful suggestions. This research is supported by the National Natural Science Foundation of China (Grant No.: 71572190) and the National Program for Support of Top-notch Young Professionals for Huihua Nie. The remaining errors are in the authors' sole responsibilities.

Appendix A

Table A1
Definition and descriptive statistics of variables.
Source: Authors' calculation based on the World Bank Enterprise Survey (cross-refer to Section 2.1).

Variable	Definition	Mean	S.D.
Corruption	Share of days in the sample year that the firm spends dealing with four government departments: taxation, public security, environment, and labor & social security.	0.161	0.115
Seek help from senior leaders	Dummy variable taking the value 1 if the firm sought help from government officials or senior political leaders to help solve the issues were there any disputes or different interpretations between the firm and the government in the past 3 years.	0.052	0.222
Share of helpful officials	Firm's perceived share of officials in the above four government departments whom the firm considered to be helpful for its growth and development.	0.416	0.379
Net profit	Ln(firm's total sales income per employee in 2004 – various costs per employee in 2004). All monetary variables are inflated to the real term in 2005 prices by provincial price indices of fixed investment.	0.058	3.640
Expected profit	Total net profit used for reinvestment per employee in 2004 plus new fixed assets investment per employee in 2004. The sum is then inflated to the real term in 2005 prices by provincial price indices of fixed investment.	2.037	1.877
Opportunity cost	Value of fixed assets per employee in 2004, inflated to the real term in 2005 prices by provincial price indices of fixed investment.	3.953	1.347
Private shares	Share of the firm owned by private shareholders.	0.393	0.447

Table A1 *(continued)*

Variable	Definition	Mean	S.D.
Foreign shares	Share of the firm owned by foreign shareholders.	0.147	0.318
Tax burden	Share of all taxes and fees in the firm's total sales in 2005.	0.036	0.033
Natural resource industry	Dummy variable taking the value 1 if the firm belongs to industries that the government could extract resource rent, 0 otherwise. Those industries include timber processing, bamboo, cane, palm fiber and straw products, petroleum processing and coking, raw chemical materials and chemical products, medical and pharmaceutical products, chemical fiber products, rubber products, plastic products, non-metal mineral products, smelting and pressing of ferrous and non-ferrous metals, and metal products.	0.409	0.492
Industry intensity	Authors' calculations according to Nunn's (2007) second measure of contract intensity for each industry. We specify 29 industries for disaggregation.	0.858	0.152
Competitor	Ln(no. of other sample firms within the district where this firm is located).	2.410	0.736
Sell inter-province	Dummy variable taking the value 1 if the firm sells part of its products out of the province where it is located, 0 otherwise.	0.827	0.378
Export	Dummy variable taking the value 1 if the firm directly exports goods, 0 otherwise.	0.464	0.499
Manager's educational level	Categorical variable taking the values 1 (no formal edu.), 2 (primary sch.), 3 (junior high sch.), 4 (senior high sch.), 5 (college), 6 (undergraduate), and 7 (master or above).	5.609	0.990
Manager appointed by gov.	Dummy variable taking the value 1 if the general manager of the firm is appointed directly by the government.	0.112	0.315
Judicial system	Share of the firm's legal contracts or properties are actually protected in 2005.	0.509	0.427
Ln(age)	Ln(no. of years since the firm was established).	2.126	0.853
Ln(size)	Ln(no. of employees).	5.860	1.420
Ln(per capita GDP)	Ln(per capita GDP in 2005 of the city where the firm is located). We compiled the data from World Bank (2006).	9.033	0.629
Ln(pop.)	Ln(total population in 2005 of the city where the firm is located). We compiled the data from World Bank (2006).	6.258	0.549
Highway	The ratio of length of highway (km) over the population size (measured by 10 thousand people) within the province.	13.535	6.956
Information	The number of varieties of publications per 10 thousand people within the province.	36.840	13.620
Marketization	Provincial marketization index constructed by and compiled from Fan et al. (2010). The index is a weighted average indicator containing 5 categories: development of products and factors markets, the relationship between the government and markets, development of the non-state sector, market intermediaries, and commercial legal environment. There are in total 23 indicators in those categories. The scale of each indicator ranges between 0 (worst) and 10 (best). The value for the ith province's performance in jth indicator is calculated as $10 \times (V_{ij} - V_{j,min}) / (V_{j,max} - V_{j,min})$. The overall marketization index for the ith province is the weighted average across 23 indicators. Refer to Fan et al. (2010) for detailed weighting schemes.	6.869	1.667

