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"GREASING" OR "SANDING-THE-WHEELS"? AN EMPIRICAL ASSESSMENT ON THE IMPACT OF CORRUPTION ON FIRM INNOVATION IN CHINA

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Corruption is generally considered to affect firm innovation negatively. Yet recent scholarship is indicating that corruption may yield positive effects on innovation practices by removing certain barriers associated with starting up or operating businesses. The differing perspectives on the impact of corruption on firm innovation have engendered two contrasting hypotheses: the 'sand-the-wheels' and 'grease-the-wheels' hypotheses. The former contends that corruption is detrimental to innovation whereas the latter argues that it is favourable to innovation. Using firm-level data from the World Bank Enterprise Survey 2012, this study examines the impact of corruption (bribery) on innovation activities (new products and process) in the context of the Chinese business environment to test these hypotheses. A linear probability model (LPM) is employed and tested against a sample of 2,700 privately-owned Chinese firms. The results suggest that bribery has a positive impact on both new product and process innovation. Firm characteristics such as license, R&D, equipment, firm age, ownership, and ICT technologies were also found to have a significant effect on the innovation activities of the firms. The findings provide support for the grease-the-wheels hypothesis in the short-term, but the long-term effect may be different. In the short-term, this thesis indicates that corruption can accelerate innovation for those who can afford it by facilitating the process of obtaining licenses and permits to operate the business.

Keywords: corruption, China, firms, innovation, grease-the-wheels, sand-the-wheels

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1. Introduction

Whereas innovation has been widely studied and acclaimed to have a positive impact on productivity and regarded a vital source for economic growth (Aghion & Howitt, 1998; Almeida & Fernandes, 2008), the relationship between corruption and innovation practices has remained underresearched. Yet research is indicating that corruption is a notable factor determining reasons for differences and divergences in innovation and growth performances. While it is commonly held that corruption is detrimental and should be avoided (Mauro, 1995; Fisman & Svensson, 2007; Cai et al., 2011) sundry scholars have suggested that corruption could in fact promote economic growth in some cases (Leff, 1964; Hellman et al., 2003; Vial & Hanoteau, 2010). Being more specific, some scholars have found that petty corruption or bribery involving smaller amounts of money can be conducive to economic growth and favorable to innovation practices, particularly where institutions are weak and underdeveloped (Leff, 1964; Nguyen et al., 2016).

These diverging views and findings have given rise to two contrasting hypotheses that have emerged through the scholarly exercise of assessing the impact of corruption on innovation practices. On the one hand, there is the 'sanding-the-wheels' hypothesis, which states that corruption increases transaction costs, fuels business uncertainty, causes resource misallocation, while also impairing trust for formal institutions – believed to be essential for innovation (Luo, 2005; Anokhin & Schulze, 2009; DiRienzo & Das, 2015). On the other hand, there is the 'greasing-the-wheels' hypothesis, that regards corruption as a means from which to accelerate innovation for those that can afford it, by facilitating the process of obtaining permits and licences to start up and operate business. While both hypotheses have been substantiated with empirical evidence deriving from diverse settings (Avnimelech et al., 2011; De Waldemar, 2012; Krammer, 2014; Goedhuys et al., 2016; Nguyen et al., 2016), there is a shortage

of papers exploring the impact of corruptive behavior on Chinese firms' innovation practices.

Therefore, this thesis considers how bribery defined as a form of corruption, impacts innovation activities (new products and processes) in the context of the Chinese business environment. For analytical purposes, the aforementioned "sand-the-wheels" and "grease-the-wheels" hypotheses are employed to empirically investigate whether corruption acts as a barrier to innovation in the case of Chinese firms – or whether it facilitates it.

The aim of this thesis is as such to clarify the theory and test the hypotheses to determine how corruption impacts businesses' innovation practices. This thesis thus seeks to answer the following research question: what is the impact of corruption (bribery) on innovation activities (new products and processes) in Chinese firms?

Disposition

The remainder of the paper has the following disposition. Chapter 2 introduces the theoretical debates, hypotheses, and provides an overview of the institutional context relevant for the research question. Chapter 3 provides a short review of the relevant literature on the topic based on the two contrasting hypotheses. Chapter 4 describes the data sample and provides a rationale for the choice of variables followed by a discussion of the estimation strategy. Chapter 5 presents the results from the LPM regressions, before and after the inclusion of the instrument variables and additional controls. Chapter 6 discusses the findings and policy implications in the context of the research question, theories, previous studies. Lastly, chapter 7 concludes the essay, discusses the limitations of the study, and list a few suggested areas for future research.

2. Theory and Hypotheses

2.1 Organizational Corruption

The definition of corruption has been widely discussed in academic literature resulting in a general style of classification or typology. Most often, it is refered to as "the abuse of public power or authority for private benefit" (Anokhin & Schulze, 2009, p.1). Researchers have commonly used this notion of corruption interchangeably with bribery to refer to the process in which bureaucrats exchange public goods, such as permits and licenses for informal payments. Corruption, as per the Transparency International (2018a) can be classified into three separate categories: grand, petty, and political corruption. Grand corruption is considered an act committed where policies and the functioning of the state are distorted. Petty corruption, on the contrary, often involves the day-to-day misuse of the authoritarian officials in their interaction with the population for access to "basic goods and services." Finally, political corruption refers to the abuse of public authority, involving political-decision makers, often to stay in power, to sustain status and wealth (Amundsen, 1999; Transparency International, n.d.). However, for the thesis purpose, bribe payments will be adopted to measure the level of corruption. It is categorized as an "internal" measurement because it is calculated off the firm's experiences and assessments of corruption (Asiedu & Freeman, 2009, p.201). The implications of this type of measurement are discussed in chapter 4.7 estimation strategy.

2.2 Corruption and Innovation: a Theoretical Debate

Two conflicting hypotheses have emerged through the scholarly assessment of the impact of corruption on innovation. The first hypothesis posits that corruption increases transaction costs, and thus, acts as a barrier to innovation. The other hypothesis states that corruption may help firms overcome

bureaucratic inefficiencies. The following section will focus on the arguments related to innovation performance to disclose how corruption may sand or grease-the-wheel of innovation.

Sand-the-Wheels Hypothesis

The notion that corruption is harmful to innovation and economic growth has been widely supported by researchers. Rose-Ackerman (1997) suggest that officials may cause delay or introduce needless requirements to induce corruption. Such delays tend to have a negative impact on innovation efforts.

Anokhin and Schulze (2009) argue that the basis of trust for institutions get undermined and impaired when corruption is involved. Moreover, firms come under greater risk when there is a chance that public servants may appropriate their rewards. Additionally, they can exploit their unique access to inside information that the private sector does not posses yet may be essential to firm innovation to gain leverage over other firms. Thus, when trust for institutions do not exist, firms could be discouraged to proceed with projects they deem too risky, or where future profits are ambiguous. Yet another uncertainty is the case where corruption is ex post opportunistic. Since corruptive behavior is not supported by any legal institutions, this makes it easier for the agent – in this case the public official – to demand additional payments even after the initial undertaking. Besides, due to the negotiations being in favor of the agents as they have the upperhand in the agreement, the official may expropriate without fear for repercussions from the firm or innovator (Luo, 2005).

Corruption may also create a misallocation of human resources, where efforts are redirected to unproductive (corruptive) activitities instead of productive (innovation) activities – which in the long-run – have a detrimental impact on firms' pursuit of innovation. It is well established that payoffs are very important to entrepreneurs as they are mainly driven by profits. Which means that given the reward structure in a society, the allocation of talents will flow according to

where they can generate the highest returns. This carries important implications for the economy and will have a serious impact on its growth and development (Baumol, 1996). Additionally, resources spent on corruption could otherwise have been spent on innovation, especially early in the development phase of firm innovation when sizeable funding is required to kickstart projects. Instead such resources are directed to negotiations with bureaucrats, which means that less is spent on innovation resulting in fewer projects being realized. Thus, only a select few activities that yield high enough profits may be capitalized in the end due to high transaction costs. Kurer (1993) affirms that in a system where policies are deliberately sub-optimal from the outset and can be used to appropriate bribes, are likely to motivate government officials to distort prices for personal gains. This in turn may impede innovation, and subsequently, translate into a welfare loss.

Hence, corruption creates uncertainty, distrust in formal and legal institutions which inhibits firms' potential to pursue innovation practices. This type of system creates "inequality in opportunities," as it only favor a certain group of people or firms (those who can afford it), which in turn foments social unrest.

Qian and Xu (1998) developed a model in which they predicted the relationship between the screening of innovation projects and financial constraints. Their model suggests that bureaucracy is committing an error by rejecting otherwise favorable projects which in turn protracts innovation. Additionally, in more centralized economies, red tape may also reduce the number of similar projects, especially if they are more uncertain in character, which is likely the case for projects that are funded by the government compared to private financing. This means that if there are two competing firms for permits, the loser will not be able to pursue innovation projects.

Rose-Ackerman (1997) theorizes how corrupt firms may not be particularly innovative as they prioritize corrupt practices to the detriment of innovation activities. Firms can bribe themselves into a group of eligible bidders for valuable resources and information. Or convince the officials to structure the bidding requirement so that the corrupt firm becomes the only one entitled to benefit. They could also bribe themselves to the final contract, and once chosen; they could inflate prices and compromise on product innovation and quality.

