The Impact of Corruption Perception on Corporate Innovation under Intellectual Property Rights Risk *

Yuou Wu †
Georgetown University

April 2019

Abstract

This paper studies the effect of perception of corruption on innovation and how it varies given intellectual property rights (IPR) risk. I incorporate two main discussions from the literature, the "sand in the wheel" theory and the "grease the wheel" theory, and study the effect of competition on innovation in the context of corruption. Theoretically, I show corruption may promote or discourage innovations depending on the difference between the real and the standard patent costs and a firm's bargaining power. In both cases, IPR risk makes firms less sensitive to the impact of corruption, potentially because IPR risk reduces a bureaucrat's value of service. Using World Bank Enterprise Survey data, with an instrumental variable approach, I show that empirical evidence supports the "sand in the wheel theory". I also find that IPR risk does mitigate the impact of corruption, especially for developing countries, where IPR enforcement tend to be weak.

Keywords: Corruption, Innovation, Growth, Intellectual Property Rights, Competition

*This paper was written as an undergraduate thesis for an honor's degree in International Economics at Georgetown University. I am thankful for my thesis advisor Prof. Rodney Ludema's assistance in theoretical model construction and Prof. Henry Hyatt's assistance in identifying empirical strategy.

† *Author's email:* wuyuou@gmail.com

Contents

1 Introduction

Innovation increases firms' competitive edge and is one of the drivers behind sustainable long-term growth. Product innovation can help firms open up new markets while process innovation helps firms reduce cost and increase efficiency. A healthy innovative environment needs a proper institutional set-up that prevents patent violation and additional profit extortion from rent-seeking activitiessuch as corruption. Bribe solicitation among those who abuse power reduces firms' profit from innovation. Additionally, corruption creates a toxic business environment, where competitors may steal patents without penalties or may pay bribes to delay competitors' patent application, thereby indirectly reducing the innovative firm's profit rather than expanding the overall welfare. Despite challenges, firms are sensitive to political environment and can adjust their behavior based on whether to invest in innovations or to free-ride on other firms' product designs. Therefore, corruption perception may have an impact on firms' incentives to innovate because the cost of obtaining innovation-related permits is higher and profit from innovation is lower when regulatory protection is insufficient. To further investigate the behavior impact corruption has on innovation, this paper looks at how corruption perception affects a firm's innovation decision and how this may change under intellectual property rights (IPR) risk given imperfect IPR enforcement.

There are two different theories attempting to answer this question. One line of literature supports the "sand in the wheel" hypothesis, which states that corruption harms innovation because it erodes social trust, promotes rent-seeking behaviors, and enables the government to expropriate firms. On the other hand, others who support the "grease the wheel hypothesis," shows that corruption helps reduce institutional inefficiency and unnecessary costs from bureaucracy. Building on these two diverging theories, this paper establishes a simple model that shows theoretically, whether corruption is beneficial or harmful depends on the difference between the standard and real value of the patents and firm's bargaining power.

Concurrently, because institutional efficiency and intellectual property rights (IPR) protection are significant determining factors for firm's innovation decision, this paper further incorporates IPR risk to investigate the added impact it has on the relationship between corruption and innovation. In this paper, we interpret IPR risk as the risk of having a patent stolen by a firm's competitor. Therefore, if this is the case, IPR risk is primarily determined by IPR enforcement and the number of competitors. When IPR enforcement is imperfect, which is usually the case in developing economies, the number of competitors may be the primary driver for IPR risk. Therefore, we use the number of competitors as a proxy for IPR risk in this paper. Our model shows that despite the impact of corruption on innovation, higher IPR risk makes firms less sensitive to the impact of corruption. To break it down, when corruption has a negative impact on innovation ("sand in the wheel" theory), we expect to see a positive effect of competition on this relationship. Alternatively, if corruption promotes innovation ("grease the wheel" theory), IPR risk makes this relationship less significant in magnitude. Intuitively, this is potentially because higher IPR risk reduces bureaucrat's value of service, as payment for their service does not guarantee a firm's profit from patents.

To test whether the theoretical results hold, we conduct an empirical analysis using data from the World Bank's Enterprise Survey. This paper uses repeated cross-sectional data conducted on 137,219 firms in 57 countries, mostly developing countries, during 2007-2017. The data-set includes firms' direct responses to questions about their business environment, and therefore is more relevant for studying firms' innovation incentives than more subjective country aggregated measures such as World Corruption Index from Transparency International. To see how our theoretical model holds true in reality, we empirically test the hypothesis using a linear probability model with both OLS and an instrumental variable (IV) strategy. Both methods are further tested using weights to gain an understanding of the population. In the IV models, we construct a city level leave-one-out mean (LOOM) by averaging other firms' perception of corruption in the same city and use it as the instrument. This assumes a firm's decision on innovation is influenced by the general corruption trends in similar geographical locations, but only through change in the firm's corruption perception. Therefore this instrument satisfies both the exclusion restriction and relevance criterion. Our result supports the "sand in the wheel" hypothesis. Holding everything else constant, corruption reduces the probability a firm innovates by 4.26 percentage points, an estimation that is statistically significant at the 0.1% level.

To investigate the impact of IPR risk, which is proxied by the number of competitors, we add an interaction term between corruption and competition to the model to show the marginal effect IPR risk has on the relationship between corruption perception and innovation. We find that given a negative relationship between corruption and innovation, IPR risk reduces the severity of such relationship. In other words, it makes firms less sensitive to corruption, especially when the risk is high. Competition helps reduce the impact of corruption on innovation by 0.85 percentage points. IPR risk has a trade-off relationship with corruption and the relationship is particularly significant for firms that see corruption more as an obstacle. Lastly, we test the robustness of the model using "percentage of contract paid in informal payments and gifts" as an alternative measure for corruption. The robustness check shows both our main and marginal results are consistent and significant.

This research is unique because it causally tested the effect of corruption on innovation using an IV strategy and firm level data and shows how corruption impacts firms given a certain level of IPR risk. Although there are limitations due to the use of survey data, our results still inform us the value of tackling the problem of corruption and strengthening intellectual rights protection in order to promote corporate innovation.

2 Theoretical Framework

Many researchers have explored the relationship between corruption and innovation. Most of the work has been empirical. Previous research projects have examined this relationship through different causal channels. They can be classified into two distinct groups: those that support the "sand in the wheel" theory, which states that corruption hinders innovation; and those that support the "grease the wheel" theory, which shows how corruption reduces institutional inefficiency and promotes innovation. In this section, we establish a simple model with a two stage game tree, capturing the interaction between a bureaucrat and an innovative firm. Assuming corruption can be measured as the requirement of a bribe to get things done, the model shows the effect can vary depending on the real and standard cost to obtain a patent.

Additionally, this paper demonstrates the effect of corruption through a particular channel: intellectual property rights (IPR) protection. Lower IPR protection could discourage innovation because companies' would be forced to split the profit with their competitors when the patents are stolen. This IPR risk could be more salient due to low IPR enforcement and high number of competitors. Low IPR enforcement could be affected by many factors such as poor institutional set-up and low bureaucratic efficiency. Meanwhile, the higher the competitors, the greater the likelihood that a firm's patent would get stolen and the lower the profit left for the innovator. Therefore, when IPR enforcement is not perfectly efficient, the number of competitors directly affects IPR risk. In this paper, we incorporate the competition factor in our model to see how corruption affects innovation through IPR risk. The results show that under the sand in the wheel theory, higher IPR risk mitigates the impact of corruption, and under the grease the wheel theory, higher IPR risk would reverse the benefit of corruption. There are few research projects that theoretically look at the impact of corruption on innovation under the lens of IPR risk. This is therefore one of the main contributions this paper will add to the literature.

