UNU-MERIT Working Paper Series

#2014-077

Democratizing intellectual property systems: How corruption hinders equal opportunities for firms

Caroline Paunov

Maastricht Economic and social Research institute on Innovation and Technology (UNU-MERIT)
email: info@merit.unu.edu | website: http://www.merit.unu.edu

Maastricht Graduate School of Governance (MGSoG)
email: info-governance@maastrichtuniversity.nl | website: http://mgsog.merit.unu.edu

Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands
Tel: (31) (43) 388 4400, Fax: (31) (43) 388 4499

UNU-MERIT Working Papers

ISSN 1871-9872

Maastricht Economic and social Research Institute on Innovation and Technology, UNU-MERIT

Maastricht Graduate School of Governance MGSoG

UNU-MERIT Working Papers intend to disseminate preliminary results of research carried out at UNU-MERIT and MGSoG to stimulate discussion on the issues raised.

Democratizing Intellectual Property Systems: How Corruption Hinders Equal Opportunities for Firms

Caroline Paunov*
OECD

Version: 23 November 2014

Abstract

This paper analyses how corruption affects firms' ownership of intellectual property titles that relate to firms' technological, organizational and further innovation efforts: quality certificates and patents. Using firm-level data covering 48 developing and emerging countries, we show corruption reduced the likelihood of firms seeking quality certificates. Smaller firms were more affected by corruption and benefited less from higher levels of trust in their business environment. Corruption did not have impacts on the quality certificate ownership of exporters, foreign- and publicly-owned firms. Firms' machinery investments were also negatively affected. By contrast, we do not find effects on firms' ownership of patents.

Keywords: Intellectual property, corruption, trust, firm heterogeneities, innovation, developing and emerging countries

JEL Codes: O34, O12, D23, L6, L2

*Caroline Paunov, OECD, 2, rue André Pascal, 75 775 Paris Cedex 16, France. Email: caroline.paunov@oecd.org and caroline.paunov@gmail.com. Phone: 00 33 (0) 1 45 24 90 40.
The author would like to thank Kazuyuki Tanji for providing valuable research assistance for an earlier version of this paper. The author would also like to thank Nathan Nunn and two anonymous referees as well as Ana M. Fernandes and Dominique Guellec. The findings expressed in this paper are those of the author and do not necessarily represent the views of the OECD or its member countries.

1. Introduction

Intellectual property (IP) titles can be a powerful tool for innovation policy in both developed and developing countries and by stimulating innovation they can shape countries' growth prospects (Chen and Puttitanun, 2005, Maskus, 2000). This will be the case if IP titles incentivize the variety of domestic firms to invest in research and development (R&D) in view of producing inventions, facilitate firms' access to external finance and support expanding the market base for firms' innovations.[1] Providing conditions for small firms to benefit from IP is particularly critical in order to expand the often very small group of innovators (Khan, 2005; OECD, 2014).[2] However, as IP titles are granted and enforced by national institutions, their functioning will depend on the quality of institutions. Limiting corruption, i.e. the use of public office for private gains, is undoubtedly among the critical institutional framework conditions. It is strongly negatively correlated with confidence in public institutions (Clausen et al., 2011). A wide literature demonstrates that corruption has been a major obstacle to economic development, particularly via its negative impacts on productive investments including innovation and consequently growth (e.g. Murphy et al., 1993; Mauro, 1995; Wei, 2000; Aidt, 2009).[3] Moreover, corruption may affect firms differently since the capacity to deal with the costs it imposes and incentives as well as "opportunities" for engaging in corrupt behavior differ across firms. Corrupt business environments may also have different impacts across IP titles to the extent that conditions for awarding IP titles give officials different "opportunities" to seek bribes with low risk of detection. Ultimately, with heterogeneous impacts, corruption may hinder the "democratization of innovation" - a widening of the group of innovators – as it imposes unequal opportunities for firms to benefit from the IP system.

