Does bribery sand or grease the wheels of firm level innovation: Evidence from Latin American countries

Nirosha Hewa Wellalage

School of Accounting, Finance & Economics

The University of Waikato,

Hamilton, New Zealand

nirosha@waikato.ac.nz

Sujani Thrikawela

Waikato Institute of Technology

Hamilton, New Zealand

sujani.thrikawala@wintec.ac.nz

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Abstract

This paper examines the effects of bribery on product and process innovation at the firm level in Latin American countries. We provide insights into the heterogeneous effects of bribery on the types of innovations across firms. Using the locality-sector average of bribe payments as a percentage of firm annual sales, we control for endogeneity bias, which is a recurring econometric problem in corruption-innovation studies. Overall, we find evidence to support the 'sand the wheels' hypothesis and argue that this negative effect is slightly higher in process innovation compared to product innovation. Using interaction terms to see the effects of bribery on different firm sizes and institutional structures, we find that bribery hurts firm innovation for micro and small firms, but not for large firms. The results also suggest that the negative

effect of corruption on firm level innovation is stronger for firms in weak institutional environments than for firms in strong institutional settings. Practical interventions to promote strong institutional governance are not easy to arrange when corruption is endemic. Greater awareness of the extortionist environment of companies in these countries in the international community may bring pressures to bear for reform.

Keywords: Bribes, innovations, endogeneity, emerging economies; Latin America

JEL Classification: D73, O3, G30, L25

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1 Introduction

Firm innovations are essential for sustainable economic development and growth as these help in value creation and a country's infrastructure development and employment (Anokhin and Schulze 2009; Ayyagari et al. 2014). However, innovators from emerging economies face considerably high bribing pressure from corrupt public officials (Murphy et al. 1993) and little or no institutional support for innovative firms (Kotabe et al. 2017). In this study, we estimate the effect of bribe payments on firm level innovations in Latin American economies. Additionally, we provide insights into the heterogeneous effects of bribery on the types of innovations across firms and institutions. Given that innovation has been recognized as the main driver of long-term economic growth, a clear understanding of how corruption affects innovation can assist development in emerging economies.

We seek to integrate transaction cost theory (Williamson 1979; Williamson 1987), institutional theory (Scott 2001; Scott 2013) and legitimacy theory (Deegan 2002; Deegan 2014) to understand the effects of bribery on firm level innovation. The literature suggests two competing views: corruption as 'sand in the wheels', where corruption is an involuntary tax (See Fungáčová et al. 2015; Mauro 1995; Reinikka and Svensson 2005), and corruption as 'greasing the wheels' (See Hanousek and Kochanova 2016; Luo 2005; Voskanyan 2000). When firm operators are in a location and sector of prolific bribery, the indirect competitive effects of bribes can affect firm level innovations in two ways. That is, for bribes to facilitate innovation in a locality sector, they should benefit all or most of the bribing firms. Conversely, if bribery helps only a minority of bribing firms and creates negative externalities (Wei and Kaufmann 1999), then firm innovation will deteriorate in a sector or local environment where bribery is commonplace.

Our examination of the relationship between innovation and corruption uses firm-level data for 6,040 firms in Latin American countries. Intrigued by the seemingly high levels of corruption and low levels of business innovation in Latin American countries (Lederman et al. 2014), we undertake an examination of the key variables involved. As a starting point, we investigate whether corruption engenders low innovation or vice versa, or whether both are shaped by other factors. The insights gained from this study potentially offer practical guidance for policymakers, businesses, financial institutions and international bodies. It is important to safeguard the private sector firm in the Latin American region by encouraging innovation, strengthening human capital, increasing productivity, promoting competition, reducing corruption, and the costs of bureaucratic processes.

After controlling for firm characteristics and accounting for the unobservable characteristics of firms which are typically linked to innovation decisions, we find that bribery has a negative effect on firm level innovations, supporting the theory that corruption 'sands the wheels' of firm innovation. The empirical findings in our study show that the negative effect of bribe payments on innovations is slightly higher in process innovation outcomes than in product innovations. We also provide insights into the heterogeneous effects of bribery on innovation across firms. In particular, our results indicate that large and medium size firms are not as severely affected as micro and small firms and may even potentially gain from bribery activities. This indicates that sometimes, bribery is a rational strategic response of large enterprise innovators, compensating for a lack of kinship or political affiliations, and hedging against political risk, although bribery acts as an involuntary "tax" for smaller firms. Further, we find that the negative effect on bribery on firm level innovation is much stronger for firms in weak institutional environments than for firms in strong institutional settings.

This paper expands three different aspects of prior research. Growing evidence in research on economic growth and performance stresses the significant impact of bribery

in firm-level innovation activities (See:Ayyagari et al. 2011; Ayyagari et al. 2014; D'Este et al. 2012). However, the measures of innovation used in those studies rarely distinguish between types of innovations and between types of firms. In other words, insight into the heterogeneous effects of bribery on firm level innovation remains limited in the literature. The only two exceptions to this are Mahagaonkar (2010) who distinguished corruption effects on four types of innovation in African firms and Habiyaremye and Raymond (2018), who distinguished various components of innovation activities and corruption practices in Eastern European and Central Asian firms. While recent Latin American studies like Birhanu et al. (2016) and Gaviria and Pagés (2002) have attempted to model the effects of corruption on economic outcomes, there has been minimal empirical evidence to demonstrate the heterogeneous effects of bribery on firm level innovation, a gap that our paper seeks to address. In addition to extending the analysis of corruption and innovation by exploring the heterogeneous effects of bribes and the relationship between firm level innovation, innovation types, and firm size, we also analyze the corruption behavior of firms in different institutional settings and at different levels of sector- locality corruption. We provide a fresh perspective on earlier studies of corruption in emerging countries and highlight the importance of heterogeneity in policy formulations.

Our second contribution is related to measurements of innovation and bribery. Studies to date largely use indirect proxies such as R&D expenses and patents to measure innovations and country level corruption perception indices to measure corruption (see (Dreher and Gassebner 2013; Lööf and Nabavi 2016; Mancusi and Vezzulli 2010), which do not adequately capture the corruption-innovation nexus of firm behavior in emerging economies. This study employs two direct measures of innovation for product and process, following the recommendation of the *Oslo Manual*, as this provides a more robust measure of firm-level innovation for firms, especially those in non-mature economies. We use firm level estimates of bribery, which captures the non-uniform distribution of bribe payments within a

country, while others reflect aggregate, country-level, views on the extent of bribery[1]. The specific costs of bribery payments for firms directly link the effect of bribery in fiscal terms to the performance of firms.

Our third contribution is methodological. The perceived and actual level of corruption depends on how society and institute accept and follow the rules (Melgar et al. 2010), which depends on unobserved individual characteristics, such as values and moral views. Therefore, the validity of any conclusions drawn about the relationship between corruption and innovation rests on a proper treatment of the potential endogeneity problem. Using the locality-sector average of bribe payments as a percentage of firm annual sales, we control for endogeneity bias, which is a recurring econometric problem in innovation studies.

The remainder of this paper is organized in sections. The next section reviews prior research while Section 3 reports the data, sample and measures used. Section 4 then describes the methods of analysis and Section 5 reports the results from the analysis. Section 6 reports on the robustness testing of this study before the final section offers a discussion and conclusion.

2 Literature Review, Theoretical Background and Hypotheses Development

2.1 Literature Review

Corruption remains the greatest obstacle for sustainable economic development (United Nations 2006) and has been a topic of debate for over 50 years. In recent years, corruption has attracted much attention by economists and policymakers as it underpins social, cultural, and political discrimination by weakening access to public resources, information and decision-

[1] Cooray and Schneider (2018) and Mauro (1995) used country level corruption index as a proxy for corruption.

making. Corruption is defined as acceptance or extortion of money for private benefit by government officials (Tanzi and Davoodi 1997). However, it remains a point of debate as to whether such illegal payments are harmful to economic activities such as productivity, trade, foreign investment, entrepreneurship, or innovation (Krammer, 2017). In the growing stream of research on corruption, the relationship between corruption and innovation has received scant attention (Anokhin & Schulze, 2009) and remains unclear (Wang & You, 2012).

The literature on the effects of corruption on innovation has two opposing views. One branch of literature depicts corruption as being sand in the wheels, wherein corruption is likely to have detrimental effects on firms (Avnimelech et al. 2014; Dincer 2019; Fungáčová et al. 2015; Mauro 1995; Reinikka and Svensson 2005). In particular, a bribe amounts to a tax on firms and constitutes an obstacle to firm growth (Fungáčová et al. 2015), increases uncertainty (Shleifer and Vishny 1993), limits access to credit (Hewa Wellalage et al. 2019), and reduces foreign investments (Cuervo-Cazurra 2006). Corruption undermines the foundations of institutional trust, which is necessary to develop innovative activities (Habiyaremye and Raymond 2013). It has been argued that corruption increases transaction costs, which makes innovative opportunities much less attractive (Luo 2005).

The opposing view argues that corruption greases the wheels, claiming that in emerging economies, corruption is likely to have beneficial effects for firms suffering from obstructive private monopolies and government practices (Goedhuys et al. 2016; Kabadurmuş 2017; Voskanyan 2000). Hanousek and Kochanovac (2016) argue that the positive effects of bribery on a firm can outweigh the negative effects. Corruption can speed up the slow-moving permit queue (Luo, 2005), and enable licenses to be easily and quickly issued (Bertrand, Djankov, Hanna, & Mullainathan, 2007; Huntington, 2006), thereby reducing the transaction costs associated with the new product or process development. A recent study by Krammer (2017) confirms the greasing the wheel effect by employing data from over 6,000 firms in 30 emerging

markets. In support of this view, Krastanova (2014) finds that for Bulgarian firms, paying bribes minimises bureaucratic hurdles and speeds up product innovation.