Grease-the-Wheels Hypothesis

There are, however, also theories supporting the notion that corruption can promote innovation in certain cases (Leff, 1964; Leys, 1965; Acemoglu & Verdier, 1998) particularly in countries where institutions are weak and underdeveloped (Acemoglu & Verdier, 2000; de Vaal & Ebben, 2011; Krammer, 2014). Moreover, researchers have also argued that government intervention to correct corruption in its entirety may create yet another "trade-off between market failure and government failure," as correcting for corruption may lead to an exacerbation of the problem and increased inefficiency (Acemoglu & Verdier, 2000, p.194). Thus, the main assumption of the greasing hypothesis suggests that corruption can help firms overcome complex and lengthy bureacratic procedures. This is particularly the case in economies where legislations are rigid and inefficient and may otherwise hamper innovation and economic expansion (Leff, 1964; Leys, 1965). Moreover, in economies where bureaucracy is prominent and disruptive, corruption can become an incentive for officials to reduce red tape and facilitate the establishment of new firms or projects that they may not otherwise take into consideration (Leff, 1964; Leys, 1965). This would reduce the delays that are otherwise common in such business environments. Delays that often cost firms their first mover-advantages (See Mahagaonkar (2010) for a review).

Further arguments in favor of corruption and efficiency are often underpinned by one of the two following assumptions. One the one hand, that the government

is not supportive or may even be hostile to innovation, and on the other, that there may be other more immediate goals that politicians or public officials are more likely to prioritize. Assuming that not all firms could afford to bribe in the first place, given the situation, those that can are presumably the more efficient ones (Leff, 1964). The efficiency-enhancing perspective was further supported by Lui (1985), who developed a queuing system that he argues could yield the highest optimal efficiency under specific conditions. Similarly, Lien (1986) shows through a framework developed by Beck and Maher (1986) that when resources are limited, bidding for them could incite competition and through this process, resource allocation efficiency can be achieved. The idea has been explored previously by Bayley (1966), who argues that corruption may in some cases "[impel] better choices," mainly when government policies may hurt or impede innovation and productivity. Hence, firms can use corruption as a tool to hedge against these risks (Bayley, 1966, p.727; Mahagaonkar, 2010, p.83).

The theory on bureaucratic inefficiencies has also explored the impact of corruption on human capital, where it is argued that corruption can increase the quality of civil servants. Bayley (1966) explains that in economies where salaries of government officials are low, those who are talented may have to redirect their abilities to a different profession to improve their qualities of life. Then, to remain in office under these circumstances, civil servants can only find ways to complement their meager wages. The case appears relevant for developing countries where salaries are kept particularly low. This view was supported by Quah (2006, p.176) who asserts that low wages are one of the main reasons motivating officials in China to accept bribes to hasten the requests of the private sector, or to make an exception to the rule, and when the benefit for them personally outweighs the costs of corruption. Thus, through corruption, civil servants can increase their standards of living, which in extension increases the supply and the quality of the civil servants (Bayley, 1966).

Mahagaonkar (2010) explores what he considers the second and fourth dimension in his arguments for interpreting corruption as positively impacting innovation. Unlike the cases posited by the 'sanding' hypothesis, corruption from a 'greasing' standpoint claim that corruption can decrease business uncertainty. Through a relationship with the government, firms can feel confident in obtaining their licenses and permits for their innovation practices. Moreover, the development of a long-standing relationship with the officials can provide stability, which helps firms make arrangements in advance – an essential aspect for firms operating in countries where the administration is slow and cumbersome. The fourth dimension has much to do with protecting the business from political risks to ensure that investments in innovative activities are safe (Mahagaonkar, 2010). Moreover, bribery may also protect firms' innovation practices from organized criminal activities and the risk of government predation (Mahagaonkar, 2010; Cai et al., 2011).

2.3 Bribery and New Product and Process Innovation

Innovation is a term that relates to a range of different innovation activities. Hence, this thesis has referred to the OECD Oslo Manual (2005) as a guide to define and classify innovations at the firm level. While the Oslo Manual categorized innovation into four different groups this thesis considers two when assessing the impact of corruption (bribery) on innovation: product and process innovation. For the followings reasons: Reasons of feasibility and sufficiency for the study. Product innovation is a good or product that is a "new or significantly improved with respects to its characteristics or intended uses," which could also include improvements on the technical, material, and functional aspects. It can make use of new knowledge or technologies, but could also incorporate a mixture of knowledge and technology that is already there. Process innovation, on the other hand, is: "the implementation of a new significantly improved production

or delivery method. This includes significant changes in techniques, equipment, and software." (OECD, 2005, p.49).

According to Katila and Ahuja (2002, p.1183), new products "represent the potential commercial value of a firm's R&D activities." Thus, they argue that the impact of innovation on firm performances may not be evident until after the product is launched on the market. New product and process innovation are also a complement to other proxies for firm innovation such as R&D expenditure (Katila & Ahuja, 2002) and innovation intensity (Belderbos et al., 2006). The difference between R&D intensity and innovation, however, is that the former only measures the expenditure and does not consider the final innovation output (Bassanini & Ernst, 2002).

Introducing a new product or process is both risky and resource-consuming, often characterized by uncertainty, costs, and the high risk of failure (Baumann & Kritikos, 2016). Moreover, where the external environments are regarded as unpredictable, firm owners are expected to have less confidence in introducing new products or processes (Li & Atuahene-Gima, 2001; Bstieler, 2012; See Krammer (2014) for a review of relevant studies). Thus, as proposed by previous research, this thesis considers the institutional context and settings in the firms' decision to pursue innovative activities by studying the impact of corruption (bribery) on innovation (new products and processes), as they are pivotal challenges faced by the firm.

Adopting a similar approach to Mahagaonkar (2010) the impact of corruption on product and process innovation are considered separately, by examining the "grease-the-wheel" and "sand-the-wheel" hypotheses. Mahagaonkar theorizes that with regards to new product innovation, due to rules and regulations firms have to get permits and licenses, which increases the costs incurred by the business. If resources are available, the firm may bribe the official to grease-the-wheels of innovation to 'get things done.' However, if funding is not present, the firm may

decide not to introduce new products in which there is a sanding-effect (Mahagoankar, 2010). Hence the hypotheses:

H1: Corruption (bribery) **does not** affect new product innovation that occurs within the Chinese firms.

H0: Corruption (bribery) **does** affect new product innovation that occurs within the Chinese firms.

Since process innovation involves "the implementation of a new significantly improved production or delivery method. This includes significant changes in techniques, equipment, and software" (OECD, 2005, p.49). Mahagaonkar (2010) posits that it is an aspect internal to the firm, and thus does not involve exclusive permissions from the government. Therefore, they assume that bribery may not affect process innovations. Moreover, they argue that firms trying to introduce new technology or pursue a technological upgrade that has already been established should not suffer from corruption as "the value of the technology is already well known." Contrarily, as firms may need government consent to import and use necessary technologies, bribery could have either a positive or negative effect on process innovation (Mahagaonkar, 2010, p.85). Thus, for process innovation, the following hypotheses are tested:

H1a: Corruption (bribery) **does not** affect new process innovation that occurs within the Chinese firms.

H0a: Corruption (bribery) **does** affect new process innovation that occurs within the Chinese firms.

2.4 The context of corruption in Transitional China

China's growth since 1978 could be considered as an outlier. Despite suffering from weak institutions, bad governance, and a lack of enforcement of regulations, the formerly impoverished planned economy has evolved into becoming the

world's second-largest economy directed by “entrepreneurial bureaucrats” (Ang, 2017, p.103). The subsequent rise of new markets since the reform and opening act has since then motivated an institutional change consisting of improvised top-down and bottom-up approaches. The decentralized system and the revenue sharing scheme not only encouraged governments to promote the economies under their jurisdiction but also came to stimulate pervasive corruption, mainly due to “weak government controls” (Ang, 2016, p.128). Moreover, instead of following the technocratic route of its East Asian neighboring states in attracting investors and “picking winners” (e.g., favoring specific industries), the Chinese government directed their bureaucrats to welcome all kinds of investments. The officials were required to (and rewarded for) courting investors and making use of one resource they had in excess: their network of personal connections (Ang, 2016, p.175; Green, 2017). The local government was made to use all their contacts to attract investors; thus, instead of professionally conducting their official duties, the Chinese method of investment promotion was infused with the private and public spheres. The system of close personal ties between bureaucrats and investors, together with the "commission-based compensation system," according to Ang (2016, p.32), came to breed corruption naturally. However, as the Chinese market has become more mature, and integrated with the global market, weak institutions and corrupted practices may have a corroding impact on business operations, firm innovation and the economy.