The objective of this paper is to investigate empirically the impacts of corruption on the ownership of IP titles that relate to firms' technological, organizational and further non-technological innovation efforts: quality certificates and patents. Quality certificates are formal awards certifying firms comply with quality standards that result from organizational and other non-technological innovations. Patents, by contrast, are legal titles granted to the creators of new inventions - where novelty relates to the state of the art in their technology field, capable of industrial application. Moreover, the analysis explicitly investigates whether corruption has negative "distributional" impacts by testing whether impacts differ for firms of different size among other firm characteristics. Our analysis draws on a sample of cross-country firm-level data drawn from the World Bank Enterprise Surveys across 48 developing and emerging countries for 2007-2011. In order to identify causal effects of corrupt business environments, our empirical methodology addresses two critical challenges: First, we identify a suitable objective measure of corruption faced by firms by using a unique measure

[1] See Greenhalgh and Rogers (2010) for additional detail. OECD (2014) discusses contributions in the context of developing and emerging countries.
[2] Khan (2005) provides a historical account of how the institutional quality of the American IP system of the 19th century provided opportunities for non-elite inventors serving social welfare rather than the interests of any single group. This in turn facilitated wider contributions to socio-economic progress.
[3] Bardhan (1997) provides a more substantial overview of the early literature and the main arguments.

of corruption in firms' business environment. The measure, obtained at the country-location and country levels, is based on the incidence of informal gifts or payments requested for business operations. It was used previously at the firm level by Svensson (2003) and Fisman and Svensson (2007) among others. Second, inferring causality from regressions of firms' IP ownership on business environment conditions such as corruption is challenging due to a multiplicity of potential omitted variables that could drive results. In order to address such concerns, our results are obtained from regressions that account for an extensive set of firm characteristics and industries' business environment conditions. The latter includes controls for access to credit, infrastructure quality, industry investment intensities, the availability of skills as well as the level of economic development and industry characteristics. We also introduce location, country and industry fixed effects. We are able to do so as firms' needs for IP differ due to characteristics inherent to industries, notably differences in technologies used and in the importance of innovation (Cohen et al., 2000; ESA-USPTO, 2012). We then estimate whether firms operating in industries that are relatively more in need of IP obtain less IP if they face more corruption. Our identification approach relates most closely to Aghion et al. (2013) who exploit differences in the intensity of patent protection across industry to investigate whether strong patent rights and product market competition are complementary in stimulating innovation.[4]

Our results show that corruption has negative impacts on firms' ownership of quality certificates in industries with stronger IP needs. Larger firms are less affected than smaller businesses. Our results are robust to a variety of tests including the use of alternative measures of industry IP intensities, i.e. their need for IP, and of corruption. Moreover, we find symmetric effects of the levels of trust in business operations firms face; trust disproportionately benefits larger businesses.[5] In addition, we show that corruption neither affects exporters nor foreign- and publicly-owned firms negatively. This is likely to be the case as these firms can insulate themselves more easily from the negative effects of corruption than others. Moreover, differences in "opportunities" for extracting rents by public officials affect how corrupt business environments impact on firms' IP ownership and, more generally, their efforts to engage in innovation: We show that, differently from quality certificates, the evidence of corruption's effects on firms' ownership of patents is weak. IP offices grant the latter if the firms' invention introduces novelty and shows industrial applicability. Those technology-based criteria are more clear-cut than those required for granting quality certificates. In consequence, opportunities for corrupt officials to seek rents without risk of discovery are higher, protecting firms more from abuse. The stronger effects of corruption on certificate ownership of services firms compared to manufacturers may also relate to larger opportunities for corruption. In addition, we find corruption

[4] This empirical methodology has also been extensively used to identify effects of financial market development on firm, industry and country performance following Rajan and Zingales (1998). Other applications include Nunn (2007), Manova (2008), Chor (2010) and Chor and Manova (2012).

[5] Our measure of trust in business relationships is obtained by aggregating the average share of firms' sales paid for after delivery. McMillan and Woodruff (1999) use this measure at the firm level to study the determinants of business trust; Karlan et al. (2009) focus similarly on informal borrowing arrangements by households to evaluate their theory of trust.

has significant negative effects on firms' investment in machinery indicating that their implementation of process innovations is also affected. Finally, we show corruption did not reduce firms' ownership of quality certificates in countries that use IP the least. We find no substantial differences regarding impacts for countries with increasing intensities in their use of IP. Corruption imposes similar costs across these different levels of development.