Table 1 review the most recent literature related to corruption and innovation studies.

<<INSERT Table 1 here>>

Given that the effects of bribery on firm level innovation remains a subject of debate, further work is required to understand how bribes impact on firm level innovation in emerging economies.

2.2 Theoretical Considerations and Derived Hypotheses

This paper draws on three main theoretical frameworks: transaction cost theory, institutional theory, and legitimacy theory, all of which lead to the development of the hypotheses in this study.

Transaction cost theory suggests that every transaction in an organization produces costs in terms of coordinating, monitoring, controlling and managing transactions but that firms can minimize these costs with an optimum organization structure (Williamson 1979; Williamson 1987). Corruption increases costs in relation to searching for information, negotiation, monitoring and enforcement costs, all of which increase transaction costs and the final cost of the given goods or services (Lambsdorff 2002). On the other hand, corruption can decrease costs if it enables the organization to avoid significant delays in obtaining official approvals. Transaction costs exist in an innovative environment (Ayyagari et al. 2011; Hsieh et al. 2016), which suggests that the relationship between corruption and transaction costs is involved in explaining innovation outcomes (Barasa 2018).

Institutional theory suggests that an organization's activities and behavior are affected and encircled by the political, social and economic systems surrounding the organization (Scott

2001). This theory provides a rich and complex view of an organization and has spread rapidly due to the influence of institutional actors on organizational and decision-making processes (Hoskisson et al. 2000). The institutional environment can have two dimensions: formal and informal. The development of innovations is centered on a formal institutional environment (Williams and Vorley 2014). The formal environment refers to codified rules and regulations that govern the interaction among the different economic actors. The literature indicates that a well-developed formal institutional environment deters the rent-seeking behavior of economic participants (Tambunan 2007) by creating a strong platform for innovation (Manolova et al. 2008).

According to legitimacy theory, the actions of a firm should be appropriate within the socially constructed system of values, norms and beliefs of their respective society (Suchman 1995). However, these bounds and norms are not fixed and change over time. Firms continuously seek to ensure whether their activities are acceptable to the community in which they operate (Deegan 2002; Deegan 2014). In other words, legitimacy is a relative concept to the social system in which the company operates. To determine what establishes legitimacy, firms rely on indications from the institutional environment (Chizema and Pogrebna 2019) and act in strict compliance with the terms of their societal values (Deegan 2002). The level of social and political pressure placed on firms as they carry out their operations signal the extent to which their activities are deemed acceptable by society (Deegan 2014). If a firm is in an institutional environment where high corruption and unethical practices are rife, corruption may have a significant effect on a firm's actions in its search for institutional legitimacy' (Keig et al. 2015).

We propose that legitimacy theory has a role in explaining perceptions of bribery and firm level innovation. That is, the behaviors of a firm, such as the use of bribes, are subject to institutional pressures in the market, especially corrupt officials in government bureaus.

Furthermore, to overcome various institutional pressures in the emerging markets on innovations and to thrive in the business environment, entrepreneurs must use bribes (Krammer 2017). Therefore, bribery will become the norm of competence when deploying new products into the market (Krammer 2017; Luo 2005).

2.1.1 Hypotheses development

Corruption has a significant impact on firm level innovation activities, which in turn affects the country's economic environment (Ayyagari et al. 2014; Barasa 2018). It is generally agreed that corruption has a negative effect on a country's growth, and it undermines the foundations of institutional trust, which is necessary to develop innovative activities (Habiyaremye and Raymond 2013). According to transaction costs theory, corruption will increase transaction costs in the market, which leads to hindering entrepreneurial innovation activities (Chadee and Roxas 2013; Zhu et al. 2012). These high transaction costs arising from corruption may lead to a decrease or a complete withdrawal from innovation by firms (Fan et al. 2017; O'Connell 2016).

Compared with non-innovators, innovating firms have a greater likelihood of paying more bribes as they interact more with government employees. In particular, Ayyagari et al. (2014) find that, in a sample of 57 countries, corruption acts as a tax on innovation because bribe payment is higher among innovating firms than in non-innovating firms. Furthermore, they confirm that when obtaining government services, the innovating firms that pay bribes do not receive greater benefits than firms that do not pay bribes. Innovating firms must pay a higher percentage of the contract value as a bribe and this discourages innovations. Nevertheless, even if bribing expedites individual transactions with bureaucrats, its purpose will fail in the long term, since the number of such future transactions will increase and offset any likely gains (Wei and Kaufmann 1999). Thus, we formulate our first hypothesis as follows:

H1: Corruption has a negative impact on firm-level innovation

The impact of corruption may vary depending on firm size (See Hanousek and Kochanova 2016; Paunov 2016). In particular, the literature indicates that the detrimental effects of corruption are reduced when firm size is increased (See Paunov 2016; Shleifer and Vishny 1993). Small innovative firms have a high level of vulnerability to public corruption compared with firms that are already established (Zhou and Peng 2012; Zhu et al. 2012). Unlike larger well-established firms, small innovative firms are continually involved in innovative activities, such as changing factory layouts, acquiring equipment, importing new products, or registering a new logo for a new product. As a result, government officials who have power over these processes receive attention from these types of firms (Murphy et al. 1993).

Using firm level data for 48 developing and emerging countries, Paunov (2016) emphasizes that paying informal gifts and payments to obtain business license/quality certificates have a stronger negative impact on smaller firms than for larger firms. These smaller firms normally have less resources to draw on when bribing public bureaucrats and they always receive fewer benefits from patents and quality certificates. The literature reports that corruption may temper the negative effect of small firm innovation rather than for large firms (See Clarke and Xu 2004; Schiffer and Weder 2001). This may be the result of small firms engaging in forceful bribery whereas large firms engage in strategic bribery (Zhou and Peng 2012). Overall, we can conclude that an increase in firm size decreases the negative impact on firm level innovation. Thus, we formulate our hypothesis as follows:

H2: An increase in firm size positively moderates the relationship between paying bribes and firm level innovation.

Institutional theory suggests that firms seek external legitimacy by complying with their institutional context (Glynn and Abzug 2002). Corruption affects firm legitimacy through its

effects on formal and informal activities (Rodriguez et al. 2005). In a business environment where rules and regulations are weak, corruption and bribery often exist in day-to-day life, making firms susceptible to this value system (Krammer 2017).

According to transaction costs theory, corruption can either improve or weaken firm performance through transaction costs (Fan et al. 2017; O'Connell 2016). Corruption is less damaging and is sometimes beneficial within a weak institution's structure for several reasons (Dreher and Gassebner 2013; Méon and Sekkat 2005). In fact, corruption may be positively associated with overcoming bureaucratic processes, and unclear or complex regulations (Agrawal and Knoeber 2001; Khwaja and Mian 2005) in a weak institutional environment where the costs of prevention usually outweigh the benefits (Acemoglu and Verdier 2000). Emerging economies report that bribes facilitate innovation by reducing queues (Krammer 2017; Nguyen et al. 2016). Bribes present as an attractive alternative to circumventing red-tape and reducing the negative effects of nepotism and political favouritism by shielding innovative firms against the political risk in many emerging markets (Kasuga 2013). Krastanova (2014), for instance, finds that for Bulgarian firms, paying bribes minimises bureaucratic hurdles and speeds up product innovation. Our next hypothesis is as follows:

H3: Better developed institutional environments weaken the relationship between paying bribes and firm level innovation

3 Data and sample

The current study extracted data from the World Bank 2016 and 2017 Enterprise Surveys[2]. The World Bank's Enterprise Survey database includes both qualitative and quantitative data at the

2 The World Bank's Enterprise Surveys offer an expansive array of economic data on 135,000 firms in 139 countries. Its website (http://www.enterprisesurveys.org/data) provides details as to how the surveys are

firm level. These surveys comprise a representative random sample of firms with data collected across the world by using the same core questionnaire and the same sampling method. The most recent Enterprises survey provides data for eleven Latin American countries (Argentina, Bolivia, Colombia, Ecuador, El Salvador, Paraguay, Peru, Guatemala, Honduras, Nicaragua and Uruguay), which are all included in our study sample. The surveys employ stratified random sampling techniques with identical questionnaires across all countries. This stratified random sampling ensures a representative sample, which minimizes sample selection biases in data analysis. The strata for Enterprise Surveys are firm size, business sector, and geographic region within a country.

Table 2 displays the total study sample of the paper. The net result is a sample of 6,040 firm-level observations. The sample covers micro, small, medium and large firms.

Table 2 also reports the bribe payments (as a percentage of total sales) level of each county in the sample. Peru pays more bribes than other countries in the sample. The second largest bribe-paying country is Bolivia. We also report the 2017 Corruption Perception Index (CPI) values for each country. The index reports that, with the exception of Uruguay, all countries score below 39, which, in 2017, is below the average world score of 43.