2.1 Sand in the wheel theory: Corruption impedes economic growth and innovation

One strand of literature supports the idea that corruption hinders innovation. This negative effect is characterized as the "sand in the wheel" hypothesis and it has been explored both theoretically and empirically. Previous literature reveals two main political mechanisms. One is the expropriation theory demonstrated by Murphy, Shleifer and Vishny (1993). They show that innovators are vulnerable to corruption because they need government services to acquire permits and licenses, thereby exposing themselves to higher risks of government expropriation. Although the authors primarily focused on the impact of corruption on growth, this mechanism applies to innovation as well.

Alternatively, Baumol (1998) shows a different mechanism within the the rent-seeking theory, which states that high corruption gives more opportunities for firms to collaborate with bureaucrats and to pursue rent-seeking activities. Firms thus have less incentive to engage in innovative activities. Such a rent-seeking effect not only applies to firms, but also to labor: talents may flow from innovative sectors to more profitable rent-seeking sectors in highly corrupt economies (Li, Xu and Zou, 2000).

In addition to political mechanisms related to firms' relations with the government, corruption also affects the business environment and firms' decisions when they expect certain behaviors from their competitors. Anokhin and Schulze (2009) reveal an angle of corruption based on potential post-invention business operating environment that may stall a firm's decision to innovate in the first place. They argue that corruption erodes social trust. Without such trust, monitoring and transaction costs will restrict the scale and scope of trade, thereby hampering innovation and productivity. When corruption is prevalent, it is risky for firms to rely on legal contracts or the integrity of bureaucrats. Through a micro-analysis, they show that there is a concave and positive relationship between the control of corruption and the amount of domestic innovation. However, in line with the other mechanism mentioned above, Anokhin and Schulze's analysis requires further decomposition to demonstrate the extent to which the effect of corruption is attributed to lack of social trust.

To take the influence of other existing firms into account, Veracierto (2016) simplifies the corruption game to an entry decision problem in which an entrant and an incumbent compete for the government's approval of product. Veracierto spells out a firm and a government official's interaction along with the threat of a new entrant to show that a firm's innovation decision depends on the probability a bribe can be detected by the central government and the amount of penalty imposed on the bureaucrat.

In addition to explaining the theories, a majority of papers approach this research question using empirical strategies and focus on specific economies. Paunov (2016) shows that corruption reduces the likelihood of firms obtaining patents in industries that use patents more intensively, and this phenomenon is most evident for smaller firms. Research on China reveals that anti-corruption efforts reduce corruption-related payments and funds. The impact is especially salient for newer firms, ones that do not have a strong political connection, and those that are not in regulated industries. This supports the expropriation theory demonstrated by many other research (Xu and Yano, 2017; Fang et al., 2018). Waldemar (2012) also shows a negative relationship between new product and corruption is present in India.

Effects of corruption on innovation not only exist in developing countries, but also in developed countries such as the US (Zelekha, Avnimelech and Sharabi, 2014; Ellis, Smith and White, 2015). Botrić and Božić (2017) use the Business Environment Survey for their analysis, showing a link between firms' innovation activities and their perception of corruption in post-transition economies in Europe. Moreover, Huang and Yuan (2016) reveal that the negative impact of corruption can channel through a reduction of social trust and the effect is stronger for firms that have weaker bargaining powers and for the ones located in areas with low local religiosity. This is consistent with the hypotheses Anokhin and Schulze demonstrate with regards to social trust.

In many cases, corruption can also be measured as the level of political connection. Akcigit, Baslandze and Lotti (2018) look at the equilibrium labor output and labor productivity of politically connected firms, revealing the dynamics of incumbents and entrants with different degrees of political connection under a two-stage pricing game framework. They conclude that even if corruption may be beneficial to reduce certain types of market friction, there may still be important social costs through lower reallocation and growth. Researching the anti-corruption campaign in China, Li (2016) shows that the level of corporate innovation significantly increased after the anti-corruption campaign, and particularly so for firms that previously had political connections with high anti-corruption intensity.

2.2 Grease the wheel theory: Corruption increases institutional efficiency

However, literature also supports a "grease the wheel" theory, which states that an appropriate level of corruption helps reduce institutional inefficiency and thereby promote economic growth. This can be equally applied with respect to innovation. Many authors show that the effect of corruption on growth depends on political regimes and quality of governance (Aidt, Dutta and Sena, 2008; Méon and Sekkat, 2005). The adverse impact of corruption is greater for high-quality regimes and is not evident for low-quality institutions. Other authors show that corruption can help officials make the right decisions: the lowest cost firms are more competitive in low quality regimes and the existence of corruption may create results similar to those from a competitive auction process under imperfect information (Beck and Maher, 1986; Lien, 1986).

Further, viewing corruption from a temporal dimension, Lui (1985) shows that under certain conditions, corruption may effectively reduce queuing time, giving administrators an incentive to speed up an otherwise convoluted bureaucratic process. In response to Lui, Andvig (1991) points out that further research needs to address the dynamics of the queuing theory when new entrants join the queue and firms in the queue do not change their behavior. Although bribery in these circumstances may increase administrative efficiency, these efficiencies may come at the expense of low product quality and limit healthy competitions among firms (Bardhan, 1997).

Empirically, Dreher and Gassebner (2013) show that corruption facilitates firm entry in highly regulated economies but excessive regulations are detrimental to entrepreneurship. However, as the authors have acknowledged, regulation may be a result of corruption introduced by bureaucrats with the intention of rent-extraction. This endogeneity implies the predetermined mechanism for firms to comply with corrupt behaviors in order to enter the market and may therefore render the added effect of corruption ambiguous.

Another empirical case that supports greasing the wheel theory comes from Krammer (2013), who shows that in addition to institutional efficiency, corruption allows firms access to decision making processes and reduces uncertainty. However, this assumes corruption is a bargaining process independent of other firms. Competition with other firms in the same industry may create asymmetric information, especially given that innovation is a competitive behavior. It would be unreasonable to assume firms would collectively act to lower the price of bribes. Krammer finds evidence supporting the "grease the wheel" theory by using the bribe amount as a percentage of sales. The inclusion of a country-region-sector variable measuring the dispersion of bribes may also introduce potential bias as it is used along with industry and country fix effects.

Empirical evidence may show different impacts of corruption on innovation depending on certain conditions. Taking account of the number of civil servants, Acemoglu and Verdier (2000) show the optimal amount of government intervention and level of bureaucratic wage that would maximize firm growth. Their model seeks to achieve an equilibrium between bureaucrats and entrepreneurs given a certain level of government intervention. Whether corruption has an impact on growth therefore depends on the political environment. A similar mechanism may be applied to innovation.

Given the existing two strands of literature and the complexity of the corruption question, this paper seeks to explore the topic further with a game theory approach, taking account of the interaction between the firm and the bureaucrat to capture the direct and indirect effects of corruption.