The paper contributes to several debates regarding innovation, corruption and development. First, to the best of our knowledge this is the first paper to document for a sample of firms in developing and emerging countries that corrupt business environments affect development prospects via negative and heterogeneous impacts on firms' ownership of IP titles. That is, the paper provides evidence of an additional channel of negative impacts of corruption on productive investments: namely via its detrimental effects on firms' efforts to innovate. The fact that smaller firms are more affected introduces an additional burden: it biases policy impacts of IP systems towards larger firms excluding a group of potentially innovative but smaller firms. Second, the paper introduces a novel identification strategy to investigate the impacts of corrupt business environments on an important indicator of firm innovation performance, IP ownership, by addressing the identification challenge that arise when analyzing impacts of institutions on performance. Third, the paper also contributes to the discussion on heterogeneous benefits from IP systems, which prevent the democratization of innovation systems by showing that differences in capacities of firms to deal with corruption are an additional factor affecting differential use of IP systems. Fourth, the paper documents differences in impacts of corruption across different intellectual property titles, a factor pointing to the importance of differential "opportunities" for corruption to affect firms' innovation activities. This provides insights for approaches to address the devastating effects of corruption on firms' productive activities.

Various policy implications arise from our findings. First, we show that corruption is a non-negligible barrier to an economy's development of firms' innovation capacities. It provides an additional motivation for policy makers to fight corruption. Moreover, the larger costs for smaller-sized firms require efforts aimed at providing adequate framework conditions for those businesses to develop their capacities. Our findings indicate overcoming resistance within the business community will be critical to create effective business associations fighting corruption (Dixit, 2014). Finally, our findings on differential effects of corruption and, in particular, the weak impacts on patenting are relevant when it comes to designing solutions to addressing the challenge of corruption. They point to the value of setting up objective award criteria across public services provided to businesses as a means for fighting corruptions' negative effects on firms' investment in improving their productive capacities.

The paper builds on the literature on the impacts of corrupt environments on performance indicators at the cross-country level such as Mauro (1995). It differs, however, critically in its focus on firm-level performance and relates from that angle to several papers that have analyzed how firms' payments of bribes affected their growth and productivity. Using data of firms in Uganda, Fisman and

Svensson (2007) find negative effects on firm growth. The finding is corroborated by evidence from cross-country data by De Rosa et al. (2010). Beck et al. (2005) show corruption problems negatively affect firms' growth rates, particularly those of the smaller-sized firms. By contrast, Vial and Hanoteau (2010) identify a positive effect of bribery on firms' growth for Indonesian firms in support of the "greasing the wheels" hypothesis of corruption. There is less evidence on other performance indicators, one exception is Ayyagari et al. (2010) who document how bribery correlates negatively with firms' innovation performance, particularly that of small and young firms. They also find innovators are more likely to pay bribes than firms that do not innovate. One explanation might be that, differently from non-innovators, innovators require the public service of an operating IP system. This, however, is not analyzed by the authors.[6] None of the papers consider the effects of bribery on firms' ownership of IP titles. The papers also differ from ours in their focus on the effects on firms which were requested to pay bribes. While related, the latter is not equivalent: more corrupt environments will likely lead more firms to pay bribes than less corrupt environments but they will also affect those which were not given the "opportunity" to pay public officials illegally for services. This is likely since the illegal nature of the activity favors preferentially engaging fewer firms. However, it does not mean these firms were not equally affected by corruption in other ways. This often includes facing longer delays in the delivery of services (as those firms who pay bribes are privileged) or lower quality services (in the extreme potentially leading to rejection of even valid applications). Our approach also allows for a different identification strategy while at the same time controlling for potential measurement error (with some firms not wanting to report on bribery payments) and endogeneity concerns regarding firm-level indicators of corruption.