Weak formal institutions, including the legal system and regulations, are far from the only obstacles to doing business in China. Both government controls and the distortions of the market mechanism also plays a role in creating an environment that encourages rent-seeking activities (Nee & Opper, 2012). Beyond policy formulations, provincial governments in China also remain in control of crucial inputs such as raw materials, energy, capital, and labor; effectively shaping firms’ business operations and its environment. Thus,

providing government officials with far-reaching control that could be misused. In particular, since the government exercise supervision over the resource distribution, in terms of investments projects, bank loans, and land-lease to name a few, firms are encouraged to develop a relationship with officials and legislators to acquire business dealings that are crucial to the development of the firm (Gao et al., 2010). Compared to private enterprises with little or no connection, firms that are more closely associated with government officials such as state- or partly state-owned firms could often receive backing in the form of access to strategic resources such as capital and contracts which could foster firm innovation practices (Chen et al., 2014).

Consequently, in China – where formal institutions are insufficient and legal protection is inadequate – incentives to innovate could be considered lacking. Dang and Yang (2016) explain that under the unique conditions of the business environment in China, firms with limited resources have two choices. One the one hand, growth can be achieved through political connection, or on the other hand, by allocating resources toward innovation. Thus, in an economy were pivotal institutions are defective, and the government is controlling resources, costs of obtaining connections will be considerably lower. Subsequently, there may exist a trade-off between corruption and innovation.

2.5 Guanxi and Corruption

The concept of corruption could not be understood or evaluated without first considering the context, the formal and informal rules of Chinese society. The guanxi network is assumed to have evolved as a consequence of weak and inefficient institutions thousands of years ago (Schramm & Taube, 2003). However, the concept of guanxi as the use of a personal connection to gain political favors has only gained recognition as a consequence of the economic policies introduced in 1978 (Fan, 2002; Huang & Rice, 2012). Generally, guanxi

refers to interpersonal relationships and has been quoted as an imperative factor in negotiations and successful business operations in China (Fan, 2002). Despite its nature and use, guanxi is not necessarily recognized as something 'bad' or 'harmful.' The term in itself, from a sociological perspective, is intricate, and may be defined in terms of relationships, connections, exchanges, and resources. However described, guanxi is a costly process to develop, yet it is dynamic and can provide many benefits as well as opportunities the more extensive the network (Fan, 2002). It is implicitly understood that, to maintain a long-term guanxi-network favors need to be met when requested. As such, this concept acts as one of the major forces in shaping Chinese culture, society, and business environment (Xin and Pearce, 1996).

More recently, the practice of guanxi has undergone change and is now heavily exercised by firms and government officials in business settings. It has increased to a stage that it is now by some considered cancerous to the development of the country (Fan, 2002). The changing market dynamics since the reform and opening act in the late 1970s, coupled with the insufficient legal institutions has made firms impelled to engage in corruption to stay ahead of the competition (Huang & Rice, 2012). While firms may initiate guanxi corruption, the contrary is also true, as it is also common that businesses are forced into such relationships or otherwise they might lose access to licenses and permits which in turn would impede growth and development. Nevertheless, gaining access to a guanxi networks remains essential for business pursuits in China (Huang & Rice, 2012).

3. Literature Review

3.1 Corruption and Innovation: Contradicting Effects

Despite the infamous views of corruption, the available evidence concerning the effect of corruption on firms' innovation activities has yet to reach a consensus. While both of the sanding-greasing hypotheses have been substantiated with some empirical evidence, there is still a shortage of papers emploring the relationship between corruptive behavior and firm innovation practices. Nevertheless, the available studies focusing on the influence of corruption on innovation could be divided into two groups, one dealing with country-level data, and another using firm-level data. We begin the chapter by discussing the former before moving on to the latter.

Most research conducted on an aggregated level finds corruption to have an inhibiting effect on innovation activities. In a cross-country study by DiRienzo and Das (2014) based on data from the Global innovation index, several proxies for diversity were tested in conjunction with corruption to examine their impact on innovation. The authors found evidence that corruption has an adverse effect on innovation, and that this impact is prominently observed in developing countries but less so as the level of development increases. Ethnic diversity was found to affect innovation negatively, while religious diversity was found to promote innovation. Another study based on country-level data by Rodrígues-Pose and Cataldo (2014) finds that the quality of government is correlated with innovation. Mainly, corrupted institutions are obstacles to innovation and undermine further efforts to promote innovation.

Anokhin and Schulze (2009) posit that business uncertainty, lack of institutional trust, and transaction costs of doing business severely reduces the level of innovation. To test the hypothesis that better corruption control is likely to contribute to an increase in innovation and entrepreneurship, they ran

regressions on longitudinal data covering 64 countries during a period between 1996-2002. Their findings support the notion that corruption control indeed has a positive impact on innovation.

Natário et al. (2011) make a convincing case that the control of corruption, an aspect of institutional efficiency, is positively correlated with innovation capacity. By grouping countries according to their ability to introduce product and process innovation and performing cluster analyses, the authors found that economies with greater corruption control also displayed a higher level of innovation capacity. Meanwhile, countries with less efficient institutions, lower corruption control also exhibited slight innovation capacity. Further evidence supporting the sand-the-wheels hypothesis was found in Avnimelech et al. (2011) study of 176 countries. They discovered that corruption has an inhibiting impact on innovation through the displacement of talents from productive innovation practices towards rent-seeking and lobbying activities.

The evidence, however, is not clear cut at the firm-level, as there are indications of both hypotheses at work. One paper finding evidence for the former was De Waldermar's (2012) empirical study employing Indian firm-level data from 2005. They revealed that corruption in the form of bribery was negatively correlated with product innovation, even after controlling for various robustness checks and endogeneity. In other words, corruption seems to reduce the likelihood of new product innovation by firms in India. Similarly, Paunov (2016) also employed firm-level data from the World Bank Enterprises Survey to test a similar hypothesis against 48 countries from 2007-2011. Paunov's estimations show that there is a negative association between corruption and quality certificates and that this impact is stronger for smaller firms. While corruption did not reduce the number of patents, it did negatively affect firms' investments in, for instance, machinery which is essential in the development of innovation. Habiyaremye and Raymond (2013) evaluated the involvement of multinational

firms in corruptive activities in host countries where governance is weak and corruption more rampant. Their results also confirm that transnational corruption undermines and discourages innovation efforts which hit the domestic firms the hardest. Furthermore, local firms might be forced to shut down as a consequence of foreign firms gaining an unfair advantage through corruption over the former. In the long-run, this could have dire consequences on the host country's capabilities to introduce innovation, making them less competitive in regional or global markets. Additional support was found by Ayyagari et al. (2010) who observed that corruption can have a distorting impact on innovation. Moreover, innovators in particular are more often than not victims to government predation which is very costly for firms and may deter them from pursuing innovation projects.

There has also been evidence of corruption greasing-the-wheels of innovation. Nguyen et al. (2016) employed firm-level data conducted since 2005 to evaluate the relationship between corruption and innovation. By adopting the well-cited method by Fisman and Svensson (2007) they correct for measurement biases and endogeneity by instrumenting for bribery in their model. Their results suggest that corruption is positively associated with innovation providing support for the greasing hypothesis. The authors argue that weak formal and informal institutions have prompted corruption to become the 'next best thing' for Vietnamese firms. Hence, paying bribes is one channel which firms can tap to innovate successfully. Another illustration of how corruption could facilitate innovation is presented by Goedhuys et al. (2016). The paper investigates the relationship between innovation output, corruption, and institutional obstacles faced by Egyptian and Tunisian firms. The authors find that while the perceived level of corruption may depress innovation, once corruption interacts with institutional barriers, they obtained positive estimates. Hence, implying that

corruption helps firms circumvent bureaucracy and thus, hastens the process of acquiring necessary permits and licenses required for firm innovation.

Yet another study at firm-level is Mahagaonkar's (2010), who looked into data on the African continent. One common aspect that these countries share is weak institutions and complicated bureaucratic procedures. The author posits that firms may be involved in multiple innovation activities and thus are affected differently by corruption. The paper is relatively unique in the sense that it tests several types of innovation: product-, process-, organizational-, and marketing innovation. By running a regression corrected for endogeneity on firm-level data from 2004, Mahagaonkar found corruption to be detrimental to all innovation types except for marketing innovation. He argues that by easing the process of obtaining special permits, firms can gain an advantage over competitors. Moreover, corruption can also reduce the level of uncertainty in doing business and protect against government expropriation. These findings suggest that corruption can both sand-the-wheels and grease-the-wheels simultaneously when more than one type of innovation is practiced by the firms.

Finally, more research has indicated that these effects could co-exist, where bribery is most likely harmful for the development of small firms, yet the opposite is not correct for large firms. Zhou and Peng (2012) explain that for larger firms, their choice to bribe a government official could be a business strategy, while smaller firms may have no options but to yield to corruption. Similarly, Vial Hanoteau (2010) demonstrates findings revealing both outcomes, but that the impact differs on the micro and macro-level. While firms engaging in bribery might see a short-term improvement in productivity, in the long-run corruption could distort markets which are harmful to economic growth and development.

In conclusion, while scholars seem to agree that corruption affects the degree of innovation employed by firms, no consensus has been reached on whether the effect should be considered negative or positive, although both outcomes are

possible. Thus, the objective of this thesis is to contribute by adding to this gap in the literature on the relationship between innovation and corruption by assessing the case of China using a collection of empirical data from the World Bank (2013). To narrow the scope of the study, this paper will only consider two types of innovation activities as opposed to all four compared by Mahagaonkar (2010).