<< INSERT Table 2 here>>

3.1 Variables

Following Wellalage and Fernandez (2019), Gorodnichenko and Schnitzer (2013), and Mahagaonkar (2010), this study uses product innovation and process innovation (dummy

conducted. An Enterprise Survey is a firm-level survey of a representative sample of an economy's private sector. The surveys cover a wide range of business environment topics including innovation, corruption, crime, access to finance, firm ownerships, infrastructure, competition and performance measure.

variables) as proxies for firm level innovation. Product and process innovation variables were derived from the following survey question(s):

> *During the last three years, has this establishment introduced new or significantly improved products or service methods of manufacturing products or offering service?*

The direct measures of innovation are more appropriate for our study for two reasons. First, in a given context, most sample firms are not engaged in R&D and patents (approximately 10% report R&D expenditure and no patents information available for this sample of firms). This aligns with the view that the traditional measures of innovation (such as R&D expenditure and patents) are less likely to be observable in domestically owned small firms (Acemoglu et al. 2006) and in emerging markets (Gorodnichenko and Schnitzer 2013). Second, indirect proxies such as R&D expenses and patents fail to adequately capture the innovative behavior of firms in developing economies (Lööf and Nabavi 2016; Mancusi and Vezzulli 2010). An important way for firms in emerging markets to catch up with developed markets is by adopting innovation from elsewhere (Acemoglu et al. 2006; Ayyagari et al. 2011; Ayyagari et al. 2014). Proxies provided by the *Oslo Manual* adequately capture both innovations new to the firm and innovations new to the world (Wellalage and Fernandez 2019).

However, following prior research, we acknowledge the subjectivity of these self-reported measures of innovation, compared to more objective measures, such as patent and R&D investments (See Gorodnichenko and Schnitzer 2013; Wellalage and Fernandez 2019). In order to verify the robustness of our results, we use R&D expenditures as a proxy for innovation as well.

Our main independent variable is *Bribes(p),* This takes a value ranging from 0 to 100 as a percent of annual sales. In terms of corruption perception indicators, this monitory value

of corruption improves its accuracy (Méndez and Sepúlveda 2009; O'Toole and Tarp 2014). It has been derived from the following interview question in the Enterprise Survey:

> *"It is said that establishments are sometimes required to make gifts or informal payments to public officials to 'get things done' about customs, taxes, licenses, regulations, services, etc. 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 Enterprise Survey, 2016/2017)

By their very nature, corrupt activities do not offer much in the way of paper trails. Therefore, this question represents the best available information to create a proxy for bribes. The World Bank data collection is carried out independently, is unconnected with government officials, and ensures the anonymity of participants. This minimizes measurement errors in the *Bribes(p)* variable. Also, in referring to 'establishments like this' the question serves to elicit candid responses (Billon and Gillanders 2016). This indirect formulation of the question implies that respondents are not asked to admit that their firm has paid bribes but to gauge the behavior of similar types of firms. Although seemingly less precise, this approach reduces self-censorship biases, which proliferate in socially sensitive research.

Table 1 in the Appendix presents definitions and metrics for all variables included in the models.

Table 3 panel A shows descriptive statistics of the full study sample. Panel B reports descriptive statistics of the sample, based on the size (large, medium, small and micro) of respective firms. Approximately 24% of firms are large firms, 34% are medium size, and 42% belong to the small and micro category. Table 3 shows that the mean value of the product and process innovation is 64% and 47% respectively for the full sample. However, Panel B illustrates that the percentage of firms engaged with firm level innovations are reduced

according to firm size. In fact, the mean value indicates that about 72% of large firms are engaged in product innovations and 52% of large firms are engaged in process innovations. Meanwhile, only 56% of micro firms are engaged in product innovations and 36% in process innovations. Of the entire sample, about 18% of annual sales are paid out in the form of informal payments or gifts to public officials. This indicates the existence of a high level of corruption, where firms make some form of payment and regular payment. This percentage is higher in large firms, which is approximately 19%. Panel B shows that medium size firms pay 18%, small firms pay 17%, and micro firms pay 13% of their annual sales as bribes. A reason for this pattern may be that large firms, because they are likely to have more opportunities to interact with government officials, encounter more instances of requests for bribes from government officials. In the same vein, micro and small firms have far less contact with government officials and therefore lack the same opportunities to engage in corruption.

<<INSERT Table 3 here>>

4 Method

Given the dichotomous nature of innovation dependent variables (*Product_Inno* and *Process_Inno*), we use a discrete probability model

$$Pr\left(Inno_{i,j} = 1\right) = \emptyset(\propto + \beta Bribes\%_{i,j} + Control\ Variables + \varepsilon_{i,j} \text{------(1)}$$

where *Innovation* is a dummy variable which takes the value of one if the firm introduced a new or significant improvement of the product (*Product_Inno*) or process (*Process_Inno*), and zero otherwise. The subscript i and j refer to firm and country respectively. $\emptyset$ is the standard normal cumulative distribution. $Bribes\%_{i,j}$ refers to the informal payment percentage for the firm. The range of firm and country controls are included as the vector of control variables.

4.1 Endogeneity

The main concern in micro econometric analyses on the impact of corruption is endogeneity.

Apart from the omitted variable bias and measurement errors that occur when corruption is jointly determined with innovation, there is a simultaneity problem, which leads to a spurious relationship between innovation and corruption (Hewa Wellalage et al. 2019). Bribe payments may contribute to a reduction in the innovation of firms as they pose additional costs to firms. A bribe effectively amounts to a tax on firms and so creates an obstacle to innovation. Conversely, highly innovative firms may use a high level of corruption to overcome bureaucratic processes and complex regulations in accessing limited resources. A firm's decisions to pay bribes and engage in innovations can be unobservable, and these unobservable factors would be correlated with both innovation and bribes simultaneously, giving rise to an endogeneity problem.

Angrist and Krueger (2001) explain that instrumental variables (IVs) methods are widely used to control simultaneity and measurement errors in an endogenous relationship. In addition to this, recent studies use IVs to overcome an omitted variables problem (Fisman and Svensson 2007; Qi and Ongena 2018; Wellalage et al. 2018). We follow the approach of Fisman and Svensson (2007) and Qi and Ongena (2018), using the Bribes(p) by a locality-sector average of bribery (Avg_Bribes(p)) as an instrument.

For each country, we have firms in 4 localities and 27 industries. Altogether, our sample contains 108 variations in the instrument for each country, indicating the strength of the instrument. Locality-sector average of bribes(p) captures the institutional environment in the locality, business methods, and rent extraction preferences of bureaucrats, which are factors exogenous to the firm. However, instrumentation of firm-level bribery existence by a locality-sector average of bribes(p) eliminates the omitted unobservable biases correlated with bribery at the firm level, but not at the locality-sector level (Qi and Ongena 2018). Econometrically,

the most common guideline for determining the relevance of selected instruments are in the first stage equation in the F-test for joint significance. If the F-test for joint significance exceeds the value 10, this indicates that the selected instrument is accepted as relevant.

Unlike control variables, an instrumental variable (Avg_Bribes(p)) is assumed to have no direct effect on the outcome (Innovation). Instead, the effect of the Avg_Bribes(p) on the Innovation (Product_Inno and Process_Inno) is entirely mediated via its effect on treatment assignment. In other words, this indicates that our instrument variable is satisfied with an exclusion restriction condition (Heckman et al. 2006). To determine whether bribes(p) have a causal effect on innovation, we use the instrumental variables Avg_Bribes(p).

5 Results

5.1 The impact of bribes on firm level innovation

Table 4 column 1 and 5 report probit estimation (marginal effect) results in assuming that the model contains no endogenous regressors. The marginal effects of our main variable of interest, Bribes(p), turns out to be positive and significant for both product and process innovations, indicating that increases in bribe payments lead to higher firm level innovations. This incoherent positive effect may be due to the endogeneity of the Bribes(p) variable. Also, prior studies allude to the way in which innovation studies are influenced by common factors of unobserved heterogeneity (See Savignac 2008). The unobservable risks for the firm on the outcome of innovation may also influence the bribe payment of the firm. On the one hand, innovative firms are more likely to be paying high bribes to facilitate innovative activities, while on the other hand, bribes may also discourage firms from engaging in innovation. To correct the problem of endogeneity mentioned above, we re-estimate Equation (1) using the instrumental variable approach.

In the first stage, the endogenous variable (Bribes(p)) is regressed on the instrument (Avg_Bribes(p)), along with any other exogenous variables (controls) and these are reported in column 2 and 6 of Table 4. We also report diagnostic tests for the weak instrument. We have only one endogenous regressor; therefore, we can compare Stock and Yogo's thresholds (in here 10%) and Cragg-Donald F statistic. Our Cragg-Donald F statistics (F statistics for Product Innovation is 144.71 and process innovation is 140.99) are higher than the Stock and Yogo's thresholds (16.38), enabling us to conclude that the instruments are not weak. The under-identification test (Anderson canon. corr. LM statistic) indicates that the instrument is relevant.

After correcting for the endogeneity bias, the coefficient of our main variable of interest turns out to be negative and significant (Column 3 and 7). This indicates that with every one unit (percent in the case of our study) increase in the Bribes(p) on average, there is a decrease of 0.036 (3.6% in here) in the probability of the product innovation taking the value of 1. Likewise, every one unit (again, percent in our study) increase in the Bribes(p) on average leads to a decrease of 0.039 (3.9% in here) in the probability of the process innovation taking the value of 1. This indicates that firms paying bribes are less likely to be innovative. Our finding supports the argument that bribing has a sand in the wheels effect on firm innovation (Fungáčová et al. 2015; Mauro 1995; Reinikka and Svensson 2005). In particular, the study by Fisman and Svensson (2007) found similar results in that a one percentage point increase in the bribery rate reduces firm growth in three percentage points. Based on the foregoing discussion of transaction costs, our results indicate that corruption increases the transaction costs, which hinders the potential scale and scope of the innovation. Based on the institutional theory argument, corruption may hinder innovation in two ways. First, when the corruption level increases, the public loses its trust in the system as a whole (Zelekha 2013). When trust in institutions is weak, firms become reluctant to proceed with risky, innovative projects which project ambiguous future profits. On the other hand, corruption is ex post opportunistic. In a

weak institutional environment, a public official can demand additional payments even after the initial undertaking because bribing behavior is not supported by any legal institutions. Thus, we accept our H1: Corruption has a negative impact on firm-level innovation.