The paper also relates to the literature that has documented why smaller firms can be at a disadvantage when it comes to benefitting from IP compared to larger firms. Several types of costs can be particularly burdensome to small firms while large firms can benefit from economies of scale. This starts with registration fees related to obtaining IP, which have been shown to affect smaller firms while they are usually not an obstacle for larger businesses (EPO, 2010).[7] Moreover, patents are only valuable to firms if they can effectively enforce these rights. For small companies, enforcement costs such as attorney fees, management costs and time required to deal with litigation, are an important challenge as these costs are not proportional to firm size. What is more, the size of firms' patent portfolios can help avoid costly litigation by using cross-licensing strategies.[8] Smaller firms are therefore at a disadvantage compared to larger firms. Another advantage that large firms have is that they can reach agreements more easily because of repeated interaction with their competitors

[6] Ullah and Wei (2013) study the impacts of quality certification on firms' growth and investigate whether corrupt businesses environments affect the relationship; they find this to be the case and evidence that in such circumstances quality certificates do not contribute to firms' growth.

[7] This is even more challenging in developing and emerging country contexts where financial market frictions render obtaining financial resources to pay for IP application fees and related costs more substantial. Beyond financial costs, lack of available skills for filling in IP applications adds to the costs faced in the application process.

[8] In cross-licensing arrangements, IP owners grant licenses to each other for exploiting IP rights for parts or all of their IP portfolios.

(Lanjouw and Schankerman, 2004). Moreover, the fact that smaller companies are less prepared to withstand litigation increases their risks of facing further litigation. In addition, lack of capacities for managing IP portfolios and negotiating those on markets for knowledge impose a sunk cost that disadvantages smaller entities (OECD, 2014). The "democratization of IP systems," thus, has to face a variety of proven obstacles including also corruption, the focus of this analysis.

The remainder of the paper proceeds as follows. Section 2 describes the data. Section 3 discusses the theoretical framework. Section 4 presents the empirical methodology and Section 5 presents the results we obtain. Section 6 concludes.

2. Data

Our analysis relies on firm-level data drawn from the World Bank Enterprise Surveys (WBES). The WBES collect information in each country on a representative sample of formal (registered) firms in the private, non-agricultural sector. The selection of firms in each country is done by stratified random sampling. These data have been widely used to investigate various dimensions of the business climate and its effects on firms' performance (e.g. Almeida and Fernandes, 2008; Fisman and Svensson, 2007).[9] The data are part of the new round of surveys reflecting improvements with respect to the earlier surveys of 2000-2006. Our baseline dataset includes information for a cross section of firms from 48 countries from the major world regions with different income levels, covering manufacturing industries and various firm size categories for the 2007-2011 period. The dataset is based on selected observations from the full 65,285 observations of the 2007-2011 data as our analysis is restricted to the group of manufacturing firms and requires observation on firms' patenting and quality certificate ownership as well as on corruption. Table 1 summarizes the data coverage across firm size, years, and world regions. The industry coverage is varied representing, as is characteristic for developing and emerging countries, a relatively substantial share of food and beverage and also textile and garments producers. Most firms in our sample are from lower- and upper-middle income countries, a consequence of the data requirements needed for our analysis.

The surveys cover critical information on firms needed to address the question how corruption affects firms' IP ownership. The data also provides substantial additional information on firms including on sales, employment, ownership type, and export performance as well as use of technology. Appendix Table 1 provides definitions of variables used for the analysis and baseline statistics for these variables. Regarding information on firms' IP titles, the dataset has information on firms' ownership of IP through patents and quality certificates. Overall, 9.6% of the firms in our sample hold patents while a larger share, about 24.5%, has quality certificates.

Second, the dataset also covers, differently from the usual firm-level datasets, information about business climate conditions including corruption, which can be defined as the "use of public office for private gains, where an official (the agent) entrusted with carrying out a task by the public (the

[9] Dethier et al. (2011) provide a comprehensive overview of WBES.

principal) engages in some sort of malfeasance for private enrichment" (p.1321, Bardhan, 1997). A key advantage of the data is that it allows addressing three critical challenges that arise when it comes to measuring corruption. One challenge is that corruption is, as is the case for other illegal activities, often underreported particularly if information is collected from those benefitting from corruption (Banerjee et al., 2012). Moreover and more fundamentally, aggregate corruption measures may not adequately capture the specific dimension of interest for an empirical study such as ours since they seek to integrate a variety of different dimensions of corruption. For instance, differences might exist regarding the levels of corruption businesses and individuals face for different types of interactions with the public sector. We are, in our specific case, interested in corruption faced by firms as they seek to conduct business operations. Therefore, we need an indicator that focuses more specifically on corruption in firm-government relations. Finally, a critical challenge for rigorous quantitative assessments of corruption is that they need to rely on a fact-based definition of corruption so as to reduce well-known biases introduced by subjective perception-based assessments of corruption (Olken, 2009; Svensson, 2003).