4. Data and Empirical Methodology

4.1 The Data Sample

To investigate the impact of corruption on innovation activities of Chinese firms, this paper has employed survey data from 2,700 privately-owned firms (World Bank, 2013). The surveys were organized to acquire insights on firms operating in the private and public-sector in a set of longitudinal data that are comparable across countries and time. The interviews were conducted for both the manufacturing and the service industry with geographical coverage comprising twenty-five metro areas (World Bank, 2013). Since our dataset considers only the analysis of one country, severe issues such as unobserved heterogeneity across data should be significantly reduced (Fisman & Svensson, 2007).

The data was collected using a stratified random sampling method as preferred to the simple random sampling method to reduce sampling errors. By employing the stratified sampling methodology, populations are first divided into homogenous groups or strata where random samples are later drawn from each of the strata. By doing this, the population representativeness can be maintained and the estimates calculated with more precision (World Bank, 2019a). Three different stratas were used in the Enterprise Survey: firm size, industry and the location within the country. More specifically, the survey covers small, medium and large firms and 28 sectors including manufacturing, retail and service

industries. Details on the innovation outcomes are discussed in chapter 4.5 descriptive statistics.

The response rate for the survey was 13.8 percent, which is the percentage of businesses contacted per successful interview. The seemingly high number is a consequence of two things, firstly, the refusal to participate both in the screener and the primary survey and secondly, the weak sample frame. To tackle the issue of "non-responsiveness," the World Bank (2013) adopted two methods. For questions of "sensitive" nature, such as informal payments, the census takers were trained to collect the rejections or non-participation as options other than "don't know." Where data is incomplete, firms were contacted again at a later date for completion, when and if necessary. The World Bank employed the most considerable efforts to contact businesses that were initially eligible and chosen for the survey. Replacement firms were only approached after repeated attempts to interview were rejected (World Bank, 2013).

4.2 Dependent Variables

By adapting the OECD Oslo Manual (2005) guidelines on data collection and interpretation, this paper measures firm innovation by using proxies for new product and process innovation. Both are computed as '1' if firms have engaged in the activity and '0' if otherwise. Due to the nature of our dependent variable, binary choice models are preferred to the OLS method, which follows the methods of previous literature that models innovation using binary specifications (Fisman & Svensson, 2007; Nguyen et al. (2016); De Waldemar (2012).

TABLE 1
Dependent Variables and Definitions

Variable name	Definition
Product Innovation	Introduction of new product or services in the firm
Process Innovation	Introduction of new technology for process improvements

Note: All variables are binary, unless otherwise stated.

4.3 Independent Variables

Following the previous methodology conducted by Fisman and Svensson (2007), Mahagaonkar (2010), and De Waldemar (2012) our paper will rely on an indirectly phrased question about informal payments as our variable of interest to measure corruption. The managers of the firm were first asked if "establishments are sometimes required to make gifts or informal payments to public officials to get things done with regard to customs, taxes, licenses, regulations, services, etc." (World Bank, 2013, p.32). If there are payments, "on average, what percentage of total annual sales, or estimated total annual value, do establishments like this one pay in informal payments or gifts to public officials for this purpose?" (World Bank, 2013, p.32) which is similar to the question modeled by Fisman and Svensson (2007) in their paper.

4.4 Control Variables

Following the initial definition of innovation by Schumpeter, an increasing body of literature has studied the characteristics of firms and their impact on innovation activities. Several of those studies found determinants such as firm size, competition, and financing to have an impact on innovation outputs. As more empirical work on innovation was undertaken, additional firm characteristics such as worker skills and management expertise were also included. However, since the focus of the study and the variable of interest is corruption, only a few stylized variables were taken into consideration, combined from various strands of literature. The following variables taken from literature includes; firm size (Stock et al., 2002), firm age (Hansen, 1992; Coad, Segarra & Teruel, 2016), ownership (Gao et al., 2010; Chen et al., 2014; Xu et al., 2017), foreign investment and exporting activities (Lederman, 2010), financial

constraints (Carpenter & Petersen, 2002; Savignac, 2008), human capital and management expertise (Toner, 2011; Junge et al., 2012; Balsmeier & Czarnitzki, 2014; Diebolt & Hippe, 2019; Lederman, 2010) and regions (Démurger et al., 2002).

Firm size – The size of the firm and its impact on innovation activities have been a subjects of vigorous scholarly debate (Hansen, 1992; Stock et al., 2012). The Schumpeterian hypothesis claims that bigger firms are more innovative due to their ability to generate costs advantages in research and development activities. Accumulation of knowledge and competences also require fewer efforts for larger firms, and they are more likely to procure and adopt new technology that has yet to be fully exploited in the market. R&D diversification into multiple projects will also allow larger companies to increase their returns where resources are pooled while reducing exposure to particular projects. There are, however, arguments that smaller firms may be better at innovating. It is suggested that smaller firms, due to being perceived as more flexible, more seamlessly adjust to new market conditions (Stock et al., 2012). In this thesis, firm size refers to the number of full-time employees employed in the company and will be normalized using logarithm.

Firm age – The available empirical evidence shows that firm age could have opposing effects on innovation. Older firms can suffer from obsolescence, as the research activities that they undertake may not satisfy the current demands of the industry. Moreover, Coad et al. (2016) also found evidence that younger firms are more likely to take risks. Hence they often commit to significantly riskier projects, which suggests that firm age is inversely correlated with innovation (Huergo & Jaumandreu, 2004; Coad et al., 2016). In this thesis, firm age refers to the length of a firm in operation, derived from the year in which a firm began its operations. Firm age is measured by taking the logarithm of the numbers of years since a firm has started operating.

Ownership – firms operating in China can face some severe problems due to market distortions and weak formal institutions. Moreover, due to the government having absolute control over vital resources needed for production, this could have a severe curbing effect on firm innovation. Thus, firms that are closely connected with the local government could through their relationship have access to essential resources such as raw material, financing, and projects which are all crucial to innovation (Chen et al., 2014). On the other hand, firms with stronger ties to the government seem to be more inefficient at introducing innovations due to soft-budget constraints (Li et al., 2014). This effect seems to be greater for firms operating in an environment with stronger intellectual property rights (Fang et al., 2017). Hence, controlling for government participation is essential for this thesis. The variable is organized by employing dummy variables, with major state-ownership coded '1', and '0' otherwise. Here state-ownership refers to the shares held by the government or state, where SOEs are firms in which the state holds a significant participation rate (50% or more).

Foreign technology and exporting activities – Yet another body of literature considers technology diffusion an important input in a firm's innovation practices. In general, it is assumed that access to imports of licensed foreign technology and exporting activities seem to have an impact on firms' propensity to innovate, which supports the global engagement hypothesis (Lederman, 2010). The variables exports and investment in new equipment are coded '1' if the firm is engaged in both activities, and '0' if they are not. Moreover, the use of ICT is also included in the regressions as it is a part of a firms technological competences and thus, important in the development of new product and processes (Goedhuys & Veugelers, 2012). The ICT variables are organized as the firm's access to the website and email and coded '1' for when there is access, and '0' when these technologies are not employed.

Financial constraints – Research has shown that firms that are credit constrained tend to reduce innovation outputs significantly due to the difficulty in raising capital and external investments. This effect seems to hold true both for established- and new firms (Savignac, 2008). Due to the importance of finance for firms' innovation activities, a variable will be created reporting whether the firm has access to a credit line or a loan, or not (Ayyagari et al., 2011; De Waldermar, 2012). The variable financial constraints are computed as '0' for when there is no access, and '1' for firms that have a credit line.

Human capital – Human capital – research has shown that a higher level of human capital is positively correlated with innovation output (Toner, 2011; Junge, 2012; Diebolt & Hippe, 2019). Rapid technological changes and improvements mean that firms need a qualified workforce that can absorb, adapt, and implement new technology quickly. It is more likely the case if workers' have a higher education or are more skilled since innovation output requires a certain level of technical competence and other productive skills. Thus, the expectation that workers skills' should have a favorable implication on firms' innovation practices and productivity (Toner, 2011). In this thesis, the years of schooling of a permanent employee was used as a proxy for human capital. My categorization is based on De Waldermar (2012) and Krastanova (2014) and computes for employees with higher education. This thesis uses an additional proxy for human capital by considering formal training programs for permanent-employed workers following De Waldermar (2012).

Management expertise – As decision-makers, top-managers have the ability to influence the firm's likelihood and ability to innovate. It is also assumed that experienced managers are more insightful in the business environment and know how to maneuver between opportunities and external threats. Balsmeier and Czarnitzki (2014) provide evidence of a positive association between the manager's experience and the probability of firms introducing new product

innovation. Management expertise refers to the number of years that the manager has spent in the sector.

Coastal – regional disparities between the inland and coastal provinces has been a characteristic of the Chinese economy since 1978. Although the growth of the coastal areas is most commonly connected to the central government's preferential treatment program, research has also suggested that the geographical location may well contribute to the gap the same. The initial preferential treatments have in fact allowed those regions to have a first-mover advantage in terms of economic liberties (Démurger et al., 2002). Many of the policies and functions of these designated areas have been devised to encourage and facilitate the process of technology development and innovation in numerous industries (World Bank, 2019b, p.1). Thus, the need to control for coastal provinces in our case. Coastal is a binary variable generated based on the regions where each firm is located. Coastal is coded '1' for firm's that are located in an open coastal city (OCC), and '0' for those that are not.