Notes: The sample size is 9077 firms. Monetary variables are inflated to 2005 prices by provincial CPI, except the value of fixed assets which is inflated to 2005 prices by provincial price indices of fixed asset investment. Both price indices come from the China Data Center, University of Michigan.

Appendix B. Decomposition of marginal effects

First, if only the firm i changes its kth characteristic x_k by an amount δ, the marginal change in its corruption level is calculated by $\frac{\partial \hat{c}(\mathbf{x}_k)}{\partial x_{ik}} = \frac{\partial \hat{c}(\mathbf{x}_k+\delta_i)}{\partial \delta}$. Changing x_k for each firm sequentially and then averaging it across all firms yields the average direct marginal effect (ADME):

$$\begin{aligned}\frac{1}{N}\sum_{i=1}^{N}\frac{\partial \hat{c}(\mathbf{x}_k)}{\partial x_{ik}} &= \frac{1}{N}\sum_{i=1}^{N}\frac{\partial \hat{c}(\mathbf{x}_k+\delta_i)}{\partial \delta}\\ &= \frac{1}{N}\sum_{i=1}^{N}\frac{\partial \hat{c}\left(x_{1k},\ldots,x_{i-1,k},x_{ik}+\delta_i,x_{i+1,k},\ldots,x_{nk}\right)}{\partial \delta}\\ &= \frac{\hat{\beta}_k}{N}\sum_{i=1}^{N}(\mathbf{I}_N-\hat{\rho}\mathbf{W})^{-1}\end{aligned} \tag{B1}$$

for single correlates (without interaction terms) and

$$\begin{aligned}\frac{1}{N}\sum_{i=1}^{N}\frac{\partial \hat{c}(\mathbf{x}_k)}{\partial x_{ik}} &= \frac{1}{N}\sum_{i=1}^{N}\frac{\partial \hat{c}(\mathbf{x}_k+\delta_i)}{\partial \delta}\\ &= \frac{1}{N}\sum_{i=1}^{N}\frac{\partial \hat{c}\left(x_{1k},\ldots,x_{i-1,k},x_{ik}+\delta_i,x_{i+1,k},\ldots,x_{nk}\right)}{\partial \delta}\\ &= \frac{\hat{\beta}_k}{N}\sum_{i=1}^{N}\left(\mathbf{I}_N-\hat{\rho}\mathbf{W}-\beta_4\mathbf{W}\mathbf{S}_p\right)^{-1}\end{aligned} \tag{B2}$$

for the correlates in $\mathbf{S}_p$ which are also interacted with the spatial lags in Eq. (3). Second, if all firms change simultaneously their kth characteristic x_k by an amount δ, the marginal change in one firm's corruption level is $\frac{\partial \Delta GI(\mathbf{x}_k)}{\partial x_{ik}} = \frac{\partial \Delta GI_i(\mathbf{x}_k+\delta \mathbf{e})}{\partial \delta}$ where $\mathbf{e} = [1, \ldots, 1]'$ is a vector of ones. Averaging it across all firms yields the average total marginal effect (ATME):