We address the triple challenge by relying on a specific question asking firms whether they had to make an informal gift or payment to obtain an operating license.[10] We obtain a measure of corruption of the business environment by computing the average shares of businesses that indicated informal payments or gifts were required to operate a license. The averages are computed at the region-country and country levels. Figure 1 plots the percentages of firms paying gifts for operation against percentages of firms with patents or certificates for different region-country contexts. The wider use of certificates compared to patents can be seen. Trendlines suggest a negative relation between higher levels of corruption and IP ownerships. There are, however, substantial heterogeneities. We are less concerned about biases reported due to the fact that the information has been provided anonymously by those affected by corruption (rather than those responsible for corruption). However, there might still be some underreporting particularly as some firms affected by corruption may be afraid to report it. The fact that we compute an aggregate measure of corruption helps reduce measurement errors compared to firm level indicators.

We also use information from external datasets on the intensity of IP used by different industries. We use historic information on US industry patenting, as obtained by Aghion et al. (2013), which place machinery and equipment producers as among most intensive sectors while food and beverages, textiles and basic metal producers are weak users of IP. As alternative measures of industry patenting intensity we employ an estimate for the United States for 2004-2008 as reported in ESA-USPTO (2012). The sectors with strongest use of patents correspond to those identified already decades earlier by Mansfield et al. (1981) as most IP sensitive: a) drugs, cosmetics and healthcare products, b) chemicals, c) machinery and equipment and d) electrical equipment. Moreover, since the different types of IP protect very different inventions, we cannot rely on a measure of patent intensity

[10] These measures have previously been used at the firm-level by Fan et al. (2009) and Ayyagari et al. (2010) among others.

as a proxy for the intensity of quality certificates used by industries. Since we do not have comparable data to those on patents, we obtain, using the entire WBES dataset for which information of quality certificates is available, the share of firms in each industry who relied on quality certificates. Additional measures are used for testing the robustness of our results and discussed in Section 5.4. Appendix Table 2 shows IP intensities by industry used as part of our analysis.

3. Theoretical Framework

Corruption can have a strong detrimental effect on growth through its negative impact on productive investments, including notably investments in innovation. Several mechanisms can induce such effects: First, corruption can reduce opportunities for innovation by diverting resources from productive public investments that would support innovation (e.g. infrastructure investments or spending in education) into private consumption (that of corrupt officials). Even if estimates of corruption are necessarily approximations, the overall amounts are potentially substantial particularly where tax receipts are low and requirements for productive and social spending substantial. The World Bank Institute estimated worldwide bribery to amount to USD 1 trillion per year (Sequeira, 2012). A second mechanism, however, imposes a much larger cost. This is the resulting misallocation of resources by firms away from productive uses including innovation and entrepreneurship activities. Murphy et al. (1993) argue that corruption will likely lead firms to invest less in innovative activities than in everyday production activities. That is because innovators require government-supplied goods such as permits, import and tax licenses and, in the case of start-up initiatives, a series of permits for operation that established producers no longer require.[11] By increasing the cost of engaging in innovation corruption will likely discourage investments in innovation hampering in this way growth prospects. [12] Corruption itself might also, depending on social preferences regarding inequality, raise demands for redistributive policies and, in consequence, reduce investments in innovation (Alesina and Angeletos, 2005). A critical public service for innovators is the IP system which can effectively support firms' innovation activities (OECD, 2014).

It is worth opening a parenthesis to describe how the two types of IP titles studied here - patents and quality certificates - are relevant for innovation. The critical role of patents in supporting innovation and growth relies on the following well-known argument: Patents, granted by national IP offices, give their owner a set of rights of exclusivity over an invention, that is, a product or process that is new, involves an inventive step and is susceptible to industrial application. The patent holder can exercise some power on the market and charge customers a markup on the price. In the absence of this exclusion right, competitors who have not incurred any research costs could imitate the invention

[11] This is supported by evidence by Djankov et al. (2002), which suggests that entry of firms is more difficult in contexts of greater corruption.