Industry – According to Barbosa et al. (2013), industry dynamics are highly relevant and significant in shaping the firm's innovation activities. Moreover, due to a combination of factors such as industry maturity, entry rate, competition, and technology, each sector dynamics and innovation level is expected to be different. Thus, the need to control them in the model. Duvanova (2014) argues that the level of sector bribery is likely to vary across sectors, where the more profitable ones may also engage in corruption of a greater magnitude.

To summarize, the following control variables were considered in the model: R&D, firm size, age, ownership status, foreign technology and exporting activities, ICTs, financial access, human capital proxies, region and industry.

4.5 Summary Statistics

The thesis relies on a dataset containing 2700 observations from the World Bank (2013); however, due to incomplete data for a few variables of interest, only 1069 firms are included in the estimations. A careful inspection shows that the dataset is suffering from missing values. Thus, the thesis follows the common approach known as listwise deletion to deal with missing values for statistical analysis (Kang, 2013). Moreover, since the thesis is interested in the relationship between innovation and bribery, observations under the category of 'Don't know' will be excluded for the dataset.

All variables in the study are binary unless otherwise stated. Two control variables, firm size, and age, however, are constructed as continuous variables as logs. Table 1 and 2 present the name and definition of the dependent and explanatory variables, while table 3 shows a summary of the variables discussed previously. On average, around 47% of the firms have engaged in new product innovation, while 57% have introduced new process innovation. Out of all the participants that have responded to the question regarding informal payments, about 4.3% of these firms have made informal payments, with the mean bribes in the percentage of sales reaching 0.21%. The trend of innovation outcomes follows that larger firms are more likely to innovate compared to smaller or medium-sized firms. Out of all the small firms in the sample, 30% have reported new product and 38% new process innovation, while for larger firms, this percentage is considerably higher at 53% for product and 63% for process innovation. With regards to sectoral innovation, the survey data shows that the chemicals, transport machines, and electronics industries reported the highest mean percentage for both new product and process innovation. However, the basic metal industry also demonstrates a high level of process innovation, as illustrated in Fig 4 and 5.

The average time spent on regulations is 14%. Moreover, 37% of the firms have allocated funds to R&D during the last three years, while 20% are currently using licensed technology from foreign-owned firms and 57% of the firms have purchased new equipment and machinery. Concerning exporting activities, 30% of the firms are engaged in either or both indirect- and direct exporting activities, and 70% of the establishments having quality licenses that are recognized internationally. In terms of human capital, 86% of the firms participating in the survey report that they offer training courses for permanent staff, in general firm's observe 3% of their permanent employees having a college or university degree, with the mean top manager experience reaching about 17 years in each sector. Finally, regarding ICT, 90% are using emails to interact with clients and suppliers, and while 75% of the firms have a website.

Since the primary variable of interest is bribery, it is revelant to consider and to analyze how the bribe payments are distributed among regions and industries in China. Fig 2 and 3 display the mean bribes in the percentage of sales first by sector and then by region. When observing the level of bribery, industries with the highest mean bribery are the furniture sector, followed by basic metals, textiles, and non-metallic mineral products. These findings are not too surprising considering the state's control over strategic industries, and China's problem with distorted prices for essential inputs, allowing for rent-seeking activities and misuse to spawn in crucial sectors such as energy, land, capital, and labor (Nee & Opper, 2012; Huang, 2012).

It is observed that Foshan and Jinan are by far the locations with the highest level of bribery in China, followed by Shijiazhuang and Shenzhen city. Despite being the region that is most afflicted by corruption, Foshan displays a high level of new product innovation. Similarly, Jinan maintains a high level of innovation while also engaging in a more corruptive behavior compared to the other regions. On the contrary, Shijiazhuang shows a high level of corruption despite falling

short in the introduction of new products. Likewise, there is a higher degree of corruption in Shanghai, yet the level of process innovation is low. Thus, the graphs below and the tables A1 and A2 in the appendix suggest no apparent association between regional innovations and bribery.

TABLE 2

Explanatory Variables and Definitions

Variable name	Definition
License	Licensed technology from foreign-owned firms
R&D	Firm's investment in R&D
Equipment	New equipment and machinery purchased the previous year
Firm age (log)	Age in years
Firm size (log)	Number of permanent staff
Ownership	If state-ownership exceeds 50%
Export	Firm's engagement in exporting activities
Finance	If firms have access to credit or loan
Training	Formal training programs for permanent employees
Education	If workforce has a tertiary education
Top Manager	Top manager experience in sector
Certification	International certification
Website	Firm's use of own website
Email	Email for interacting with clients and suppliers
Coastal	If firm is located in a coastal city/province

Note: All variables are binary, unless otherwise stated.

TABLE 3

Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
Product	1069	.473	.5	0	1
Process	1069	.569	.495	0	1
Bribery	1069	.207	1.45	0	25
Regulation	1069	1.014	2.483	0	35
License	1069	.198	.399	0	1
R&D	1069	.37	.483	0	1
Equipment	1069	.513	.5	0	1
Firm age (log)	1069	2.931	.327	1.946	4.883
Firm size (log)	1069	4.367	1.281	1.609	10.31
Ownership	1069	.055	.228	0	1
Export	1069	.297	.457	0	1
Finance	1069	.299	.458	0	1
Training	1069	.862	.345	0	1
Education	1069	.028	.165	0	1
Top Manager	1069	16.981	7.697	1	47
Certification	1069	.717	.45	0	1
Website	1069	.746	.435	0	1
Email	1069	.898	.303	0	1
Coastal	1069	.387	.487	0	1

FIG 1. MEAN BRIBERY BY SECTOR

Source: World Bank (2013) and author's own calculations.

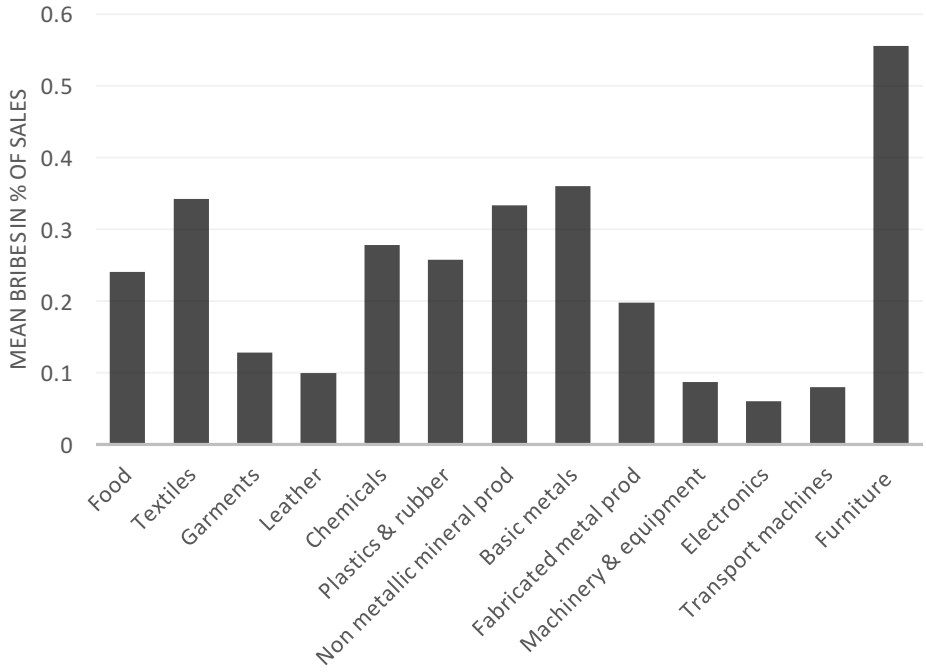


FIG 2. MEAN BRIBERY BY LOCATION

Source: World Bank (2013) and author's own calculations.

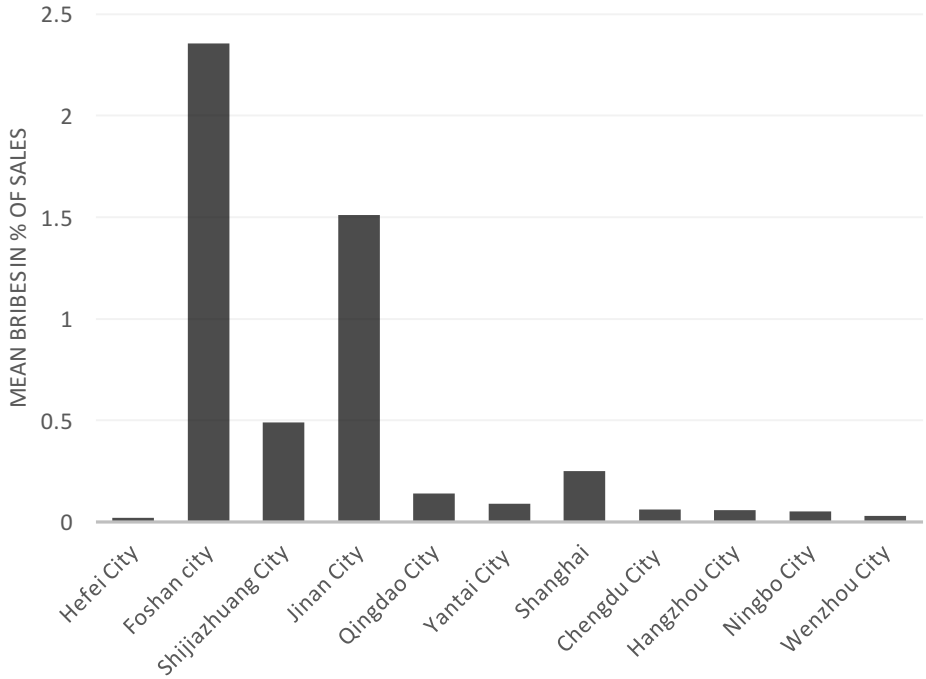


FIG 3. MEAN PRODUCT INNOVATION BY SECTOR

Source: World Bank (2013) and author's own calculations.