A comparison between the two types of innovations shows that bribes have a particularly strong effect on process innovation outcome. In fact, the magnitude differences show that bribing has 0.3% more negative impact on process innovation than on product innovation. Process innovation may be difficult to identify compared to product innovation. The number of new product ideas or patents can be directly or partially evaluated by external parties. Therefore, the opaqueness and information asymmetry in product innovation is less, and consequently, decreases the ability of public officials to extract rent from product innovators than from process innovators. Thus, we can argue that the negative effect of bribing is higher in process innovation than in product innovation.

The Bribes(p) proxy is inherited from the survey question which purposefully contains the phrase 'establishments like this.' This implies that respondents are not asked to confess that their own establishment has paid bribes but to gauge the behavior of other establishments. Therefore, one can argue that any disclosures of bribery are not necessarily confessions of personal involvement. That said, such disclosures may still come from firms which may find themselves paying bribes in the near future (Birhanu et al. 2016), because when operating in the same institutional environment, non-bribe paying firms may be at a disadvantage. Because of the sensitive nature of bribery activities, prior research relies on this as a proxy for firm-level corruption. Therefore, following prior researchers (Ayyagari et al. 2014; Birhanu et al. 2016; Hewa Wellalage et al. 2019; Wellalage et al. 2018), we interpret this measure as firms that have paid bribes. However, skeptical readers can interpret this as firms that think their peers have paid bribes.

5.2 Heterogenous effects of bribery on firms

Columns 4 and 8 of Table 4 show the heterogeneous effects of bribery on innovation across firms.

The coefficient on Avg_Bribes(p), the main effect for micro and small firms, is negative and significant, indicating that bribery has a detrimental effect on the innovation performance of micro and small firms. In particular, this negative effect is higher in process innovation (β= .076) than in product innovation (β= .075). In product innovation results, for large and medium size firms, the marginal effects of the bribes variable and of the interaction between the bribes variable and the two size variables cancel each other out (i.e. β=-.075+β=.075). In other words, the net effect is inexistence. In relation to process innovation, for large firms, the marginal effects of the bribes and size interaction are slightly positive (β=-.076 + β=.077) and for medium firms, the marginal effects of the bribes and size interaction cancel each other out (i.e. β=-.076+β=.076).

Table 5 reports the sub-sample analysis. Large firms show an insignificant but positive effect of bribes on firm product innovation (β=.021). When firm size decreases, the significant negative effect of Bribes(p) gets stronger (β values for firms are as follows: medium firm = -.043, small firm = -.048 micro firm = -.058). Large and medium size firms show a positive relationship between bribes and firm process innovation, while small and micro firms show a negative relationship. This indicates that large and medium size firms are not as severely affected as micro and small firms and potentially, they may even gain from bribery activities.

The institutional theory argument holds that when operators in micro and small firms are in a weak institutional environment and have weak property rights, the smallness of their organisations increases the risk of government interference and expropriation (Zhou and Peng 2012). Put simply, large firms may be less vulnerable to corruption than smaller firms. In

addition, the negative impact of bribery on small firms is especially pronounced because the same amount of money paid for a bribe drains a disproportionately larger chunk of resources for smaller firms than for larger firms (Zhou and Peng 2012). Thus, we accept our H2: An increase in firm size positively moderates the relationship between paying bribes and firm-level innovation.

<<INSERT Table 4 here>>

<<INSERT Table 5 here>>

5.3 Analysis of institutional environment effects on the relationship between bribes and innovation

Rather than considering country level institutional environment factors and categorizing institutional environments as weak or strong, we used micro level factors to determine institutional quality. In this study, we used micro and small firms as well, so even in strong institutional environments, they may encounter obstacles to their business growth. For such cases, the quality of the institutional environment at country level is not appropriate for micro and small firms. Therefore, we create an *Institutional quality* variable using levels of obstacles for the following five items: tax rate, tax administration, business licensing and permits, macroeconomic stability, and political instability.

The coefficient on Avg_Bribes(p), is negative and significant, indicating that regardless of firm institutional environment quality, bribery has a sand in the wheels effect on the product innovation (β= -.009) and process innovation (β= -.009) of firms. The significant and negative relationship is shown in interaction variable (Bribes(p) X level of institutional weakness) and firm level product innovations (β= -.119 +-.009=-.128) and process innovations (β= -.113+-.009=-.122). This indicates that bribes have more detrimental effects in firms in weak institutional environments compared to firms in strong institutional environments. The results

show that the negative effect is slightly more compelling in product innovation than in process innovation. Firms engaging in product innovation often need patents and licensing, requirements which necessitate interactions with government officials, more so than firms engaging in process innovation. In a weak institutional environment, government officials hold a high level of discretion over law enforcement and resource allocation (Zhu et al. 2012) which provides more opportunities for public officials to abuse their power for private benefits and to solicit illegal payments from firms (Murphy et al. 1993).

<<INSERT Table 6 here>>

5.4 The relationship between innovation and bribes at different levels of sector-locality corruption

The relationship between bribery and firm level innovation varies according to the level of corruption in the operating sector and locality. Figure 1 shows the predicted probabilities of being a product or process innovator and paying bribes[3] at different levels of sector-locality corruption. Figure 1 (A) shows that regardless whether a firm pays bribes or not, (bribes=1 or 0), the probability of product innovation decreases for firms when they operate in severely corrupt sectors and localities. The impact is high for non-bribe paying firms. For bribe paying firms, this ranges from 77.7% probability of innovation when Sec_Avg is reported at its minimum level to 39.5% when Sec_Avg is at its maximum level with a confidence level of 95%. For non-bribe paying firms, this ranges from 72% probability of innovation when sec_Avg is reported at its minimum level to 19.6% when Sec_Avg is at its maximum level with a confidence level of 95%.

[3] Determines the existence of a bribe or not: 1= yes; 0= otherwise.

Figure 1 (B) shows that the probability of process innovation increases for firms engaged in bribes (bribes=1) when they operate in highly corrupted sector and locality, ranging from 53.1% probability of innovation when Sec_Avg is reported at its minimum level to 64.7% when Sec_Avg is at its maximum level with a confidence level of 95%. In contrast, for non-bribe paying firms, the probability of process innovation decreases, ranging from 49.6% probability of innovation when Sec_Avg is reported at its minimum level to 29% when Sec_Avg is at its maximum level with a confidence level of 95%.

Overall, this result indicates that the firms paying bribes acquire a competitive advantage over other firms when they operate in highly corrupt sectors and localities. This result suggests an indirect "greasing" effect of bribes in overcoming bureaucratic barriers.

<<INSERT Figure 1 in here>>

Table 7 reports the summary of empirical results and related hypotheses.

<<INSERT Table 7 in here>>

6 Robustness

(i) Alternative proxy of bribes

We use an alternative measure of bribes as a proxy for Bribe(p) and re-run the regression. The alternative measure *Obs_Corruption* takes value one if firms report that corruption is a major or very severe obstacle to the current operations of the firm, and zero otherwise. The descriptive statistics indicate that 66.15% of sample firms have indicated that corruption is a major or very severe obstacle to their current operations. We first use baseline probit to estimate the effect of corruption on firm-level innovation, assuming an exogenous relationship between explanatory variables and Product_Inno and Process_Inno. However, to address endogeneity bias, we use the locality-industry sector average of the total time spent by senior management

on dealing with requirements imposed by government regulations in a typical week (*Avg_Mgr_time*) as an instrumental variable. This is based on the reasoning that, in an environment with high levels of corruption, managers need to spend more time dealing with regulations.

The estimates of the coefficients in the regressions with the new bribery proxy are negative and significant -- similar to those derived from our baseline regression. However, the marginal effects found in our results indicate that the IVProbit magnitudes are slightly smaller. This suggests that our results are not influenced by the construction of the bribery proxy.

<<INSERT Table 8 here>>

(ii) Propensity score matching using bribes as a dummy variable

Nonresponsive and measurement errors are clearly visible in the bribe amount variables (Ayyagari et al., 2014). Therefore, we reanalyze our data using a dichotomous variable of bribes, instead of using Bribes(p). Innovative firms may exaggerate or under report bribe amounts, therefore, a dummy variable of 'bribes' may be more accurate.

Using the propensity score method (PSM), we compare the innovation of firms exposed to no treatment *T=0* (non-bribe payments) and the innovation of firms exposed to treatment *T=1* (paying bribes). Since only one of these outcomes is observed for each firm, we estimate the average treatment on the treated (ATT), that is, the difference in innovation between those treated and those with the same probability of being treated (Cox-Edwards and Rodríguez-Oreggia 2009; Ichino et al. 2008). We use four matching methods: stratification matching; nearest neighbor matching; kernel matching; and radius matching, following (Becker and Ichino 2002). The standard error for the ATT is calculated, using a bootstrapping procedure, from the standard deviation of the ATT involving 100 bootstrap replications. In all matching models, the ATT is significant and negative for both product and process innovations. For

product innovations, the magnitude of the ATT ranges from 0.105 with the radius matching method to 0.115 with the nearest neighbor matching method. This indicates that the estimated average negative effect of paying bribes on product innovation outcomes for firms which engaged in bribery is 11%. The estimated average negative effect of paying bribes on process innovation for firms which engaged in bribery is 10% (excluding nearest neighbor matching). By comparing the propensity score method with IV probit, we see that the same order of magnitude in IV probit and ATT, confirming the robustness of our main results.