[12] Other investment options in innovation of lower value may then become more attractive. For instance, firms may adopt inefficient "fly-by-night" technologies of production because these have a high degree of reversibility to be prepared to close down if necessary as new demands from corrupt officials arise (Svensson, 2003).

and offer the good or service at a lower price than the inventor. This situation could deter inventions coming to the market in the first place. Patents can, therefore, improve the dynamic efficiency of the economy (OECD, 2009; Guellec and van Pottelsberghe, 2007).[13] While patents are an output of R&D investments, they can also be seen as input to innovation as inventions are not yet at the stage of commercial use but offer opportunities for developing innovations.[14]

Quality certificates contribute differently to innovation than patents. They are awarded to firms that fulfil a set of quality standards. Verification is undertaken by various certification bodies called registrars that can include government laboratories, private testing organizations, firms that were early adopters of ISO, industry trade groups, and accounting firms (Anderson et al., 1999). The ISO 9000 quality certificate standards, one of the most widely adopted quality certification worldwide set by the International Organization for Standardization, are a series of international standards of state-of-the-art quality management system requirements. National standards bodies issued on average more than 1 million ISO quality certificates per year over 2006-2011 (ISO, 2013). These certificates are indicators of non-technological and organizational innovations defined as "the implementation of a new organizational method in the firm's business practices, workplace organization or external relations" (OECD/Eurostat, 2005). They, thus, provide another picture of innovation activities.[15] Compared to trademarks – which give exclusive rights over the use of a sign, design or expression – quality certificates relate directly to firm-level innovation. Obtaining them requires firms to engage in considerable monetary investment (estimated at around USD 187,000 on average) and time effort (about nine months to two years) for firms (Guler et al., 2002). What is more, a wide management literature documents how holding quality certificates improves firms innovation capacities and performance (Diaye et al., 2009; Douglas et al., 2003; Terziovski et al., 2003; Terziovski and Guerrero, 2014). ISO 9000 certification is correlated with direct measures of product quality (e.g. Brown et al. 1998, Withers and Ebrahimpour 2001). There is also evidence of a positive relation between trademark and innovation activities (e.g. Schmoch 2003, Mendonça et al., 2004, Malmberg, 2005, Millot, 2012).

The nature of benefits to firms from quality certificates is to do with their role in addressing information asymmetries, which may, as described in the well-known example of the "market for lemons" (Akerlof, 1970), lead to the failure of markets to reward higher quality goods. Effectively industries concerned about the "lemons" problem have incentives to establish a certification agency to collect and disseminate product information, awarding quality certificates by a certification agency (Dranove and Zhe Jin, 2010). The ISO 9000 series has effectively operated as a signal reducing

[13] But they do so by reducing competition and increasing prices, thereby excluding some consumers. Customers willing to pay more than the marginal cost but less than the mark-up price cannot buy the good. This generates an economic inefficiency, a *deadweight loss.*

[14] In fact, patents can support innovation processes, for instance, by serving as collateral for innovative companies to obtain credit to develop innovations. They may also facilitate access to public support by signalling quality of the innovative capacity of firms.

[15] Millot (2012) finds for an analysis of French firms that trademarks, which similarly to quality certificates serve as market signal for firms' innovations, are correlated with product and marketing innovation even when controlling for patent use, suggesting trademarks are a complementary source of information on firms' innovation activities.

information asymmetries, particularly in sectors where it is more difficult for firms to signal the quality of their product (Terlaak and King, 2006). Quality certification has become a requirement for potential exporters, and signals quality and reliability to foreign buyers, value chain leaders, and transnational corporations seeking local partners and subcontractors impacts both local and international demand as a number of governments and private companies (particularly MNCs) require this certification from suppliers (Guler et al., 2002). However, while "marketing" purposes are critical motivations for firms to obtain quality certificates, firms also value process improvements - i.e. internal business innovations - associated with such certificates (Buttle, 1997).