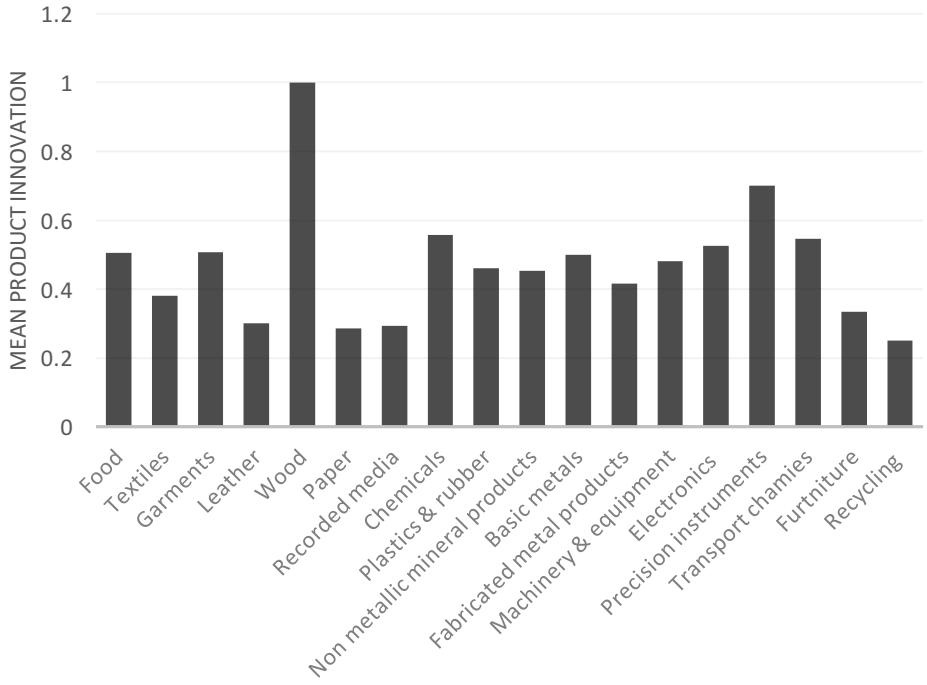
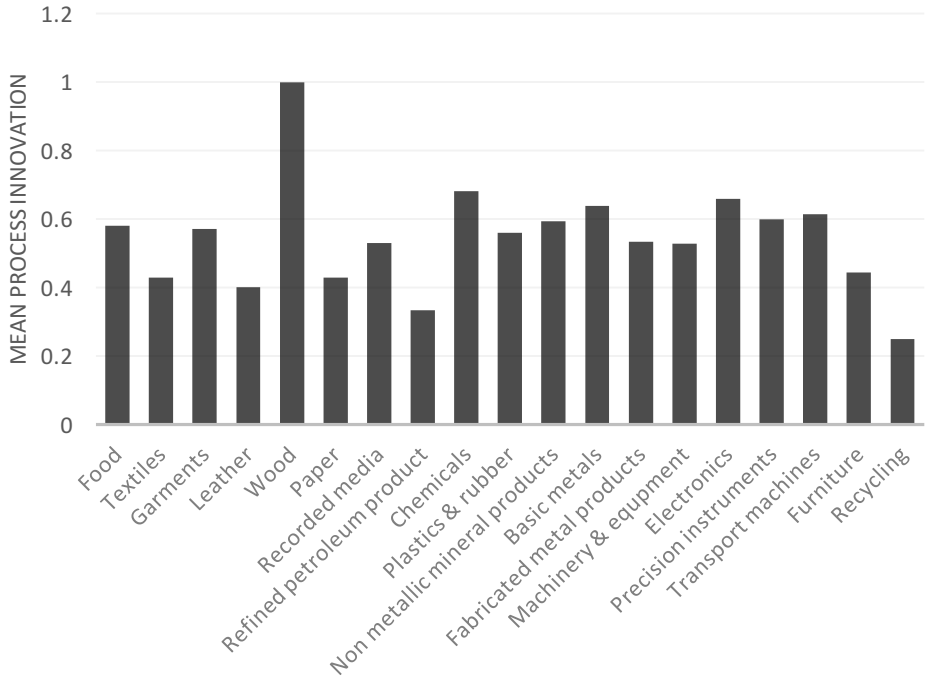


FIG 4. MEAN PROCESS INNOVATION BY SECTOR

Source: World Bank (2013) and author's own calculations.



4.6 Analytical Specification

Since the dependent variable in the model is binary, this thesis will no longer use ordinary least squares (OLS) or a linear regression model as they are inappropriate in our case (Verbeek, 2017, p.216). Instead, the model will consider a linear probability model as an alternative. The regression is expressed as follows:

$$INNOVATION_i = \beta_0 + \beta_1 Bribery_{ij} + \beta_3 FC_{ij} + \eta_{ij} + \varepsilon_{ij} \quad (1)$$

where *INNOVATION* refers to the new product or process innovation in the firm *i*. $Bribery_{ij}$ is the explanatory variable and β_1 captures the impact of corruption on innovation. FC_{ij}, refers to a set of controls comprised of determinants of product innovation and firm characteristics and η_{ij} denotes sector and industry dummies. ε_{ij} stands for the classical error term. The subscript i and j read as firm i in sector j.

4.7 Estimation Strategy

Since the initial work of Fisman and Svensson (2007), several studies have followed in their footsteps to evaluate the problems associated with the assessment of the relationship between corruption and innovation. There are mainly three econometric issues to consider: (1) measurement errors, (2) selection bias from the responses, and (3) endogeneity.

Firstly, there is the assumption that bureaucrats can tailor their bribe extraction according to the firm's capacity and inclination to pay. In such a situation, two firms in the same industry will have a different payment trajectory. This process is limited to 1) the chances that the firm might leave the industry because the payment is too high, or 2) the chances of the bureaucrat being apprehended by the law. A firm's capacity depends heavily on its performances

and ability to introduce new products to the market. Thus, given this setup, innovative firms with higher profit margins are most likely expected to pay more just because they can.

Secondly, endogeneity can be an issue if firms instead choose to specialize in rent-seeking as a way to improve productivity and increase their innovation capacity. For instance, some may actively seek to devote their resources to corrupt behavior, while other would rather use their assets to innovate instead. In environments with high bureaucratic hurdles, inefficiencies and unjustified delays that make it difficult to access public goods, there is the assumption that firms needing licenses and permits to innovate may be willing to bribe more to outperform other firms.

The problems mentioned suggest that there are unobservable firm-specific characteristics that may affect both corruption and innovation. According to Fisman and Svensson (2007), these problems could be mitigated using an instrumental variable. They propose to decompose $Bribery_{ij}$ into two terms, one that is industry-specific, while the other is firm-specific. For the thesis purpose, the instrument has been improved from the literature, as follows:

$$Bribery_{ij} = B_{ij} + B_j \qquad (2)$$

Where B_{ij} refers to the firm-specific component, while B_j represents the average amount of bribes common for all firms. B_j is constructed by calculating the average bribes for firms in sector k, excluding firm i. Similarly, the average bribery for firms in location j is calculated, again excluding firm i. Consequently, making B_j exogenous to $Bribery_{ij}$. Thus, B_j captures the intrinsic characteristics that are integral to that specific industry and location. Assuming that B_j (industry and sector-specific) is dictated by the "underlying technologies" and the disposition and ability of bureaucrats to extract rent, this element is presumed to be exogenous to the firm, and not correlated with the unobservable firm-

specific factors. Moreover, rent extraction is also anticipated to vary across locations since some bureaucrats are expected to be more skilled than others (Fisman & Svensson, 2007, p.67). Another issue that the method proposed by Fisman and Svensson (2007) will address is the issue of measurement errors that is a serious problem when dealing with corruption due to its sensitive nature. The conventional technique is again grouped averages, which Fisman and Svensson (2007) propose, and this thesis will adopt. In the case of China, sector and location bribe averages, excluding firm i is used as instruments, which yields the following model:

$$INNOVATION_i = \beta_0 + \beta_1 Brsector_i^{IV} + \beta_2 Brlocation_i^{IV} + \beta_3 FC_{ij} + \eta_{ij} + \varepsilon_{ij} \quad (3)$$

where $Brsector_i^{IV}$ and $Brlocation_i^{IV}$ are fitted values from the first-stage regressions, regressed against bribery, sector and location average (instruments), and our control variables. The first-stage regression is given by:

$$BRIBERY_I = \beta_0 + \beta_1 Brsector_i^{IV} + \beta_2 Brlocation_i^{IV} + \beta_3 FC_{ij} + \varepsilon_{ij} \quad (4)$$

5. Analysis

TABLE 4
Matrix of correlations

Variables	(1)	(2)	(3)	(4)
(1) newprod	1.000			
(2) process	.5720	1.000		
(3) bribery	.0729	.0916	1.000	
(4) redtape	.0867	.1229	.0738	1.000

The analysis is commenced by evaluating if there is any correlation between the variables. The matrix above suggests that there is a weak association between the predictor and outcome variables, with slight improvement when the relationship between the process innovation and other variables are considered. Overall, the correlation matrix indicates that there is not a linear association. However, to study the cause and effect of the relationship between our variables, a linear probability model (LPM) analysis will be considered. A few diagnostic tests were also performed, where the variance inflation factors were computed for the regressions. The results obtained were satisfactory and below the tolerance level. Moreover, the model also corrects for heteroscedasticity by including robust standard errors in all the estimations.