$$\begin{aligned}\frac{1}{N}\sum_{i=1}^{N}\frac{\partial c_i(\mathbf{x}_k)}{\partial x_{ik}} &= \frac{1}{N}\sum_{i=1}^{N}\frac{\partial c_i(\mathbf{x}_k+\delta\mathbf{e})}{\partial\delta}\\ &= \frac{1}{N}\sum_{i=1}^{N}\frac{\partial \Delta c\left(x_{1k}+\delta,\ldots,x_{i-1,k}+\delta,x_{ik}+\delta,x_{i+1,k}+\delta,\ldots,x_{nk}+\delta\right)}{\partial\delta}\\ &= \frac{\hat{\beta}_k}{N}\sum_{i=1}^{N}\sum_{j=1}^{N}\left(\mathbf{I}_N-\hat{\rho}\mathbf{W}\right)^{-1}\end{aligned} \quad (B3)$$

for single correlates and

$$\begin{aligned}\frac{1}{N}\sum_{i=1}^{N}\frac{\partial c_i(\mathbf{x}_k)}{\partial x_{ik}} &= \frac{1}{N}\sum_{i=1}^{N}\frac{\partial c_i(\mathbf{x}_k+\delta\mathbf{e})}{\partial\delta}\\ &= \frac{1}{N}\sum_{i=1}^{N}\frac{\partial \Delta c\left(x_{1k}+\delta,\ldots,x_{i-1,k}+\delta,x_{ik}+\delta,x_{i+1,k}+\delta,\ldots,x_{nk}+\delta\right)}{\partial\delta}\\ &= \frac{\hat{\beta}_k}{N}\sum_{i=1}^{N}\sum_{j=1}^{N}\left(\mathbf{I}_N-\hat{\rho}\mathbf{W}-\boldsymbol{\beta}_4\mathbf{W}\mathbf{S}_p\right)^{-1}\end{aligned} \quad (B4)$$

for the correlates also appearing in the interaction terms. The difference between ATME and ADME is the average indirect marginal effect (AIME) caused by contagious corruption.

Appendix C. Identifying the existence of contagious corruption influences and justifying the use of spatial model specification

Fig. C.1 plots the OLS residuals under Column 1 of Table 2 against the predicted firm corruption. If there were copying behavior, this regression would have omitted potentially important spatial diffusion of corruption from regressors. Therefore, the error terms of Column 1 would violate the *i.i.d.* assumption, but rather be heteroskedastic. The funnel-like pattern of residuals in Fig. 3 raises the concern of heteroskedasticity. More formally, the null hypothesis of homoscedastic errors in the Breusch-Pagan, Koenker-Bassett, and White tests is rejected at 1% significance level. In the presence of heteroskedasticity, the standard errors of the estimators in Column 1 of Table 2 are imprecise and t-tests might be wrong.[29] Moran's I test (Anselin, 2003) is also implemented to detect the spatial dependence in residuals. Under the null hypothesis of no spatial correlation in error terms, the Moran's I statistic in terms of the ratio of spatially weighted sum of squared residuals over the non-weighted ones is not statistically different from zero. This is firmly rejected at the 1% significance level with the Moran's I statistic being −3.9.

We address heteroskedasticity in OLS residuals by estimating the SAR (Columns 2–3 of Table 2), SAE (Column 4), and SARAR (Column 5) models. The Lagrange Multiplier tests of SAR or SAE against the non-spatial specification (OLS) are rejected at the 1% significance level with the χ^2 statistics being 14.87 and 18.69, justifying the spatial specifications. Among all spatial models (Columns 2–6 of Table 2), the indicator for model selection is spatial goodness-of-fit following Jeanty, Partridge, and Irwin (2010), i.e., the spatial pseudo R^2 measured by the ratio of the variance of predicted corruption to the variance of observed one where the predicted corruption is calculated as the expectation conditional corruption on observed correlates and spatial interdependence using the reduced form of Eqs. (C1)–(C2):

$$\hat{\mathbf{c}} = E\left(\mathbf{c}|\mathbf{c}_p,\mathbf{X}_f,\mathbf{X}_c,\mathbf{D}_c\right) = \left(\mathbf{I}-\hat{\rho}\mathbf{W}\right)^{-1}\left(\hat{\gamma}\mathbf{c}_p+\mathbf{X}_f\hat{\boldsymbol{\beta}}_1+\mathbf{X}_c\hat{\boldsymbol{\beta}}_2+\hat{\mathbf{D}}_c\right) \quad (C1)$$