<<INSERT Table 9 here>>

We report the covariate balance summary for product and process innovations to confirm the validity of our PSM model. The matched sample results (Table 2 in the Appendix) indicates that matching on the estimated propensity score balanced the covariates. In "Matched" group, the standardized differences are all close to zero for each covariate for product and process innovation. This confirms that the covariate balance is satisfied.

Also, we run a series of t-tests comparing the means of the treatment and control group variable by variable after the matching. The mean differences between treated and control variables are not significant at the 5% level, which indicates all covariates are balanced after matching. This is about what we expect by chance, so it seems randomization has succeeded in generating balance.

(iii) Instrumental variables (2SLS) regression with R&D as a dependent variable

We verify our results using R&D as our innovation proxy. Studies to date largely use R&D expenses as an indirect proxy of innovations (see (Dreher and Gassebner 2013; Lööf and Nabavi 2016; Mancusi and Vezzulli 2010). Although our results were insignificant for both OLS and 2SLS, the coefficient sign indicates a significant negative relationship between Bribes(p) and R&D expenses.

<<INSERT Table 10 here>>

7 Discussion and conclusion

This study empirically examines the relationship between corruption and firm level innovation in Latin American firms. We further analyze the heterogeneity effects of bribery on the types of innovations across firms. In addition, this paper examines whether a weak institutional environment increases the adverse effects of corruption on firm level innovation. Although corruption is a major concern in emerging economies, how corruption affects innovation has received limited attention. The results suggest that bribing has a significant negative effect on firm level innovation. The negative effect is slightly higher (0.3%) for process innovation than for product innovation. This result is robust to various specifications.

Further, we find that the increases in firm size positively moderate the relationship between paying bribes and firm level innovation. In other words, corruption has a more detrimental effect on small firm innovation than on large firm innovation. In the results for product innovation for large and medium size firms, the marginal effects of the bribes variable and of the interaction between the bribes variable and the two size variables cancel out. In the results for process innovation for large firms, the marginal effects of the bribes and size interaction are slightly positive whereas for medium firms, the marginal effects of the bribes and size interaction cancel out. The interaction terms on bribes and weak institutional environment have a negative and significant effect on the product and process innovation proxies, implying that a weaker institutional environment magnifies the negative effect of bribes on innovation. Finally, we find that the relationship between bribery and firm level innovation may vary according to the operating sector of the firm and the corruption level of its locality.

Overall, we find that corruption negatively affects firm level innovations, which aligns with the view of development experts. Even though corruption is less damaging for large firms, it remains a pervasive obstacle to a nation's overall economic and social development. This obstacle can be overcome by having strong regulatory and governance mechanisms, as negative effects of corruption are magnified in weak institutional structures. A weak institutional environment can lead to corruption and may encourage the practice of high levels of bribery to circumvent red tape, nepotism and political favoritism. A highly professional civil service with attractive fringe benefits and improved government regulatory systems with more protocols can control corruption in this region. Practical interventions to promote strong institutional governance are not easily established when corruption is endemic. Greater awareness in the international community of the extortionist environment of companies in these countries may bring pressures to bear for reform.

There are consequences for adopting institutional level strategies in product and process development when engaging in bribery in a weak institutional environment. To encourage entrepreneurs to engage in more innovative activities, emerging markets should have well-structured national level policies and efficient administrative mechanisms, such as preferential tax structures, efficient customs procedures, a consistent policy framework, and stringent regulations to eliminate malpractices by reducing bribery that adversely impacts the country's innovations and firm performances. Once there is more robust legislative control and monitoring of corruption, this will allow firms to mitigate any discriminatory treatment of bureaucrats without resorting to bribery. Ultimately, this will erode the relationship between corruption and innovation in emerging markets.

Our study has limitations, some of which may be possible avenues for future research. In this paper, we contribute to the firm-level empirical research on bureaucratic corruption and firm innovation. Future studies can consider macro level cross country analysis on the

incidence and depth of bribery and its relationship to levels of innovation. Also, as future data on corruption becomes more available, studies may seek to further unbundle the types of corruptions that exist and to establish more proxies for innovation. This would allow researchers to further their understanding of the differences between the various types of bribes that exist and their respective impacts on innovations.

Compliance with Ethical Standards

Conflict of interest: The authors declare that they have no conflict of interest.

Appendix

Table 1: Definition and measurement of variables included in the models.

Explanatory Variables	Definition	Measurement
Product_Inno	Product innovation designates that a firm has introduced new or significantly improved products or services during the last three years	1 = yes; 0 = otherwise
Process_Inno	The process innovation designates that a firm has introduced new or significantly improved methods of manufacturing products or offering services during the last three years	1 = yes; 0 = otherwise
Bribes(p)	Total annual bribe payments as a percentage of firm annual sales	Percentage
Formal_Fund	The proportion of the firm's working capital financed by banks and non-bank financial institutions	Percentage
Informal_Fund	The proportion of the firm's working capital financed by trade credit, money lenders, friends and family	Percentage
Own_Fund	The proportion of the firm's working capital financed by internal funds or retained earnings	Percentage
Sole_Prop	Legal status is a sole proprietorship	1 = yes; 0 = otherwise
Partnership	Legal status is a partnership or limited partnership	1 = yes; 0 = otherwise
Company	Legal status is a shareholding company (private or public).	1 = yes; 0 = otherwise
Other_firms	Legal status is other than that of the above three groups	1 = yes; 0 = otherwise
Domestic_Owned	Percentage owned by private domestic individuals, companies or organizations	Percentage
Foreign_Owned	Percentage owned by private foreign individuals, companies or organizations	Percentage
Government_Owned	Percentage owned by the government or state	Percentage
Other_Owned	Percentage owned by others outside of the above three groups	Percentage
Female_own	At least one female owner, amongst the owners of the firm	1 = yes; 0 = otherwise
Firm_age	Number of years from the date of establishment	Years
Email	Firm has work email	1 = yes; 0 = otherwise

Website	Firm has company website	1 = yes; 0 = otherwise
Political_Instability	Severity of political instability as an obstacle to the current operations of the firm	0 to 4
Court_Instability	Severity of impartial court system as an obstacle to the current operations of the firm	0 to 4
Manufacturing	Firm representing the manufacturing industry	1 = yes; 0 = otherwise
Retail	Firm representing the retail industry	1 = yes; 0 = otherwise
Other_Industry	Firm representing an industry other than manufacturing and retail	1 = yes; 0 = otherwise
Large	100 or more employees	1 = yes; 0 = otherwise
Medium	Between 20 and 99 employees	1 = yes; 0 = otherwise
Small	Between 6 and 19 employees	1 = yes; 0 = otherwise
Micro	Between 0 to 5 employees	1 = yes; 0 = otherwise

Table 2: Covariate balance summary

	Product innovation		Process innovation	
	Raw	Matched	Raw	Matched
Number of Obs	3980	7960	3978	7956
Treated Obs	2700	3980	2697	3978
Control Obs	1280	3980	1281	3978

	Product Innovation Standardized differences		t-test (Treated and control)*	Process Innovation Standardized differences		t-test (Treated and control)*
	Raw	Matched		Raw	Matched	
Formal_Fund	.078	.019	-.480 (.631)	.078	-.019	.977 (.482)
Infromal_Fund	.143	-.026	-1.56 (.116)	.144	-.008	-.783 (.433)
Own_Fund	-.178	-.001	1.71 (0.09)	-.180	.018	.174 (.298)
Sole_Prop	-.061	.002	-1.18 (.237)	-.061	-.017	-1.26 (.207)
Partnership	-.028	-.007	.575 (.565)	-.026	-.011	.263 (.206)
Company	.066	.007	.015 (.988)	.065	.022	-.570 (.568)
Domestic_Own	.061	.001	-1.54 (.121)	.059	.022	-.664 (.506)
Foreign_Own	-.032	-.007	.875 (.600)	-.030	-.009	.832 (.405)
Government_Own	.034	.011	.381 (.174)	.034	.003	.264 (.237)
Female_Own	.001	-.003	.965 (.334)	-.001	-.002	-.146 (.882)
Firm_Age	-.016	-.007	.787 (.430)	-.017	-.016	-.451 (.651)
Email	.117	-.002	-.474 (.635)	.116	-.001	-.804 (.421)
Website	.156	.004	1.57 (.116)	.156	.015	.547 (.110)
Weak_Intuitional Quality	-.397	.005	-.245 (.806)	-.397	.020	.230 (.817)
Manufacturing	.113	-.024	-.374 (.708)	.117	-.011	-.240 (.809)
Retail	-.134	.013	.549 (.109)	-.133	-.025	1.62 (.104)
Other_Industry	-		.781 (.075)			1.62 (.272)
Large	.029	.025	.542 (.587)	.025	.008	1.62 (.140)

Medium	.018	-.027	1.60 (.109)	.021	-.015	1.62 (.497)
Small& Micro	-	-	-1.60 (.109)	-	-	1.62 (.497)

*t-tests comparing the means of the treatment and control group variable by variable after the matching. P values in parentheses

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Table 1: Recent literature related to corruption and innovation

Author/s, Title Journal Name and Year	Journal name	Research Question	Data and Methodology	Findings/ Results	Conclusion
Dincer (2019) Does corruption slow down innovation? Evidence from a cointegrated panel of US states	European Journal of Political Economy	How corruption impacts innovative activities in the U.S.?	Annual data from 48 contiguous U.S. states between 1977-2006 Fully Modified Ordinary Least Squares (FMOLS)	Corruption hurts innovation.	Corruption does slow down innovation in long-run.
Kabadurmuş (2017) Corruption and Innovation: The Case of EECA Countries	Journal of Entrepreneurship and Innovation Management	Is sand or grease effect of corruption dominant for Eastern Europe and Central Asia region?	Firm-level data for 27 Eastern European and Central Asian countries. Logit and Tobit regression.	Corruption has a positive effect on the rate of innovation	Grease effect of corruption is dominated in this region.
Krammer (2017) Greasing the wheels of change: Bribery, institutions, and new product introductions in emerging markets	Journal of Management	How bribing affects the innovative performance of firms in emerging markets and How this relationship moderates by the quality of the institutions?	Over 6,000 firms in 30 emerging markets in Central Asia and Eastern Europe Probit model	Firm bribery positively impacts on their ability to introduce new products. However, it depends on the formal and informal pressures in firms' environments.	Bureaucratic obstacles and uncertainty help firms to be innovative through illegal cost minimization strategies. Norms and informal practices moderate the efficiency of firm strategies in emerging markets.
Nguyen et al. (2016) The impact of petty corruption on firm innovation in Vietnam	Crime, Law and Social Change	How petty corruption impact on firm innovation activities?	SMEs in Vietnam from 2005 to 2011 Logit model.	Corruption in the form of bribery has a positive effect on firm innovation.	Bribery payments by innovative SMEs in Vietnam grease the wheel of the bureaucratic machinery.