Two new variables were introduced to instruments for corruption using the two-stage least square method mentioned in the previous chapter, to address the problems of endogeneity. In the first stage, the predictor variable 'bribery' is regressed against **both** sector and region averages as instruments for corruption (coded sectorIV and locationIV) and the control variables. The primary variables of interest in the first stage are the two instrument, sectorIV, and locationIV. The result shows that there is a robust association between 'bribery' and the instrumental variables. Moreover, the test for the relevance of the instruments performed using a simple F-test for joint significance shows that both the p-

values of the first-stage and F-tests are significant, implying that the two instruments are not weak. The second stage follows with the fitted values from the first regression used as instruments for 'bribery.'

5.2 Main results

The analysis begins with LPM estimations as a benchmark without accounting for selection bias, measurement errors, and endogeneity problems. The estimates and p-values for the two predictor variables are reported in Table 5 and 6, column 1. The analysis suggests that having a *license, investing in R&D, new equipment, and exporting activities* increases the firm's propensity to product innovate. For process innovation, the firm characteristics: *license, R&D, and equipment* are statistically significant and positive. *Training* is positively correlated with product innovation; however, it seems not to be significant for process innovation. ICT variables, including *email*, are significant for process innovation, while the variable *website* is statistically significant in the case of product innovation. The results show that the *ownership structure* is important for the two predictor variables. In this case, the observed effect is negative, which can be interpreted as: private firms with major state-participation are less inclined to introduce new products and process innovation. Although evidence in the literature has been conflicting so far, studies have shown that state-controlled firms tend to be more inefficient due to soft-budget constraints (Li et al., 2014). Across both the benchmark estimations, bribery appears to be both positive and significant for product and process innovation, suggesting that greasing is prevalent. These findings conforms to previous research, where corruption were found to grease-the-wheel of innovation, thus, implying that circumventing bureaucratic delays and unnecessary procedures could increase a firm's likelihood to innovate.

To address the potential problems of selection biases, measurement errors and endogeneity, both sector and region averages has been used as instruments for bribery, simultaneously. The results of the estimates for both predictor variables are listed in Table 5 and Table 6, column 2, respectively. There are some slight changes in the explanatory power of the variables: *license, R&D, equipment, export, and website*, although they remain positive and highly significant for product innovation.

Once the instrument variables were included, the control variable *training* increases in statistical significance, while *education* has now also gained significance for product innovation. The result from our IV-estimation provides support for the hypothesis that corruption in the form of *bribery* impacts innovation activities (new products and processes) positively. Specifically, the coefficient of bribery is 0.146 and 0.113 significant to 1%. The interpretation is the following: a one-unit increase in bribes is predicted to increase the probability of new product and process innovation being introduced by 0.146 and 0.113, correspondingly.

5.3 Robustness

This thesis has, to test the robustness of the model, experimented with alternative specifications, including potential explanatory variables such as the measures of competition in column 3. Firms subjected to competition are expected to reduce their likelihood to engage in new product innovation or processes. Following the theory on the relationship between competition and innovation, in sectors that are dominated by "laggard" enterprises, market competition is predicted to have a discouraging effect on the firms' inclination to innovate (Aghion et al., 2005). A variable measuring the time spent on bureaucracy and regulations were also included as additional controls to our IV-specification. The variable has been adopted from Svensson (2003), where they

found that firms that deal extensively with administrative tasks of regulatory nature are more inclined to pay bribes. However, including the variable into our equation has not dramatically affected the relationship between corruption (bribery) and product and process innovation. While the extent of regulation came out insignificant, for new product innovation, the positive coefficients suggest that regulation is positively associated with innovation in both cases. As bureaucracy act as a significant constraint to innovation, it is reasonable to assume that in order to obtain permits, senior management would have to spend more time dealing with a representative of the state (Ayyagari, 2010). Finally, we also included both location and sector dummies in our regression with the result listed in column 4. The coastal dummy was found to have a negative and significant effect on both product and process innovation which confounds the interpretation.

TABLE 5

LPM Estimations: Product Innovation

Dependent: Product	(1)	(2)	(3)	(4)	(5)
Method:	LPM	IV LPM 1	IV LPM 2	IV LPM 3	IV LPM 4
Bribery	0.029**	0.146***	0.150***	0.149***	0.044**
	(0.012)	(0.037)	(0.038)	(0.038)	(0.018)
License	0.248***	0.256***	0.253***	0.252***	0.232***
	(0.036)	(0.037)	(0.039)	(0.039)	(0.038)
R&D	0.275***	0.264***	0.234***	0.232***	0.261***
	(0.033)	(0.034)	(0.037)	(0.037)	(0.034)
Equipment	0.083***	0.061*	0.058	0.055	0.058*
	(0.030)	(0.033)	(0.036)	(0.036)	(0.032)
Firm age (log)	0.027	0.028	0.028	0.029	0.032
	(0.045)	(0.046)	(0.048)	(0.048)	(0.046)
Firm size (log)	0.001	0.006	0.009	0.010	0.006
	(0.012)	(0.012)	(0.013)	(0.013)	(0.012)
Ownership	-0.202***	-0.220***	-0.268***	-0.267***	-0.251***
	(0.049)	(0.055)	(0.056)	(0.056)	(0.049)
Export	0.068**	0.066**	0.031	0.029	0.044
	(0.032)	(0.033)	(0.036)	(0.036)	(0.035)
Finance	0.036	0.025	0.011	0.009	0.006
	(0.032)	(0.035)	(0.036)	(0.036)	(0.034)
Training	0.096**	0.128***	0.108**	0.106**	0.065
	(0.040)	(0.049)	(0.051)	(0.051)	(0.041)
Education	0.132*	0.161**	0.157*	0.156*	0.175*
	(0.075)	(0.074)	(0.092)	(0.091)	(0.090)
Manager	-0.000	0.001	0.000	0.000	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Certification	-0.017	-0.017	-0.038	-0.038	-0.046
	(0.035)	(0.039)	(0.042)	(0.041)	(0.036)
Website	0.096***	0.116***	0.190***	0.189***	0.180***
	(0.036)	(0.039)	(0.043)	(0.044)	(0.038)
Email	0.059	0.064	0.069	0.069	0.036
	(0.044)	(0.048)	(0.050)	(0.050)	(0.045)
Competition			-0.079**	-0.080**	-0.091***
			(0.036)	(0.036)	(0.035)
Regulation				0.005	0.008
				(0.005)	(0.005)
Coastal					-0.137***
					(0.029)
Observations	1,069	1,069	948	948	948
R-squared	0.244	0.130	0.143	0.145	0.287
Industry Dummies	NO	NO	NO	NO	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Instruments: IVsector, IVlocation

.