2.3 A Simple Model of the Effect of Corruption on Innovation

We consider a simple model that nests both the "sand in the wheel" and the "grease the wheel" hypotheses. The model is a two-stage Nash bargaining game with two agents: a firm and a bureaucrat, who have a set of possible payoffs $U = (u_f, u_b)$. The first stage is the innovation stage and the second is the patenting stage. In the first stage, the firm chooses whether or not to pay a fixed R&D cost $\rho > 0$. Payment of this fixed cost results in a successful innovation (with certainty), while failure to pay the cost results in no innovation. Moreover, the firm faces a threat from its competitors who may illegally obtain the fruit of the innovation and thereby reducing its revenue. Therefore, if the firm chooses to innovate, it earns an operating revenue of $u_f = r(n)$, provided it obtains a patent; otherwise, it earns $u_f = 0$. n indicates the number of competitors the firm faces and we may assume $r(n)$ is a decreasing function in n. This means that with more competitors to split the benefit of the innovation, the share of profit for the innovator decreases.

It is assumed that the firm innovates in the first stage and seeks to obtain a patent in the second stage. Standard patent cost is ϕ, which includes possible patent application cost and time cost incurred during the patent application process. During this stage, a bureaucrat may solicit a bribe from the firm and has the power to hold-up or delay patent issuance. Bribe solicitation comes with risks and it is assumed to happen with an exogenous probability p. In this case, p represents the prevalence of corruption a firm faces or as the probability a firm expects to pay a bribe. Therefore, the higher the p, the higher the firm's perceives corruption. If a bribe is successful, the bureaucrat may speed up the patent application process and reduce the cost to $\phi^{'} \leq \phi$. Therefore with probability p, the firm must pay a fee $\phi^{'} + b$, where $\phi^{'}$ is the real cost of the patent and b is a bribe paid to the local bureaucrat, and with probability *1-p*, the firm must pay ϕ to obtain the patent. For the firm, a bribe is valuable when it sufficiently reduces the patent cost.

When a bureaucrat solicits a bribe from a firm, the bribe level is a solution to a Nash bargaining problem. We assume that if the negotiation fails, the firm makes no payment, receives no patent, and cannot carry the product out into the market, and the bureaucrat gets zero payoff. If an agreement is reached between the firm and the bureaucrat, the bureaucrat gets a payoff $u_b = b$ and the firm has an expected payoff $u_f = r(n) - \phi' - b$. These conditions create a bargaining set U with threat point $(u_0, v_0) = (0, 0)$, which satisfies the bargaining axioms: U is compact and convex, and all the other possible utilities payoffs generate higher utilities to both agents than the threat point. Thus, the bargaining set contains a bargaining solution (U_f, U_b) that satisfies the Nash bargaining solution axioms.[1] To find the bribe level under the bargaining solution, b is chosen to maximize the Nash product:

$$\max_b [r(n) - \phi' - b]^{\alpha} (b)^{1-\alpha}. \tag{1}$$

where α represents the bargaining power of the firm and $1-\alpha$ represents the bargaining power of the bureaucrat. Throughout we assume $r(n) > \phi_0 > 0$, meaning the new product will always bring a positive revenue to the firm when a patent is granted. Solving (1) we get:

$$-\alpha[r(n) - \phi' - b]^{\alpha-1}(b)^{1-\alpha} + (1-\alpha)[r(n) - \phi' - b]^{\alpha}(b)^{-\alpha} = 0$$

$$-\alpha(b) + (1-\alpha)[(r(n) - \phi' - b] = 0$$

$$b = (1-\alpha)[(r(n) - \phi']$$

In other words, the bribe is a share of the surplus generated by the patent, $r(n) - \phi'$,

[1] Readers may consult standard game theory textbook for a reference of these axioms.

and the share is decreasing in firm's bargaining skill. The model can be characterized in the game tree presented in Figure 1.

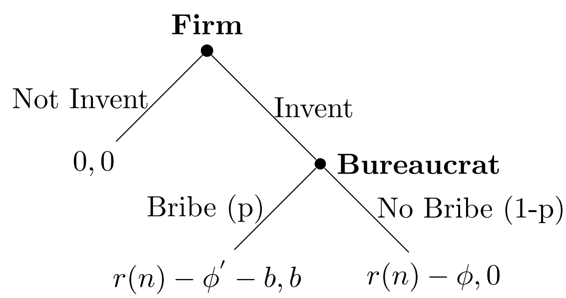

Figure 1: Simple model in game tree form

Given this negotiated bribe, and the probability the bureaucrat solicit a bribe, the firm's operating revenue following innovation, net of the expected patenting cost is:

$$R = p[r(n) - b - \phi^{'}] + (1 - p)[r(n) - \phi].$$

Replace b by the result we obtained from solving (1), we get:

$$R = p\{r(n) - (1 - \alpha)[(r(n) - \phi^{'}] - \phi^{'}\} + (1 - p)[r(n) - \phi]. \tag{2}$$

To see how a firm's revenue is affected by the prevalence of corruption factor p, differentiation with respects to p gives:

$$\begin{aligned} \frac{\partial R}{\partial p} &= r(n) - (1 - \alpha)r(n) + \phi^{'}(1 - \alpha) - \phi^{'} - r(n) + \phi \\ &= (1 - \alpha)(\phi^{'} - r(n)) + (\phi - \phi^{'}). \end{aligned} \tag{3}$$

The sign of the first order derivative is ambiguous. Based on our assumptions, we know the first term $(1 - \alpha)(\phi^{'} - r(n)) < 0$ given $1 - \alpha > 0$ and $\phi^{'} < \phi < r(n)$. For the second term $\phi - \phi^{'}$, we know $\phi^{'} \leq \phi$, if the standard patent fee reflects the real cost of the patent, i.e., $\phi = \phi^{'}$, then R is unambiguously decreasing in p, meaning the higher the corruption, the lower the revenue. This captures the "sand in the wheel" hypothesis. In this case, bribery merely adds to the cost of patenting. However, if the patent fee is excessive (i.e., $\phi > \phi^{'}$), perhaps because of unmotivated bureaucrats and prolonged application processing time when bribes are not possible, it is possible that R is increasing in p. This would be more likely if the firm's bargaining skill were high (i.e., α close to one). This positive derivative captures the "grease the wheel" hypothesis.

Returning to the first stage, we can see that the firm will choose to innovate if $R > \rho$, the forefront investment cost of innovation. Suppose ρ is a random variable drawn from a normal probability distribution $N(\rho)$, and the probability that a firm innovates is $N(R)$. As $N(R)$ is an increasing function of R, we conclude a reduction in corruption results in larger R, larger $N(R)$ and a higher probability of innovation under the "sand in the wheel" hypothesis. Conversely, a reduction in corruption results in smaller R, smaller $N(R)$ and a lower probability of innovation under the "grease the wheel" hypothesis.

Moreover, to see how corruption has an impact on innovation given a certain level of IPR risk when the IPR enforcement is weak, we further look at how revenue change with respect to the number of competitors. We obtain the first-order derivative of $\frac{\partial R}{\partial p}$ on n, the number of competitors, and get:

$$\frac{\partial R}{\partial p \partial n} = -(1 - \alpha) r'(n). \tag{4}$$

Since $r(n)$ is a linear function strictly decreasing in n, the result of the derivative is $-(1-\alpha)r'(n) > 0$. Therefore, when the coefficient of the first derivative on p is negative, the effect of corruption on innovation will be less negative when the firm faces more competitors, or when the IPR risk is high. Given our assumptions, empirically, this means when IPR enforcement is poor and when corruption has a negative impact on innovation, IPR risk will mitigate the social cost of corruption. On the contrary, if the coefficient of the first derivative on p is positive, the positive effect of corruption on innovation will be smaller when firm faces more competitors. This is potentially because higher IPR risk makes bureaucrat's bribe service less valuable. It exhibits a trade-off relationship between corruption and IPR risk. When IPR enforcement is weak, a firm's decision to innovate given the presence of corruption depends on the prevalence of competition. When competition is high and IPR enforcement is inefficient, firms are less sensitive to the level of corruption. Conversely, corruption has a greater impact when IPR risk is lower. We will further demonstrate this empirically in the following section.