Paunov (2016) Corruption's asymmetric impacts on firm innovation	Journal of Development Economics	How corruption impacts on the ownership of quality certificates and patents for smaller- and larger-sized firms?	Data for 48 developing and emerging countries for the period 2007–2011 Linear probability regression	There is a negative effect between corruption and firms' ownership of quality certificates and it is stronger for smaller firms than larger firms.	Corruption is impacting on the firm's investment in innovation. Therefore, it is important to make policies to fight for corruption.
Goedhuys et al. (2016) Corruption, innovation and firm growth: firm-level evidence from Egypt and Tunisia	Eurasian Business Review	How corruption effect on innovative behavior of firms when doing severe bureaucratic and institutional obstacles exist?	Analyse 3489 firm-level data from Egypt and Tunisia. Conditional recursive mixed-process model (CMP)	Corruption has a direct negative effect on innovative firms, but a positive effect when there is an institutional obstacle.	Corruption can identify as a mechanism that bypasses the bureaucratic obstacles and resonate the firm growth and product innovations.
Ayyagari et al. (2014) Bribe payments and innovation in developing countries: Are innovating firms disproportionately affected?	Journal of Financial and Quantitative Analysis	How bribery is associated with firm innovation and whether innovating firms pay more bribes than non innovators?	25,000 firms in 57 countries OLS regression.	Innovating firms pay more bribes than non innovators. This difference is larger in countries with more bureaucratic regulation and weaker governance.	Innovators are more likely to be victims of corruption than criminals as they pay more in bribes than their gain by underreporting revenues to tax authorities. Corruption acts as a tax on innovation
Avnimelech et al. (2014) The effect of corruption on entrepreneurship in developed vs non-developed countries	International Journal of Entrepreneurial Behavior, Research & Politics	How corruption is linked to productive entrepreneurship in general and is it depends on countries' specific characteristics in particular?	Data set of entrepreneurial activity within 176 countries, collected from the professional networking site LinkedIn OLS regression	Highly corrupted countries usually face low levels of productive Entrepreneurship. Further, this negative effect is much more significant for developed countries than in developing countries and depends on country specific characteristic.	It is important to fight for corruption developed and western developing country to reduce the negative impact of it.

Anokhin and Schulze (2009) Entrepreneurship, innovation, and corruption	Journal of Business Venturing	How the level of corruption affects rates of entrepreneurial activities and innovation across nations?	Data from 64 countries for a period of 1996 to 2002 Quantile regression	There is a positive concave relationship between the control of corruption and domestic entrepreneurial and innovative activities. Further, this relationship moderates by foreign direct investment.	Better control of corruption can help to improve the level of innovation and entrepreneurship.
(Mahagaonkar 2010) Corruption and innovation	Book Chapter Money and ideas	How corruption impacts firm level innovation?	Sample of 3477 firms in the African continent Probit and instrumental variable probit models.	Corruption has a negative impact on the product and organizational innovation, a positive impact on marketing innovations but no effect on process innovation.	Corruption is more disruptive for innovative firms due to increased cost of corruption, imperfect financial markets and corrupt officials.

Table 2: Total Study Sample

Country	Micro & Small	Medium	Large	Total	Bribes	CPI score in 2017*
Argentina	353	324	254	931	17%	39
Bolivia	181	98	82	361	27%	33
Colombia	396	357	214	967	20%	37
Ecuador	145	129	78	352	16%	32
El Salvador	346	224	147	719	11%	33
Guatemala	113	133	97	345	13%	28
Honduras	177	92	61	332	13%	29
Nicaragua	151	122	58	333	17%	26
Paraguay	118	129	115	362	19%	29

Peru	470	300	232	1002	33%	37
Uruguay	123	133	80	336	10%	70
Total observations /Average	2573	2041	1418	6040	17.9%	

Corruption Perception Index- 2017. The index, which ranks 180 countries and territories by their perceived levels of public sector corruption according to experts and businesspeople, uses a scale of 0 to 100, where 0 is highly corrupt and 100 is very clean.

Table 3: Descriptive statistics

Variables	Panel A Full firm sample			Panel B Large			Panel B Medium			Panel B *Small			Panel B *Micro		
	Obs	Mean	Std	Obs	Mean	Std	Obs	Mean	Std	Obs	Mean	Std	Obs	Mean	Std
Product_Inno	6040	.6361	.4812	1418	.7165	.4509	2041	.6619	.4732	2503	.5706	.4951	70	.5573	.5008
Process_Inno	6040	.4698	.4991	1418	.5719	.4950	2041	.4785	.4997	2503	.4067	.4913	70	.3770	.4887
Bribes(p)	5231	17.97	20.12	1215	19.03	20.70	1770	18.24	19.84	2180	17.29	20.03	66	13.25	19.19
Formal_Fund	5398	20.76	27.40	1400	25.08	28.76	1939	21.44	26.95	2000	17.85	26.63	59	15.76	26.39
Infromal_Fund	5398	28.65	30.85	1400	28.72	29.73	1939	29.16	30.06	2000	28.11	32.02	59	30.90	34.15
Own_Fund	5396	50.57	36.70	1400	46.22	35.44	1939	49.37	36.47	1998	53.99	37.23	59	53.34	38.83
Sole_Prop	5411	.0991	.2988	1400	.0218	.1462	1852	.0593	.2364	2098	.1685	.3744	61	.3606	.4842
Partnership	5411	.3110	.4629	1400	.1491	.3563	1852	.3182	.4659	2098	.3971	.4894	61	.3934	.4925
Company	5411	.5847	.4928	1400	.8271	.3782	1852	.6197	.4856	2098	.4249	.4944	61	.2459	.4341
Other_firms	5411	.0052	.0720	1400	.0019	.0435	1852	.0027	.0516	2098	.0094	.0968	61	0	0
Domestic_Own	5420	91.50	26.34	1400	82.19	36.18	1852	93.54	22.78	2004	95.15	20.84	61	93.61	22.95
Foreign_Own	5419	7.077	24.09	1400	16.64	35.21	1301	5.475	21.01	2004	2.962	15.84	61	3.115	15.00
Government_Own	5420	.1446	3.173	1400	.3605	5.19	1801	.1726	3.272	2004	0	0	61	0	0

Other_Own	5419	1.295	10.97	1400	.9002	8.880	1801	.7801	8.327	2004	1.887	13.41	61	3.278	17.96
Female_Own	5657	.6301	.4828	1219	.6359	.4814	1987	.6382	.4807	2400	20.80	14.78	51	.6067	.4925
Firm_Age	6040	26.88	19.99	1418	37.10	24.73	2041	27.12	19.01	2503	.6209	.4852	70	25	12.80
Email	5656	.9525	.2128	1218	.9867	.1144	1988	.9787	.1444	2400	.9168	.2762	50	.7705	.4240
Website	5657	.7266	.4458	1218	.9146	.2796	1988	.7776	.4159	2400	.5831	.4932	50	.4590	.5024
Political_Instability	5275	.4779	.4996	1400	.5682	.4955	1877	.4782	.4997	1940	.4276	.4948	58	.1929	.3981
Court_Instability	5334	.1477	.3548	1400	.1851	.3885	1909	.1503	.3574	1968	.1221	.3276	57	.3793	.4894
Manufacturing	6040	.5023	.5000	1418	.5896	.4921	2041	.5276	.4994	2503	.4318	.4954	70	.4590	.5024
Retail	6040	.1772	.3819	1418	.1213	.3266	2041	.1371	.3440	2503	.2389	.4265	70	.3115	.4669
Other_Industry	6040	.3203	.4667	1418	.2891	.4536	2041	.3353	.4722	2503	.3292	.4701	70	.2295	.4240
Large	6040	.2385	.4262	-											
Medium	6040	.3398	.4736												
Small	6040	.4078	.4914												
Micro	6040	.0137	.1166												
Instrumental variable Avg_Bribes(p)	4423	17.96	3.53	1055	17.96	3.56	1503	18.15	3.42	1804	17.83	3.57	61	17.16	4.00

Table 4: Probit model with continuous endogenous regressors estimation results of innovation and bribes% relationship -Full sample