TABLE 6

LPM Estimations: Process Innovation

Dependent: Process	(1)	(2)	(3)	(4)	(5)
Method	LPM	IV LPM 1	IV LPM 2	IV LPM 3	IV LPM 4
Bribery	0.033***	0.113***	0.114***	0.113***	0.041***
	(0.005)	(0.032)	(0.032)	(0.032)	(0.011)
License	0.213***	0.219***	0.210***	0.206***	0.183***
	(0.033)	(0.034)	(0.035)	(0.035)	(0.035)
R&D	0.281***	0.274***	0.256***	0.252***	0.272***
	(0.031)	(0.032)	(0.034)	(0.034)	(0.033)
Equipment	0.153***	0.138***	0.133***	0.126***	0.128***
	(0.030)	(0.032)	(0.033)	(0.033)	(0.032)
Firm age (log)	0.061	0.061	0.058	0.061	0.052
	(0.044)	(0.044)	(0.045)	(0.045)	(0.045)
Firm size (log)	-0.002	0.002	0.006	0.007	0.005
	(0.011)	(0.011)	(0.012)	(0.012)	(0.012)
Ownership	-0.234***	-0.246***	-0.289***	-0.287***	-0.276***
	(0.052)	(0.052)	(0.054)	(0.053)	(0.051)
Export	0.019	0.018	-0.005	-0.010	0.008
	(0.030)	(0.031)	(0.033)	(0.033)	(0.034)
Finance	-0.024	-0.031	-0.041	-0.045	-0.045
	(0.031)	(0.032)	(0.034)	(0.034)	(0.033)
Training	0.067	0.090*	0.082*	0.078	0.038
	(0.044)	(0.047)	(0.048)	(0.048)	(0.044)
Education	0.006	0.025	0.048	0.046	0.058
	(0.071)	(0.070)	(0.073)	(0.073)	(0.080)
Manager	-0.002	-0.001	-0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Certification	0.039	0.039	0.038	0.040	0.035
	(0.036)	(0.037)	(0.039)	(0.039)	(0.037)
Website	0.048	0.062	0.127***	0.125***	0.119***
	(0.037)	(0.038)	(0.043)	(0.043)	(0.041)
Email	0.126***	0.129***	0.118**	0.117**	0.104**
	(0.049)	(0.050)	(0.052)	(0.052)	(0.050)
Competition			-0.061*	-0.062*	-0.062*
			(0.034)	(0.034)	(0.034)
Regulation				0.013**	0.015**
				(0.006)	(0.007)
Coastal					-0.099***
					(0.029)
Observations	1,069	1,069	948	948	948
R-squared	0.243	0.189	0.216	0.221	0.289
Industry dummies	NO	NO	NO	NO	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Instruments: IVsector, IVlocation

6. Discussion

One of the main discoveries of the thesis is that bribery has a positive impact on innovation activities, in particular, when it comes to new product and process innovation. Although the findings may seem controversial to the traditional economic theory that argues that corruption is harmful to innovation, it does provide support for the grease-the-wheel hypothesis previously discussed.

One channel in which we could interpret the results is to argue that the costs of engaging in corruption may be considered insignificant if firms are able to introduce new products and process innovation successfully. Corruption could then in the short-run impact the decision-making process of the firm as it is comparable to a business transaction. Moreover, bribes of low value may be viewed as grease to facilitate innovations, and not necessarily harmful corruption (Nguyen et al., 2016). Suggesting that bribery could decrease the transaction costs related to innovation activities by helping firms overcome bureaucratic hurdles. Where there is a prominent bureaucracy, bribery could create a strong incentive for officials to reduce the time-lag between the application and the procurement of a permit or license. Thus, the act of corruption may not uncommonly come in the form of speed money (Xu and Yano, 2017).

In the context of China, a transitional economy of unbalanced reforms with weak formal institutions, lacking both formal legal and regulatory systems, the incentives and opportunity to participate in corrupt practices has also multiplied. This discernment is not incorrect as there is evidence of corruption having a positive impact on economies with poor institutions and weak governance (Nguyen et al., 2016; Mahagaonkar, 2010; Krammer, 2014). Moreover, particular to the Chinese culture, the act of guanxi is increasingly seen as an important business strategy to operate and stay ahead of the competition (Huang & Rice, 2012). Guanxi may be perceived as corruption to grease-the-wheels of innovation.

The thesis finds corruption to have a positive implication on innovation, where a one-unit increase in bribes is predicted to increase the probability of new product and process innovation being introduced by 0.146 and 0.113, respectively. Furthermore, time spent on government regulations also appears to affect both innovation types positively, although it came out insignificant. Nevertheless, literature seems to suggest that Chinese firms spend a considerate amount of time dealing with bureaucracy to obtain licenses (Li et al., 2006).

It is important, however, to emphasize that corruption may not have a positive impact on innovation in the long-run. Moreover, the subsequent pursuit of political connection may come with unknown expenses or be detrimental to a firm's capabilities and growth in the long-run (Nguyen et al., 2016).

Relevant policy implications to the issues above imply that the Chinese government needs a series of institutional reforms with good enforcement to reduce the incentives of both officials and firms to engage in corruption. These reforms should include an increase in the quality of governance, and a decrease in the governments influence over the distribution of resources by relying more on free-market forces. Moreover, efforts to develop a more effectual legal system to ensure that the property rights are upheld and red tape reduced are also very important considerations (Xu and Yano, 2017). Given that the reward structure in the society dictate whether talented individuals will pursue innovation or rent-seeking activities, it is essential for the government to reallocating the entrepreneurial efforts towards more innovative activities (Baumol, 1996). However, these reforms are difficult to perform and would require an extensive amount of time to implement due to the conflict of interest of the ruling class. A final proposition that is highly appropriate in the case of China relates to the issue of credit constraints of civil servants and government sanctions (Quah, 2006). When salaries are low, the incentives to extract bribes are higher; thus, by extension, an increase in wages should have a positive impact on corruption.

While China is not lacking in laws against corruption, however, the execution could be considerate ineffectual as less than 3-percent are put in prison (Pei, 2007).

7. Conclusion

The importance of innovation has been widely discussed in the literature, yet corruption as a determinant of innovation has received limited attention in comparison. While it is commonly held that corruption is detrimental and should be avoided, others argue that corruption could facilitate innovation by decreasing the bureaucratic burden, especially in economies with weak institutions and poor governance. Drawing upon the contrasting hypotheses that have developed out of scholarly attempts to measure and assess the effects of corruption on innovation practices, this thesis aimed to answer the question: what is the impact of corruption (bribery) on innovation activities (new products and processes) in Chinese firms?

This study used a cross-sectoral variation of the World Bank Enterprise Survey (2013) dataset to investigate how bribery defined as a form of corruption, impacts innovation activities (new products and processes) of Chinese firms. The results implies that bribery encourages the introduction of new product and process innovation, supporting the grease-the-wheel hypothesis that corruption facilitates innovation by decreasing the transaction costs related to these activities. Bribery may assist firms in overcoming bureaucratic hurdles, and function as speed and protection money. The thesis also found time spent on government regulations also to have a positive impact on innovation, although the results came out insignificant. Nevertheless, it seems that spending more time dealing with government officials lead to higher innovation output.

Some of the limitations with this thesis is due to the constraint of the data in both size and scope. Where data could be traced over time, we could study

the long-term effect of corruption on innovation activities. Moreover, a larger sample would also increase the confidence in our estimations. Missing values due to data sensitivity may also be yet another limitation in our case. Since the study is only preliminary, there is promising room for future research. For instance, to look into the link between corruption, innovation, and growth.

Future research recommendations:

Future research can look into the relationship between bribery and other forms of innovation, for instance orgnizational and marketing innovation as few researchers have done previously. Moreover, research may also look into different forms or levels of corruption, and study its impact on the firms ability to innovate. While most research had advised to keep away from corruption, however, there has been some evidence of corruption having a positive impact on innovation – much like this study. Thus, this thesis recommend that further studies look into this aspect of corruption with a new or different set of data, such as the investment climate survey, were it is possible to compute a different set of corruption variables. By considering the impact of corruption, not only the negative, but also the positive ones, valuable information can be attained.

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9. Appendix

TABLE A1

Product Innovation by Region

Source: World Bank (2013) and author's own calculations.

Variable name	0	1	Total
Hefei	21	27	48
Beijing	12	9	21
Guangzhou	0	25	25
Shenzhen	11	42	53
Foshan	9	36	45
Dongguan	40	17	57
Shijiazhuang	28	20	48
Tangshan	30	17	47
Zhengzhou	5	36	41
Louyang	6	25	31
Wuhan	9	32	41
Nanjing	25	10	35
Wuxi	28	16	44
Suzhou	46	24	70
Nantong	39	10	49
Shenyang	30	21	51
Dalian	24	27	51
Jinan	13	32	45
Qingdao	46	4	50
Yantai	53	15	68
Shanghai	3	5	8
Chengdu	14	19	33
Hangzhou	8	12	20
Ningbo	36	20	56
Wenzhou	27	5	32
Total	563	506	1069

TABLE A2

Process Innovation by Region

Source: World Bank (2013) and author's own calculations.

Variable name	0	1	Total
Hefei	21	27	48
Beijing	10	11	21
Guangzhou	0	25	25
Shenzhen	6	47	53
Foshan	11	34	45
Dongguan	38	19	57
Shijiazhuang	18	30	48
Tangshan	24	23	47
Zhengzhou	2	39	41
Louyang	2	29	31
Wuhan	4	37	41
Nanjing	14	21	35
Wuxi	24	37	44
Suzhou	35	35	70
Nantong	26	23	49
Shenyang	32	19	51
Dalian	19	32	51
Jinan	6	39	45
Qingdao	46	4	50
Yantai	41	27	68
Shanghai	4	4	8
Chengdu	17	16	33
Hangzhou	5	15	20
Ningbo	41	15	56
Wenzhou	15	17	32
Total	461	608	1069

TABLE A3

Product Innovation by Size

Source: World Bank (2013) and author's own calculations.

Product	Small	Medium	Large	Total
0	100	245	218	563
1	43	211	252	506
Total	143	456	470	1069

TABLE A4

Process Innovation by Size

Source: World Bank (2013) and author's own calculations.

Product	Small	Medium	Large	Total
0	88	202	171	461
1	55	254	299	608
Total	143	456	470	1069