3 Empirical Analysis

3.1 Data

To see how the theory holds in reality, we empirically test the theoretical model using firm level data from the World Bank Enterprise Surveys.

The Enterprise Surveys (ES) includes data collected by the World Bank based on firms' experiences and perceptions of their business operating environment. We use repeated cross-sectional data sampled over 2007-2017, which reflects the most recent wave of data and consists of surveys conducted on 137,219 firms in 57 countries. During this time-frame, the surveys were conducted in each country two or three times with three to seven years in between each survey. ES chooses the number and types of industries based on Gross National Income and include many manufacturing industries, two service industries and a residual stratum to capture the composition of the population[2]. Firms are selected based on their contribution to value added, employment and number of firms in the industry. The minimum sample size is chosen to maintain 7.5% precision and 90% confidence interval in making an inference about the general population [3]. Replacement firms are similarly chosen in case firms decline to respond. To reflect the sampling method and the composition of the population, a probability weight is generated for each observation. Countries included in the ES are mostly developing countries, where we can assume IPR enforcement is imperfect due to resource and institutional constraints.

ES includes information on firm's past three years' innovation and asks firms whether they see different factors, such as corruption and access to credit, as obstacles to their business operations. The survey also includes a section where firms can report their bribe payment as a share of annual sales in the manufacturing industry. Comparing to other country-level indicators of corruption, such as the "Corruption Per-

[2] The detailed number of firms for each size of economy is shown in the Appendix.

[3] This means we can guarantee that the population parameter is within the 7.5% range of the observed sample parameter, except in 10% of the cases (World Bank Group, 2009)

ception Index" and the Freedom House measures, the ES is unique because it is based on firm-level data and directly reflects firms' perception of corruption based on their experiences operating in certain markets. It is independent of country characteristics, and therefore is a more suitable to measure how individual firms' innovation incentives change directly based on their perceptions of business operating environment. Figure 2 shows the average degree of how firms see corruption as an obstacle to their business in each country. The higher the score, the more severe the firms in that country regard corruption as an obstacle to their business operation. Although the subjectivity of survey data may be a concern of inaccuracy, it does not render our estimation inaccurate when the data is collected with appropriate data collection technique and obtained in large samples (Ayyagari, Demirgüç-Kunt and Maksimovic, 2014).

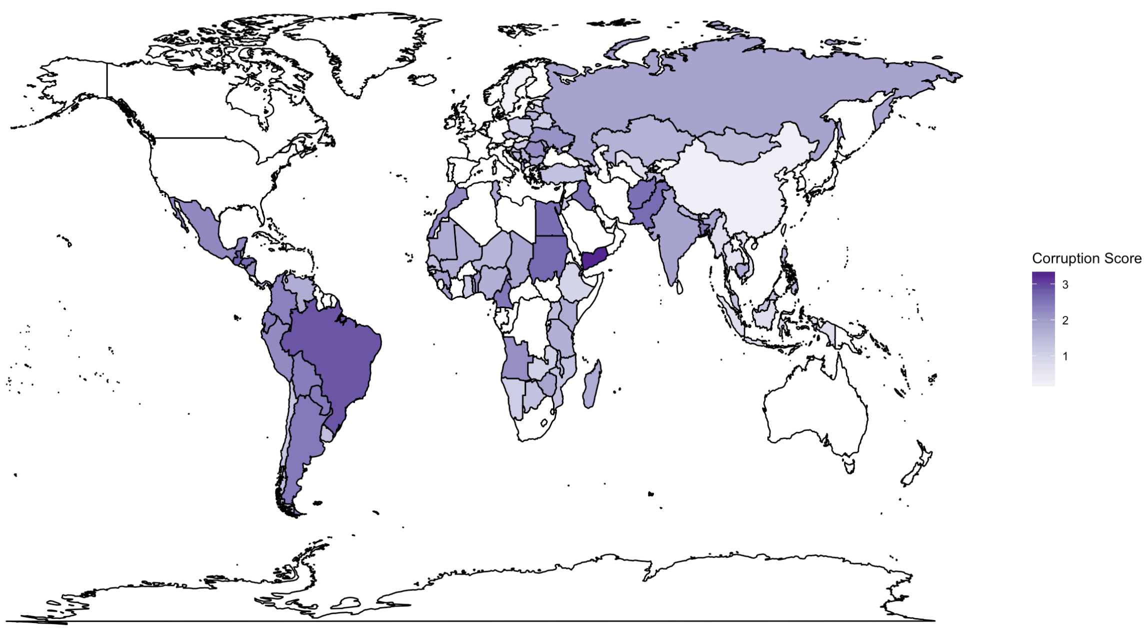

Figure 2: Prevalence of corruption in surveyed countries

Table 1 shows the descriptive statistics of the types of surveys conducted in the ES. We can see that 52.07% of the firms are in the manufacturing sector, 19.22% are from the service sector, and 4.13% of the firms are from other sectors. East Asia and Pacific (EAP) and South Asia Region (SAR) have the highest percentage of manufacturing firms participating in this survey. Europe and Central Asia (ECA) has the highest number of firms in the service sector participated in the survey. There is a total number of 136747 observations from this data set.

	Region and Survey type (%)						
Region	AFR	EAP	ECA	LAC	MNA	SAR	Total
Manufacturing	41.62	60.86	41.65	54.36	59.21	71.91	52.07
Services	21.87	12.87	26.61	19.00	14.44	11.19	19.22
Core	29.38	20.57	31.74	19.86	26.35	15.46	24.58
Indicator	7.13	5.69	0.00	6.78	0.00	1.44	4.13
N	136747						

Table 1: Region and Survey Type Summary Statistics

There are two types of innovation documented in the ES: product innovation and process innovation. Table 2 shows the weighted correlation between corruption and produce and process innovation. We can see there are strong negative correlations between corruption and the two types of innovations. This means that the more a firm sees corruption as an obstacle to its business operation, the less likely it is to innovate, which is consistent with the "sand in the wheel" hypothesis. This paper will primarily focus on product innovation because it pertains more to the assumptions in our model as patenting product is more straightforward and firms are more likely to seek patents for their product innovation.

	(1) Product	(2) Process
Corruption	-0.118***	-0.119***
Observations	129810	129736

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2: Correlation Between Corruption and Innovation

Table 3 shows the weighted descriptive statistics of the variables that are included in our regression models. The descriptive statistics are drawn from 10,198 observations. Product indicates whether the firm has introduced a new product in the last three years, with "yes" coded 1 and "no" coded 0. Only 43% of the firms created a new product in the past three years from the time of the survey. Corruption is an ordinal variable that measures the extent to which firms see corruption as an obstacle to their business operation from 0 to 4, with 0 being "No obstacle" and 4 being "Very severe obstacle". We can see that on average, firms report corruption poses a "Minor" to "Moderate" degree of obstacle to their business operation. Competition, firm size are also ordinal variables with higher number representing higher competition and larger firm size. [4] Firm size indicates the number of employees. Competition measures the self-reported number of competitors the firm faces in its industry. Firm age shows how many years the firm has been in operation. Annual sale shows the monetary sale for each firm and we transformed it to log form for our analysis. Private, foreign and government shares indicate the share of ownership held by private domestic, foreign and the government. Mean statistics on Part of a Larger Firm shows that a majority of the firms belong to a large firm.