	Panel A: Product Innovation				Panel B: Process Innovation			
Variables	Probit (Marginal effects)	First stage Probit	IV Probit dy/dx (Marginal effects)	IV Probit Interaction dy/dx (Marginal effects)	Probit (Marginal effects)	First stage Probit	IV Probit dy/dx (Marginal effects)	IV Probit Interaction dy/dx (Marginal effects)
	1	2	3	4	5	6	7	8
	Product_Inno	*Bribes(p)*	*Product_Inno*	*Product_Inno*	*Process_Inno*	*Bribes(p)*	*Process_Inno*	*Process_Inno*
Bribes(p)	.001** (.001)				.001 (.001)			
+Avg_Bribes(p)		1.13*** (.094)	-.036** (.019)	-.075*** (.012)		1.12*** (.094)	-.039** (.016)	-.076*** (.008)
Formal_Fund	.001*** (.001)	.047** (.012)	.002*** (.001)	.002 (.001)	.001** (.001)	.046*** (.012)	.002** (.001)	.001 (.001)
Infromal_Fund	.001** (.001)	.015 (.010)	.002** (.001)	.001 (.001)	.001** (.001)	.013 (.010)	.002* (.001)	.001 (.001)
Own_Fund	-	-	-		-	-	-	
Sole_Prop	.085 (.116)	-3.03 (4.61)	-.166 (.385)	-.474 (.345)	.045 (.135)	-2.87 (4.64)	-.264 (.143)	-.511** (.291)
Partnership	.067 (.122)	-.474 (.454)	-.084 (.338)	-.282 (.307)	.012 (.132)	-.529 (4.57)	-.183 (.308)	-.319 (.270)
Company	-	-	-	-		-		
Domestic_Own	-.001 (.006)	-.022 (.030)	-.002 (.002)	-.004** (.002)	.001* (.001)	-.021 (.030)	-.001 (.003)	-.003 (.003)
Foreign_Own	.002** (.001)	-.038 (.033)	.001 (.004)	-.002 (.004)	.002** (.001)	-.039 (.033)	.001 (.004)	-.002 (.004)
Government_Own	-.002 (.003)	.019 (.125)	-.004 (.008)	-.006 (.007)	.004 (.003)	.017 (.126)	.006 (.008)	-.002 (.009)
Other_Own	-	-	-	-	-	-	-	-

Female_Own	.022 (.017)	-.432 (.656)	.027 (.048)	-.008 (.052)	.001 (.017)	-.442 (.660)	-.012 (.038)	-.021 (.035)
Firm_Age	-.001 (.001)	.026 (.080)	-.001 (.001)	-.001 (.001)	-.001 (.001)	-.005 (.002)	-.005 (.001)	-.002 (.001)
Email	.101*** (.041)	2.85** (1.58)	.349*** (.095)	.458*** (.128)	.193*** (.038)	2.80** (1.58)	.495** (.165)	.507** (.261)
Website	.162*** (.019)	-.072 (.746)	.272 (.177)	.110 (.251)	.081*** (.019)	-.035 (.752)	.123 (.094)	.056 (.119)
Political_Instability	-.033** (.017)	-.200** (.890)	.102** (.047)	.056 (.044)	.001 (.012)	.619 (.456)	.075 (.051)	.046 (.039)
Fair_Instability	.017 (.019)	.055 (.176)	.034 (.087)	.040 (.070)	-.036** (.017)	-1.89** (.894)	.042 (.083)	.042 (.067)
Manufacturing	.057*** (.018)	.331 (.702)	.087 (.078)	.016 (.098)	.077*** (.018)	.171 (.706)	.102 (.094)	.024 (.116)
Retail	.057** (.022)	.106 (.953)	.049 (.102)	-.025 (.112)	-.001 (.024)	.999 (.959)	-.057 (.057)	-.062 (.049)
Other_Industry	-	-	-			-	-	
Large	.047** (.023)	1.28 (.889)	.118** (.065)	-1.30*** (.296)	.093*** (.024)	1.41 (.896)	.184** (.093)	-1.32*** (.240)
Medium	.039** (.018)	.130 (.739)	.064 (.062)	-1.31*** (.247)	.032* (.019)	.224 (.744)	.048 (.054)	1.34*** (.170)
Small& Micro	-	-	-		-		-	
Bribes(p)* Large				.075*** (.012)				.077*** (.006)
Bribes(p)* Medium				.075*** (.010)				.076*** (007)
Constant		-3.33** (5.90)				-2.99** (.5.92)		
Summary statistics								
Log likelihood			-19967	-18276			-20131	-18428
LR Chi2 /Wald Chi2			511.0	301.1			492.4	3940.5

P value			0.00	0.00			0.00	0.000
Sample size		4043	3966	3966		4041	3964	3964
Cragg-Donald Wald F statistic		144.7				141.0		
Stock-Yogo weak ID test critical values: 10% maximal IV size		16.38				16.38		
Anderson canon. corr. LM statistic		140.3***				136.8***		
Wald test of exogeneity			7.30**	4.19***			7.61**	4.18**

Note for Table 4 and 5 :[+] *Avg_Bribes(p) is an instrumental variable for Bribe(p).* [++] *(*) dy/dx is for discrete change of dummy variable from 0 to 1. The main dependent variable is a dummy variable taking one if the firm is innovative and zero otherwise. Panel A reports product innovation results and Panel B reports process innovation results. In each panel, column 1 reports the marginal effect of the probit model with exogenous regressors regression results; column 2 reports first stage probit results, column 3 reports the marginal effect of IV probit regression results. Column 4 reports the marginal effect of IV probit regression with the interaction of bribe payment and firm size. Bribe percentage is a main explanatory variable and IV probit use, locality-sector-average of bribe percentage as an instrument. These models provide standard errors, which are in parentheses. The Wald test of exogeneity is reported in the last row as a chi-squared statistic with 1 degree of freedom. * Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.*

Table 5: Probit and IV probit estimation results of innovation and bribes% relationship -Large, medium, and small and micro firms

Panel A : Large firms						
Variables	Probit (Marginal effects)	First stage Probit	IV Probit (Marginal effects)	Probit (Marginal effects)	First stage Probit	IV Probit (Marginal effects)
	1	2	3	4	5	6
	Product_ Inno	*Bribes(p)*	*Product_ Inno*	*Process_ Inno*	*Bribes(p)*	*Process_ Inno*
Bribes(p)	.001** (.001)			.002** (.001)		
+Avg_Bribes(p)		1.06*** (.150)	.021 (.510)		1.06*** (.151)	.006*** (.003)
++Control variables	YES	YES		YES	YES	YES
Constant		-9.24 (11.4)			-6.95 (11.3)	
Summary statistics						
Log likelihood			4565			4640
LR Chi2/Wald Chi2			188.0			119
P value			0.00			0.00
Sample size			925			924
Cragg-Donald Wald F statistic		49.43			49.3	
Stock-Yogo weak ID test critical values: *10% maximal IV size*		16.38			16.4	
Anderson canon. corr. LM statistic		47.71***			47.6***	
Wald test of exogeneity			9.69***			6.01**
Panel B : Medium firms						
Variables	Probit (Marginal effects)	First stage Probit	IV Probit (Marginal effects)	Probit (Marginal effects)	First stage Probit	IV Probit (Marginal effects)
	(I)	(II)	(III)	(IV)	(V)	(VI)
	Product_ Inno	*Bribes(p)*	*Product_ Inno*	*Process_ Inno*	*Bribes(p)*	*Process_ Inno*
Bribes(p)	.001** (.007)			.043 (.001)		
+Avg_Bribes(p)	-	1.05*** (.157)	-.043*** (.118)		1.03*** (.158)	.040** (.018)
++Control variables	YES	YES	YES	YES	YES	YES
Constant		.078 (13.6)			.760 (13.7)	.095** (.126)
Summary statistics						

Log likelihood				-6799.			-6876.9
LR Chi2/Wald Chi2				148.3			99.89
P value				0.00			0.000
Sample size	1389			1361			
Cragg-Donald Wald F statistic		45.02				42.53	
Stock-Yogo weak ID test critical values: *10% maximal IV size*		16.38				16.38	
Anderson canon. corr. LM statistic		44.1***				41.74***	
Wald test of exogeneity				4.52***			5.71**
	Panel C : Small firms						
	Variables	Probit (Marginal effects)	First stage Probit	IV Probit (Marginal effects)	Probit (Marginal effects)	First stage Probit	IV Probit (Marginal effects)
		(I)	(II)	(III)	(IV)	(V)	(VI)
		Product_ Inno	*Bribes(p)*	*Product_ Inno*	*Process_ Inno*	*Bribes(p)*	*Process_ Inno*
Bribes(p)		.013** (.001)			.004 (.001)		
$^{+}$*Avg_ Bribes(p)*			1.10*** (.135)	-.048*** (.001)		1.09*** (.135)	-.018* (.068)
++Control variables		YES	YES	YES	YES	YES	YES
Constant			-.838 (7.13)			-.847 (7.13)	-1.43 (1.64)
Summary statistics							
Log likelihood				8291.6			-8308.2
LR Chi2/Wald Chi2				972.16			64.93
P value				0.0000			0.000
Sample size	1671	1671	1671	1671	1671	1671	1671
Cragg-Donald Wald F statistic		64.44				65.55	
Stock-Yogo weak ID test critical values: *10% maximal IV size*		16.38				16.38	
Anderson canon. corr. LM statistic		64.44				63.63	
Wald test of exogeneity				3.37**			2.11***
	Panel D : Micro firms						
	Variables	Probit (Marginal effects)	First stage Probit	IV Probit (Marginal effects)	Probit (Marginal effects)	First stage Probit	IV Probit (Marginal effects)
		(I)	(II)	(III)	(IV)	(V)	(VI)
		Product_ Inno	*Bribes(p)*	*Product_ Inno*	*Process_ Inno*	*Bribes(p)*	*Process_ Inno*
Bribes(p)		-.005 (.005)			-.016** (.008)		
$^{+}$*Avg_ Bribes(p)*			-.947*	-.058***		-.947**	-.013**