When including the interaction terms as Eq. (3), the above predicted corruption becomes:

$$\hat{\mathbf{c}} = E\left(\mathbf{c}|\mathbf{c}_p,\mathbf{X}_f,\mathbf{X}_c,\mathbf{D}_c\right) = \left(\mathbf{I}-\hat{\rho}\mathbf{W}-\mathbf{S}_p\hat{\boldsymbol{\beta}}_4\mathbf{W}\right)^{-1}\left(\hat{\gamma}\mathbf{c}_p+\mathbf{X}_f\hat{\boldsymbol{\beta}}_1+\mathbf{X}_c\hat{\boldsymbol{\beta}}_2+\hat{\mathbf{D}}_c+\mathbf{S}_p\hat{\boldsymbol{\beta}}\right) \quad (C2)$$

The SARAR suggests a marginally better fit than SAR and SAE. The present study proceeds to discuss estimation results based on spatial specifications in Columns 2–6 of Table 2, particularly the SARAR.

[29] Columns 1–2 of Table 2 have already been adjusted for arbitrary heteroskedasticity when standard errors are computed. However, as shown by Anselin (2003), this is not enough to resolve the problem caused by spatial interdependence of corruption or other omitted variables. Our LM tests in the next paragraph also lend support to this by justifying spatial specifications.

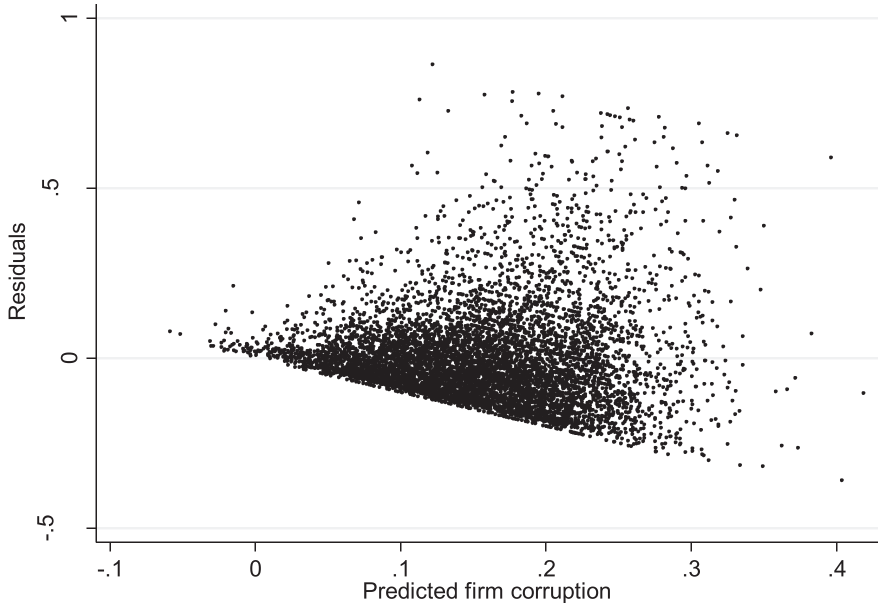

Fig. C.1. Heteroskedasticity in the full-sample regression Notes: The firm's engagement in corruption is estimated under the specification of Column 1 of Table 2 by the OLS approach. The firm's engagement in corruption is calculated as the proportion of days spent with government officials over the past year. The horizontal axis measures the predicted values of the firms' engagement in corruption posterior to this OLS estimation. The vertical axis measures the OLS residuals. Source: Authors' calculation based on the World Bank Enterprise Survey (cross-refer to Section 2.1).

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