	Summary Statistics			
	mean	sd	min	max
Product	0.43	0.49	0.00	1.00
Corruption	2.33	1.47	0.00	4.00
Competition	2.47	0.74	0.00	3.00
Firm Size	1.58	0.69	1.00	3.00
Firm Age	23.88	18.69	0.00	185.00
Domestic Private Share	93.41	23.20	0.00	100.00
Government Share	0.06	1.79	0.00	100.00
Annual Sale (log)	16.15	3.36	6.68	33.85
Part of a Large Firm	0.90	0.30	0.00	1.00
Observations	10198			

Table 3: Summary Statistics of Variables Included in the Regression Model

[4] The detailed range of each indicator can be found in the Appendix.

3.2 Empirical Model and Results

We test the causal effect of corruption on innovation using an instrumental variable approach based on firm level data. Previously, some authors studied the reverse of such effect (i.e: the impact of innovation on corruption) and revealed that corrupt officials are more likely to target innovative firms (Ayyagari, Demirgüç-Kunt and Maksimovic, 2014). The instrumental variable strategy will therefore address the reverse causality issues presented in the literature. Furthermore, to avoid other endogeneity issues, we include control variables and industry, country, and year fixed effects. We then introduce an interaction term between corruption and competition to test the marginal effect of IPR risk on the effect of corruption on innovation. In all models, to control for heteroskedasticity, robust errors are estimated for the coefficients.

The regression analysis in our models takes a linear probability form. Given the binary nature of the dependent variable "product innovation", with a linear probability model, the predicted dependent variable needs to be contained from 0 to 1. To see whether outliers pose a problem to our regression, we estimate the predicted values for innovation with estimated coefficients in both models. The red vertical line marks the 5% threshold of the end of the distributions. The results show that using linear probability model will not bias our estimation.

Additionally, given the nature of survey data and sampling methods, a sampling weight is needed if one seeks to estimate population descriptive statistics. For an estimation of causal effects, a weight could be used in order to correct for heteroskedasticity, endogenous sampling and average partial effects in the presence of un-modeled heterogeneity of effects (Solon, Haider and Wooldridge, 2015). However, in some circumstances, weighting might reduce estimate efficiency and renders the estimates imprecise. Moreover, because of missing values from the dataset due to the sensitivity of the question, or a firm manager's lack of knowledge of detailed information, using weights in our regression may not necessarily reflect the characteristics of the population. Taking the pros and cons of using weights into account for our regressions, this paper report both weighted results and unweighted results for comparison.

3.2.1 Main Effect

To address omitted variable bias, we control for firm level characteristics that are correlated with innovation and corruption. These controls are firm age, firm size, ownership structure, log-transformed annual sales, and whether the firm belongs to a larger firm. The description of these data can be found in Table 3. Moreover, because both innovation and corruption can vary depending on the country and the industry the firm is in, we introduce the country and industry fixed effects to control for country-level and industry-level endogeneities. Because countries in this dataset went through two to three rounds of survey data collection, we include year fixed effect to control for global phenomena that may affect corruption and innovation. With these control variables and fixed effects, we first estimate an OLS regression which takes the form:

$$innovation_i = \alpha + \beta corruption_i + \delta_k x_{k,i} + \gamma_k m_k + \epsilon_i \tag{5}$$

$innovation_i$ and $corruption_i$ are the main variables of our concern for each individual firm. $x_{k,i}$ consists of all firm-level control variables. m_k are dummy variables for industry, country and year. γ_k are the coefficients of these binary variables. The result of this regression can be found in Table 5, column (1).

Next, to address simultaneous equation bias due to reverse causality, we introduce an instrumental variable: the city-level leave-one-out mean of corruption (LOOM). It is constructed by the following rule, where n represents the number of firms in a city:

$$\frac{\sum_{i=1}^{n} corruption_i - corruption_i}{n-1}$$

It assumes that corruption varies depending on the geographical location a firm is in. Thus, a firm's corruption perception is likely correlated with that of other firms in the same city. For an instrumental variable to be valid, it must satisfy both the instrumental relevance and instrumental exogeneity criteria. The city-level leave-one-out mean satisfies the relevance criterion because it is strongly correlated with our dependent variable, controlling for environmental factors. The correlation between LOOM and corruption without controlling for other variables is shown in Table 4, column (1), and their correlation with controls is shown in Table 4, column (2). We can see that the correlation controlling for environmental factors is high and it is statistically significant at the 0.001 level. Furthermore, given a Cragg-Donald Wald F statistic greater than 10, we cannot reject the hypothesis in weak IV test that our instrument only weakly correlates with the dependent variable. Therefore our IV satisfies the relevance criterion.

Correlation	(1) LOOM without control	(2) LOOM with controls
Corruption	0.476***	0.803***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Correlation between instrumental variable and corruption.

Secondly, because LOOM is aggregated to the city-level excluding the individual firm of interests and the base unit for the regression analysis is firm-level, LOOM satisfies instrumental exogeneity. We can assume that that firms are heterogeneous enough that the corruption perceptions of other firms may affect the corruption perception of a firm in a given city, but will not affect its decision to innovate directly. LOOM will only affect the dependent variable indirectly through changing individual firm's own corruption perception. Therefore, we can assume city-level leave-one-out mean is uncorrelated with the error term in the second stage regression between firm's perception of corruption and innovation, and our instrument passes the exclusion restriction.

After showing that the city-level leave-one-out mean satisfies the two conditions for instrumental variable estimation, we conduct a set of two stage least squares regression, with LOOM as an instrumental variable, to show the effect of corruption perception on innovation. The 2SLS regressions take the form of:

$$\textbf{First Stage: } corruption_i = \pi_0 + \pi_1 LOOM_i + \pi_k x_{k,i} + \tau_k m_k + \nu_i$$
$$\textbf{Second Stage: } innovation_i = \alpha + \beta \widehat{corruption}_i + \delta_k x_{k,i} + \gamma_k m_k + \epsilon_i \tag{6}$$

Notations for variables are the same as those in the OLS model. In this model, $LOOM_i$ indicates the instrumental variable or city-level leave-out-mean. $\widehat{corruption}_i$ is the estimated result we obtain for $corruption_i$ from the first stage. β from the second stage regression tells us the effect of corruption on innovation controlling for other variables. The results for this basic set of regressions testing for the effect of corruption on innovation are shown in Table 5.