		(.816)	(.006)		(.816)	(.057)
++Control variables	YES	YES	YES	YES	YES	YES
Constant			1.01 (.681)		-9.50 (2.80)	-.689** (.7851)
Summary statistics						
Log likelihood			-252.11			-237.07
LR Chi2/Wald Chi2			95.12			31.36
P value			0.00			0.00
Sample size	55	55	55		56	56
Cragg-Donald Wald F statistic		18.96			18.73	
Stock-Yogo weak ID test critical values: *10% maximal IV size*		16.38			16.38	
Anderson canon. corr. LM statistic		17.39			19.66	
Wald test of exogeneity			2.67**			.364***

Table 6: Innovation and Institutional environment

	Product Innovation		Process Innovation	
Variables	Probit	IV Probit Interaction	Probit	IV Probit Interaction
	(I)	(III)	(V)	(VIII)
Bribes(p)	.005* (.003)		.005* (.003)	-
+Avg_Bribes(p)	-	-.009*** (.003)		-.009*** (.004)
Formal_Fund	.001 (.001)	.001 (.001)	.001 (.001)	.001 (.001)
Infromal_Fund	-.002* (.001)	-.001 (.001)	-.002** (.001)	-.001 (.001)
Own_Fund			-	
Sole_Prop	.231 (.339)	.055 (.320)	.111 (.336)	.006 (.301)
Partnership	.177 (.335)	-.047 (.317)	.041 (.332)	-.102 (.297)
Company	-	-		-
Domestic_Own	.003 (.002)	.003 (.002)	.004** (.002)	.005*** (.002)
Foreign_Own	.006*** (.002)	.006** (.003)	006** (.002)	.006*** (.002)
Government_Own	-.005 (.008)	.004 (.009)	.011 (.009)	.012 (.008)
Other_Own	-	-	-	-
Female_Own	.059 (.044)	.027 (.049)	.008 (.043)	.003 (.038)
Firm_Age	-.115 (.005)	.004 (.126)	.194 (.321)	.045 (.244)
Email	.301***	.026	.544***	.195

	(.104)	(.224)	(.112)	(.336)
Website	. 412*** (.049)	.244 (.209)	.181*** (.049)	.134 (.088)
Weak_Intuitional Quality	-.007 (.007)	.160** (.064)	.005 (.006)	.158** (.004)
Manufacturing	.141*** (.050)	.079 (.082)	.180*** (.046)	.120** (.092)
Retail	.148** (.063)	.008 (.082)	-.008 (.062)	.039 (.058)
Other_Industry	-	-		
Large	127** (.061)	.080 (.079)	.210*** (.058)	.139 (.109)
Medium	.099** (.050)	.066 (.062)	.063 (.049)	.048 (.050)
Small& Micro	-	-	-	-
Bribes(p)*Weak_Intuitional Quality	-.001 (.001)	-.119*** (.040)	-.001 (.001)	-.113*** (.046)
Constant	-.5631 (.405)	-2.50*** (.620)	-1.35*** (.408)	-2.88*** (.428)
Summary statistics				
Log likelihood	-2458.8	15798	-2626.8	-15983
LR Chi2 /Wald Chi2	210.01	153.9	150.91	591.9
P value	0.00	0.00	0.00	0.00
Sample size	6908	6908	6909	6909
Wald test of exogeneity		2.89**		2.77**

Table 7 : Summary of empirical results

	Results $Pr(Inno_{i,j} = 1) = \emptyset(\propto + \beta Bribes\%_{i,j} + Control\ Variables + \varepsilon_{i,j}$	Hypothesis	Hypothesis Accepted or Rejected	Table Reference
Full Sample Product_Inno	(-) Significant (β= -.036)	*H1: Corruption has a negative impact on firm-level innovation*	Accepted	Table 4
Process_Inno	(-) Significant (β= -.039)	*H1: Corruption has a negative impact on firm-level innovation*	Accepted	Table 4
Large firms only Product_Inno	Net effect is inexistence	*H2: Increase firm size positively moderates the relationship between paying bribes and*		Table 4

		firm-level innovation.		
Process_Inno	(+) Significant (β= .001)	*H2: Increase firm size positively moderates the relationship between paying bribes and firm-level innovation*	Accepted	Table 4
Medium firms only Product_Inno	Net effect is inexistence	*H2: Increase firm size positively moderates the relationship between paying bribes and firm-level innovation.*	-	Table 4
Process_Inno	Net effect is inexistence	*H2: Increase firm size positively moderates the relationship between paying bribes and firm-level innovation.*	-	Table 4
Large firms only Product_Inno	(+) insignificant (β= -.021)	*H2: Increase firm size positively moderates the relationship between paying bribes and firm-level innovation.*	-	Table 5
Process_Inno	(+) Significant (β= .006)	*H2: Increase firm size positively moderates the relationship between paying bribes and firm-level innovation.*	Accepted	Table 5
Medium firms only Product_Inno	(-) Significant (β= -.043)	*H2: Increase firm size positively moderates the relationship between paying bribes and firm-level innovation.*	Rejected	Table 5
Process_Inno	(+) Significant (β= .040)	*H2: Increase firm size positively moderates the relationship between paying bribes and*	Accepted	Table 5

		firm-level innovation.		
Small firms only Product_Inno	(-) Significant (β= -.048)	*H2: Increase firm size positively moderates the relationship between paying bribes and firm-level innovation.*	Accepted	Table 5
Process_Inno	(-) Significant (β= .018)	*H2: Increase firm size positively moderates the relationship between paying bribes and firm-level innovation.*	Accepted	Table 5
Micro firms only Product_Inno	(-) Significant (β= -.947)	*H2: Increase firm size positively moderates the relationship between paying bribes and firm-level innovation.*	Accepted	Table 5
Process_Inno	(-) Significant (β= .013)	*H2: Increase firm size positively moderates the relationship between paying bribes and firm-level innovation.*	Accepted	Table 5
Full Sample Product_Inno	(-) Significant (β= -.028)	*H3: The better developed institutional environment weakens the relationship between paying bribes and firm-level innovation*	Accepted	Table 6

Table 8: Probit and IV probit estimation results of innovation and alternative proxy of bribes (Obs_corruption) relationship

Variables	Probit	First stage Probit	IV Probit	Probit	First stage Probit	IV Probit

	(I)	(II)	(III)	(IV)	(V)	(VI)
	Product_ Inno	Obs_Corruption	*Product_ Inno*	*Process_ Inno*	Obs_Corruption	*Process_ Inno*
Obs_Corruption	-.004 (.081)			-.042** (.017)		
+*Avg_Mgr_time*		631** (.312)	-.030* (.285)		.278 (.286)	-.041** (.143)
++*Control variables*	YES	YES		YES	YES	YES
Constant		.379*** (.136)			.381** (.135)	
Summary statistics						
Log likelihood			-5228			-5393
LR Chi2/Wald Chi2			3186			221.3
P value			0.00			0.00
Sample size			4141			4141
Cragg-Donald Wald F statistic		17.02			17.34	
Stock-Yogo weak ID test critical values: *10% maximal IV size*		16.38			16.38	
Anderson canon. corr. LM statistic		15.03***			15.35***	
Wald test of exogeneity			8.12***			7.89**

*+ Avg_Mgr_time is an instrument variable for Obs_Corruption . ++ (*) dy/dx is for discrete change of dummy variable from 0 to 1. The main dependent variable is a dummy variable taking one if the firm is innovative and zero otherwise. Panel A reports product innovation results and Panel B reports process innovation results. In each panel, column I report the marginal effect of probit model with exogenous regressors regression results; column II reports first stage probit results, column III reports the marginal effect of IV probit regression results. Obs_Corruption is a main explanatory variable and IV probit use, locality sector average percentage of total senior management's time spent on dealing with requirements imposed by government regulations in a typical week over the last year as an instrument. These models provide standard errors, which are in parentheses. The Wald test of exogeneity is reported in the last row as a chi-squared statistic with 1 degree of freedom. * Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.*

Table 9: The impact on bribes on innovation: propensity score matching (PSM)

	No. treated	No. contr.	ATT[a]	Std.Err	t
Product innovation					
Nearest neighbour matching	264	247	-0.115	0.051	2.272
Kernel matching	223	2582	-0.111	0.028	3.933
Radius matching*(radius=0.01)	61	2575	-0.105	0.052	1.992
Stratification matching	222	2943	-0.110	0.030	3.666
	No. treated	No. contr.	ATT[a]	Std.Err	t
Process innovation					
Nearest neighbour matching	223	224	-0.055	0.045	1.211
Kernel matching	223	2582	-0.096	0.035	2.738

Radius matching (radius=0.01)	224	3368	-0.095	0.029	3.283
Stratification matching	222	2943	-0.095	0.028	3.340

Note: an ATT means the average treatment effect on the treated. Firm level covariates are included in all models

The standard error used to compute the t statistics is the standard deviation of the ATT after 100 bootstrap replications.

**In this matching, each treated unit is matched only with the control units whose propensity score falls into a predefined neighborhood of the propensity score (radius 0.01 in here) of the treated unit. Therefore, it is possible that some treated units are not matched because the neighborhood does not contain control units" (See https://www.stata-journal.com/sjpdf.html?articlenum=st0026)*

Table 10: Instrumental regression results

Variables	OLS	2SLS
(I)	(II)	(III)
Bribe(p)	-.001 (.001)	
+*Avg_Bribe(p)*		-.007 (.013)
++*Control variables*	YES	YES
Constant	10.01*** (.074)	18.93*** (.418)
Summary statistics		
P value	0.000	0.000
Sample size	930	930
Adjusted Rsq	0.998	0.998