In Table (5), Column (1) shows the result of the basic linear probability model controlling for firm characteristics and including various levels of fixed effects. We can see, *ceteris paribus*, there is a negative correlation between corruption perception and product innovation. Holding everything else constant, a 1 unit increase in corruption perception is correlated with a 1.18 percentage point decrease in the probability a firm would innovate. The effect of using weight does not significantly differ from the unweighted estimate. With instrumental variable, the effect of corruption on product innovation is -0.0426, which means that holding everything constant, a 1 unit increase in corruption perception is estimated to cause a 4.26 percentage point decrease in product innovation. Using weights with IV slightly changes the result, but the estimated sign remains the same. All coefficients of corruption are significant at the 0.1% level in this set of basic regression. This means if corruption has no impact on innovation, we would expect to see the estimated effect in only 0.1 % of the sample due to random sampling error. Such negative relationship is consistent with the "sand in the wheel" hypothesis in which corruption impedes innovation.

From the results, we can also see firm size, firm age, foreign share and annual sales have negative correlations with product innovation. Larger and older firms po-

	(1)	(2)	(3)	(4)
	OLS	Weighted-OLS	IV	Weighted-IV
Corruption	-0.0181***	-0.0252***	-0.0426***	-0.0645***
	(0.000)	(0.000)	(0.000)	(0.000)
Firm Size	-0.0412***	-0.0436***	-0.0405***	-0.0404**
	(0.000)	(0.001)	(0.000)	(0.001)
Firm Age	-0.0002	0.0008	-0.0002	0.0008*
	(0.154)	(0.056)	(0.168)	(0.040)
Part of a Large Firm	0.0530***	0.0938***	0.0518***	0.0873***
	(0.000)	(0.000)	(0.000)	(0.000)
Domestic Private Share	0.0002	0.0002	0.0002	0.0002
	(0.199)	(0.835)	(0.141)	(0.845)
Government Share	0.0011***	0.0009	0.0011***	0.0009
	(0.001)	(0.509)	(0.001)	(0.532)
Foreign Share	-0.0001	-0.0010	-0.0001	-0.0010
	(0.462)	(0.257)	(0.577)	(0.248)
Annual Sale (log)	-0.0185***	-0.0170**	-0.0187***	-0.0178***
	(0.000)	(0.001)	(0.000)	(0.001)
Constant	0.8067***	0.6710***	0.8931***	0.8187***
	(0.000)	(0.000)	(0.000)	(0.000)
N	68277	68277	68277	68277
Industry FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

p-values in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: Basic regression model result

tentially have greater bureaucratic hurdles to go through within the organization and their employees may have more established responsibilities. Continuation of existing firm establishment and large company structure may therefore reduce innovation accomplished by a firm. On the other hand, government share and whether the firm is part of a larger firm may have a positive correlation with innovation, potentially attributed to more available resources. The signs for these control variables are expected from general literature.

Lastly, Figure 3 shows the distribution of predicted dependent variable. We can see the red line which indicates the threshold of 5% level is below 1. This means there is less than 5% predicted value above 1, which means linear probability model does not significantly bias the result.

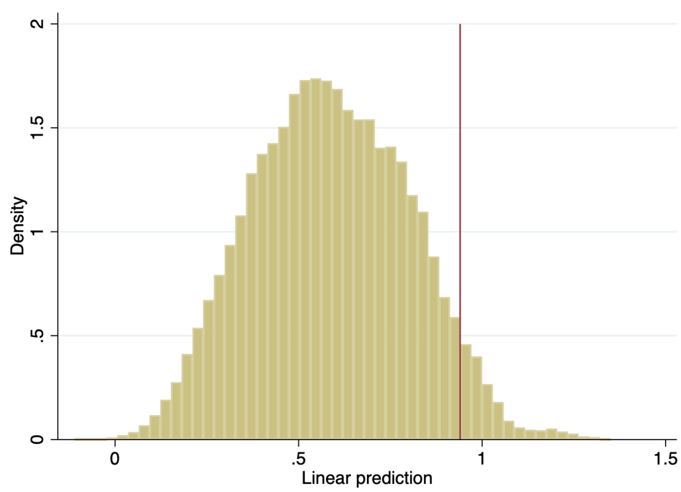

Figure 3: Linear prediction for innovation with instrumental variables, control variables and fixed effects. Probability of product innovation at 95% confidence interval

3.2.2 Marginal Effect with Competition

To see how corruption affects innovation in the presence of IPR risk given low IPR enforcement, we add an interaction term between corruption and competition to our main regression model and form a new interaction model. As mentioned previously, because ES mostly samples firms in developing countries, where IPR enforcement is more likely to be weak, we may assume a firm's number of competitors as a measure of IPR risk. From our main model, we find a negative effect of corruption on innovation. If our theoretical model is correct, with a negative relationship between corruption and innovation, we expect to see the sign for the marginal effect of competition to be positive. In other words, we expect to see competition as a factor that reduces the negative effect corruption perception has on innovation. Therefore, when IPR enforcement is imperfect, IPR risk makes firms less sensitive to corruption. Similar to the basic regression models, we control for endogeneities by including firm-level control variables and industry, country and year fixed effects. We first run an OLS regression, which takes the following form:

$$\begin{aligned} innovation_i =& \alpha + \beta_1 corruption_i + \beta_2 competition_i + \beta_3 corruption_i * competition_i + \\ & \delta_k x_{k,i} + \gamma_k m_k + \epsilon_i \end{aligned} \tag{7}$$

As in the basic regression model, x_i is the composition of the control variables, $LOOM_i$ is the instrument for corruption. β_1 captures the main effect of corruption on innovation, β_2 indicates the correlation between competition on innovation and β_3 captures the marginal effect of competition.

The unweighted result of this regression is shown in Table 6, column (1) and the weighted result is shown in column (2). In both regressions, the coefficient for competition is negative and the coefficient for the interaction term is positive. This shows that holding everything else constant, corruption has a negative effect on innovation, and a higher level of competition reduces this negative impact. Statistically, a one unit increase in corruption perception is correlated with a 4.04 percentage point decrease in innovation and one unit increase in competition is correlated with a 0.85 percentage point increase in the coefficient between corruption and innovation. This is consistent with the result from our main model and from our theoretical model. The competition coefficient for unweighted OLS is statistically significant at the 0.1% level and the interaction term between corruption and competition is statistically significant at the 5% level.

The marginal effect of corruption on innovation for companies facing different numbers of competitors are shown in Figure 4. We can see from the graph, indicated by the color-coded lines, that the higher the firm's corruption perception, the lower the probability it will innovate. For firms that do not see corruption as an obstacle or only see corruption as a moderate obstacle, having more competitors or having greater IPR risk decreases the probability they will innovate. Such effects are demonstrated with negative slopes. The slope becomes flatter, or the negative effect becomes less prominent, the higher the firm perceives corruption to be. Our result shows an offsetting effect between corruption and IPR risk: when IPR enforcement is imperfect and IPR risk is high, firms are less sensitive to corruption. On the other hand, for firms that see corruption as a very sever obstacle, having more competitors actually increases the the probability they would innovate than they would have otherwise with fewer competitors, as indicated by the positive slope in the graph. This implies that with more competitors, there is a lower likelihood for officials to solicit a bribe, or the negative impacts and the risks are spread evenly across the firms.

Next we include the instrumental variable city-level leave-out-mean into our model to see whether the relationship we see from the main model and the OLS regression still stand. To maintain the exclusion restriction of our instrument, we instrument the interaction term with $competition_i * LOOM_i$ and estimate the two instruments in the

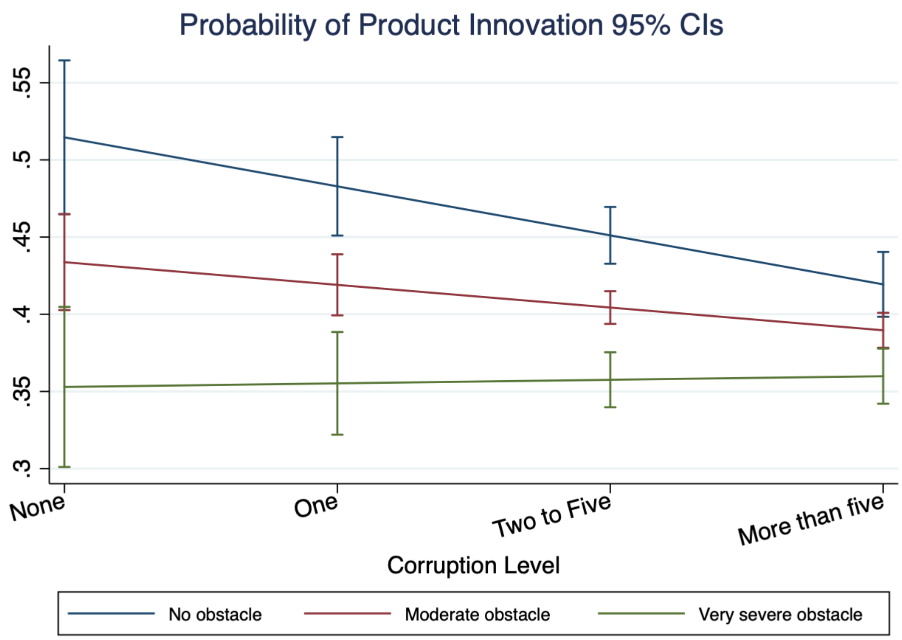

Figure 4: Probability of product innovation at 95% confidence interval based on the number of competitors.

first stage. The regression takes the form of:

First Stage:

$$corruption_i = \pi_0 + \pi_1 LOOM_i + \pi_2 LOOM_i * competition_i + \pi_3 competition_i + \pi_k x_{k,i} + \tau_k m_k + \nu_i$$

$$corruption_i * competition_i = \theta_0 + \theta_1 LOOM_i + \theta_2 LOOM_i * competition_i + \theta_3 competition_i + \theta_k x_{k,i} + \zeta_k m_k + \mu_i$$

Second Stage:

$$innovation_i = \alpha + \beta_1 \widehat{corruption}_i + \beta_2 competition_i + \beta_3 corruption_i \widehat{*} competition_i + \delta_k x_{k,i} + \gamma_k m_k + \epsilon_i \quad (8)$$

The result of the instrumented interactive model are shown in column (3) and (4) in Table 6. From the table, we can see that the main and marginal effects maintain the same signs and similar magnitudes as those in the other models, except for that in the weighted IV estimation. As explained previously at the beginning of this section, it is expected weighting observations may reduce the precision of the estimate, and it may not necessarily reflect the characteristics of the population. Whether the loss of precision is due to endogenous sampling or heteroskedasticity issues may require more knowledge of the sampling process and additional tests, which are beyond the scope of this paper.

	(1) OLS	(2) Weighted-OLS	(3) IV	(4) Weighted-IV
Corruption	-0.0404***	-0.0185	-0.0704	0.2133
	(0.000)	(0.417)	(0.104)	(0.432)
Competition	-0.0318**	-0.0059	-0.0522*	-0.0671
	(0.002)	(0.807)	(0.040)	(0.394)
Corruption × Competition	0.0085*	-0.0014	0.0192	0.0051
	(0.033)	(0.883)	(0.123)	(0.918)
Firm Size	-0.0513***	-0.0599*	-0.0516***	-0.0475
	(0.000)	(0.023)	(0.000)	(0.176)
Firm Age	0.0003	-0.0001	0.0003	-0.0007
	(0.268)	(0.874)	(0.260)	(0.410)
Part of a Large Firm	0.0692***	0.0593+	0.0687***	0.0642
	(0.000)	(0.065)	(0.000)	(0.118)
Domestic Private Share	-0.0006	0.0002	-0.0006	0.0014
	(0.354)	(0.890)	(0.357)	(0.426)
Government Share	0.0021	0.0025	0.0020	0.0037
	(0.198)	(0.280)	(0.233)	(0.202)
Foreign Share	-0.0008	0.0001	-0.0007	0.0010
	(0.268)	(0.936)	(0.273)	(0.588)
Annual Sale (log)	-0.0264***	-0.0221*	-0.0261***	-0.0158
	(0.000)	(0.027)	(0.000)	(0.225)
Constant	0.9513***	0.7384***	1.0065***	-0.0758
	(0.000)	(0.000)	(0.000)	(0.923)
N	10197	10197	10197	10197
Industry FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

p-values in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Regression model result with interaction term

4 Robustness Check

To test the robustness of our model, we carried out a robustness check using the "percent of the contract value paid as informal payments or gifts" (bribe share) as an alternative measure for corruption. Although this is not an exact measurement of bribery and contract may not be applicable to all firms, it indicates the presence of corruption because gifts are often exchanged during business transactions under informal environment.

Table 7 shows the results of this robustness check for both the main and the interaction models with both OLS and IV regressions. We can see the signs are consistent with our main analysis. The signs for corruption are negative and the signs for the interaction term are positive. Holding everything else constant, in the interaction model, corruption decreases the probability of innovation by 0.80 percentage points, and competition increases that by 0.24 percentage points. Both the main effect and the marginal effect are significant at the 5% level. Although we see the number of observations significantly drops after adding the competition variable, the sample of observations is still large enough for us to consistently estimate the coefficients.

	(1)	(2)	(3)	(4)
	OLS	IV	Interaction	IV Interaction
Bribe Share	-0.0016***	-0.0017	-0.0080**	-0.1950
	(0.000)	(0.239)	(0.006)	(0.501)
Firm Size	-0.0437***	-0.0433***	-0.0631***	-0.0715***
	(0.000)	(0.000)	(0.000)	(0.000)
Firm Age	-0.0002	-0.0002	0.0003	0.0002
	(0.092)	(0.117)	(0.252)	(0.521)
Part of a Large Firm	0.0467***	0.0467***	0.0503**	0.0310
	(0.000)	(0.000)	(0.005)	(0.378)
Domestic Private Share	0.0001	0.0001	0.0000	0.0002
	(0.779)	(0.764)	(1.000)	(0.897)
Government Share	0.0013***	0.0013***	0.0020	0.0020
	(0.000)	(0.000)	(0.374)	(0.406)
Foreign Share	-0.0003	-0.0003	-0.0001	-0.0000
	(0.203)	(0.219)	(0.902)	(0.989)
Annual Sale (log)	-0.0181***	-0.0183***	-0.0249***	-0.0348*
	(0.000)	(0.000)	(0.000)	(0.034)
Competition			-0.0237**	-0.0746
			(0.003)	(0.345)
Bribe Share $\times$ Competition			0.0024*	0.0539
			(0.036)	(0.509)
Constant	0.7808***	0.7686***	0.8000***	1.1201*
	(0.000)	(0.000)	(0.000)	(0.031)
N	50913	49586	6567	6480
Industry FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

p-values in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: Regression results using bribe amount

5 Conclusion

This paper provides a simple model that shows the effect of corruption on innovation and particularly demonstrated its impact in respects to IPR risks given inefficient IPR enforcement. The theoretical model first shows that corruption may have a positive or negative impact on innovation depending on firm's bargaining power and the difference between standard and real patent costs. Secondly, given low IPR enforcement, competition makes firms less sensitive to the impact of corruption. This means, when corruption has a negative impact on innovation ("sand in the wheel" theory), we expect to see a positive effect of competition on this relationship. IPR risk will mitigate the harm done by corruption. Alternatively, if corruption promotes innovation ("grease the wheel" theory), when the real patent cost is much higher than the standard patent cost or when the firm has higher bargaining power, we expect IPR risk to make this relationship less significant in magnitude.

Using the World Bank's Enterprise Surveys data, we test these relationships empirically on developing countries, which tend to have inefficient IPR enforcement. Although we are unable to test which theory is true in certain circumstances, empirical evidence from a linear probability model with OLS and instrumental variable specifications support the "sand in the wheel" theory: higher corruption perception impedes innovation. Moreover, IPR risk makes firms less sensitive to corruption, which means competition mitigates the negative impacts.

Our analysis tells us that corruption can negatively affect innovation in different ways. A healthy innovative environment needs a proper institutional set-up that could prevent patent violation and additional profit extortion from rent-seeking activities. Therefore, in order to promote innovation, policies should aim to safeguard firms from bureaucrats' rent extortion and reduce IPR risks, as both of them are harmful to innovation. In the situation where corruption is hard to control, promoting competition may help alleviate the negative effect of corruption, but it is not a panacea because competition itself harms innovation when corruption is prevalent.

Corruption is a complicated and politically sensitive question. This paper has its own limitations given a lack of objective data source regarding corruption. Firms may not be willing to disclose their activities on informal procurement and may inflate their figures on innovation. Future research could investigate more nuanced channels showing how corruption affects innovation. If data is available, researchers could use data on patent and bribe cost to see whether there is actually a tipping point where corruption greases the wheel and increases institutional efficiency. Despite the limitations, I hope this paper shows how corruption affects innovation and how the relationship plays out in economies with weak IPR enforcement.

References

Acemoglu, Daron, and Thierry Verdier. 2000. "The choice between market failures and corruption." *American economic review*, 90(1): 194–211.

Aidt, Toke, Jayasri Dutta, and Vania Sena. 2008. "Governance regimes, corruption and growth: Theory and evidence." *Journal of Comparative Economics*, 36(2): 195–220.

Akcigit, Ufuk, Salomé Baslandze, and Francesca Lotti. 2018. "Connecting to power: political connections, innovation, and firm dynamics." National Bureau of Economic Research.

Andvig, Jens Christopher. 1991. "The economics of corruption: A survey." *Studi economici*, 43(1): 57–94.

Anokhin, Sergey, and William S Schulze. 2009. "Entrepreneurship, innovation, and corruption." *Journal of business venturing*, 24(5): 465–476.

Ayyagari, Meghana, Asli Demirgüç-Kunt, and Vojislav Maksimovic. 2014. "Bribe payments and innovation in developing countries: Are innovating firms disproportionately affected?" *Journal of Financial and Quantitative Analysis*, 49(1): 51–75.

Bardhan, Pranab. 1997. "Corruption and development: a review of issues." *Journal of economic literature*, 35(3): 1320–1346.

Baumol, William. 1998. "Entrepreneurship: Productive, unproductive, and destructive." *Journal of Political Economy*, 98(5): 893–921.

Beck, Paul J, and Michael W Maher. 1986. "A comparison of bribery and bidding in thin markets." *Economics letters*, 20(1): 1–5.

Botrić, Valerija, and Ljiljana Božić. 2017. "Access to finance: innovative firms´ perceptions in post-transition EU members."

Dreher, Axel, and Martin Gassebner. 2013. "Greasing the wheels? The impact of regulations and corruption on firm entry." *Public Choice*, 155(3/4): 413–432.

Ellis, Jesse A, Jared D Smith, and Roger M White. 2015. "Corruption and corporate innovation." *Available at SSRN 2862128*.

Fang, Lily, Josh Lerner, Chaopeng Wu, and Qi Zhang. 2018. "Corruption, Government Subsidies, and Innovation: Evidence from China." National Bureau of Economic Research.

Huang, Qianqian, and Tao Yuan. 2016. "Does political corruption impede firm innovation? Evidence from the United States."

Krammer, Sorin Marius Sebastian. 2013. "Greasing the wheels of change: the impact of corruption on firms innovation in transition economies." 17–19.

Li, Dang. 2016. "Does China's Anti-Corruption Campaign Promote Corporate Innovation?" *China Economist*, 11(2): 95.

Lien, Da-Hsiang Donald. 1986. "A note on competitive bribery games." *Economics Letters*, 22(4): 337–341.

Li, Hongyi, Lixin Colin Xu, and Heng-fu Zou. 2000. "Corruption, income distribution, and growth." *Economics & Politics*, 12(2): 155–182.

Lui, Francis T. 1985. "An equilibrium queuing model of bribery." *Journal of political economy*, 93(4): 760–781.

Méon, Pierre-Guillaume, and Khalid Sekkat. 2005. "Does corruption grease or sand the wheels of growth?" *Public choice*, 122(1-2): 69–97.

Murphy, Kevin M, Andrei Shleifer, and Robert W Vishny. 1993. "Why is rent-seeking so costly to growth?" *The American Economic Review*, 83(2): 409–414.

Paunov, Caroline. 2016. "Corruption's asymmetric impacts on firm innovation." *Journal of Development Economics*, 118: 216–231.

Solon, Gary, Steven J Haider, and Jeffrey M Wooldridge. 2015. "What are we weighting for?" *Journal of Human resources*, 50(2): 301–316.

Veracierto, Marcelo. 2016. "Establishment dynamics, vacancies, and unemployment: A neoclassical approach." *International Economic Review*, 57(4): 1201–1236.

Waldemar, F. 2012. "New product and corruption: Evidence from Indian firms." *The Developing Economies*, 50: 268–284.

World Bank Group. 2009. "Enterprise survey and indicator surveys sampling methodology." *https://www.enterprisesurveys.org/~/media/GIAWB/EnterpriseSurveys/Documents/Methodology/Sampling_Note.pdf*.

Xu, Gang, and Go Yano. 2017. "How does anti-corruption affect corporate innovation? Evidence from recent anti-corruption efforts in China." *Journal of Comparative Economics*, 45(3): 498–519.

Zelekha, Yaron, Gil Avnimelech, and Eyal Sharabi. 2014. "Religious institutions and entrepreneurship." *Small Business Economics*, 42(4): 747–767.

A Appendix

1.

Size	GNI as of 2005	# of manuf. industries	# of services industries	Rest of the economy	Total sample size
Small	\$5-25 billion	2	1	1	480
Medium	\$25-80 billion	3	1	1	600
Large	\$80-200 billion	4	2	1	840
Very Large	>\$200 billion	6	2	1	1080

Table 8: Number of sampled industries based on size of the economy. This is the methodology the survey dataset adopted in selecting which firms to survey.

2.

Ordinal Variables	Label
Corruption	
1	No obstacle
2	Minor obstacle
3	Moderate obstacle
4	Major obstacle
Competition	
0	None
1	One
2	Two to five
3	More than five
Firm Size	
1	Small(<20)
2	Medium(20-99)
3	Large(100 And Over)

Table 9: Value labels for ordinal variables. This shows what the value labels mean for each ordinal variables.