Corruption can raise costs to obtain IP titles, either by imposing an additional fee or by reducing the speed at which applications are processed. Some of the differences between patents and quality certificates point to potentially stronger impacts of corrupt business environments on quality certificates than on patents: One reason is the nature of innovation they protect. Patents are exclusive and unique awarded to those first introducing technological inventions, which in turn can be the basis of future product or process innovations. Quality certificates, by contrast, are not unique to the firm but certify it has reached a quality standard that testifies firm-level non-technological innovation efforts. The criteria to obtain patents are generally more objective as they rely on demonstrating technological breakthroughs than those for quality certificates, which rely on a broader list of less clear-cut criteria. It will be easier for firms to denounce wrongful treatment by public officials where they can point to objective criteria their innovation fulfills. Consequently, it is more difficult for corrupt officials to demand bribes. Quality certificates will also require re-validation while once awarded patents cannot be revoked. The former may, therefore, provide a more long-term resource for corrupt officials than the latter. The fact that patents are awarded by the IP office only rather than by a diversity of national certification institutions raises risks of discovery of corruption.

However, arguments have been made to suggest that corruption can be efficiency-enhancing and help "grease the wheels" particularly in those developing and emerging contexts where institutions are less effective. Such rationale could equally be applied to the specific case of IP systems where the slow speed of processing of IP applications challenges the efficient operation of IP systems. A competitive Coasean bargaining process would lead to different firms negotiating priority processing for IP applications and should then lead to the most efficient firm to pay the highest bribe for priority processing (Bardhan, 1997). Empirical findings support this hypothesis including e.g. Méon and Weill (2010) and Vial and Hanoteau (2010). Yet, there are various caveats to arguing for efficiency-enhancing contributions of corruption. As corruption is an illegal activity there is necessarily secrecy involved, any agreements reached will not be based on enforceable contracts. This means that it is, in practice, unlikely that competitive bargaining processes can be set up with predictable actions once bribes have been paid (Bardhan, 1997). Moreover, efforts to avoid detection and punishment will mean corruption is even more distortionary. The "greasing the wheel" hypothesis emphasizes, however, that corruption effectively has certain aspects of a bargaining process.

Consequently, the characteristics of firms might well have some impact on how they are affected by corruption.

There are in fact several reasons why we would expect corruption to have differential impacts for differently sized firms to the disadvantage of smaller businesses. A first factor is simply to do with the capacity of firms to pay bribes: large firms might be more likely to pay bribes as they are less credit-constrained and might also have larger profits to pay for such additional expenditures. In line with this hypothesis, Svensson (2003) effectively shows how firms' "ability to pay" is a critical determinant of bribery payments for a sample of Ugandan firms. A second factor is that there are likely to be scale benefits in bribing in that continued payments to officials could allow large firms wider access to various government services. It can also offer the opportunity to negotiate more successfully benefitting from repeated games. Specifically, repeated interaction might not only raise risks of corruption but also help reduce risks that bribery payments will not lead officials to the provision of services. Large firms are more likely to have repeated interactions as they are often older than small businesses and have more requests of government services as their volume of products is larger. A third factor is that large established firms might be more favored in corruption games as "collusion" with large firms can create "trusted" relationships with corrupt officials. This is critical for corrupt officials in order to ensure the bribery will not be revealed. The large the number of firms officials receive bribes from and the larger the number of new firms, the higher will be the risks for corrupt officials. Moreover, search costs in identifying suitable firms can lead to collusion whereby preferential treatment is given to a selected group of firms, differently from a "competitive" bribing system.

In conclusion, corruption may affect firms' ownership of intellectual property titles; with possibly stronger effects on quality certificates than patents. It might also benefit larger firms disproportionately. In the extreme, the "greasing the wheels" hypothesis might apply for the subgroup of large firms. Such heterogeneous effects of corruption impose an additional distortion by impeding a wider set of firms from engaging in innovation activities. In such circumstances corruption would benefit larger firms to improve their competitive position relative to smaller market participants. Heterogeneous impacts of corruption are possibly one of the factors explaining why a plot of average levels of corruption and IP ownership shows substantial dispersion (Figure 1). The much flatter line for patents may also point to weaker effects of corrupt business environments on obtaining the latter. Such effects will remain hidden unless they are specifically taken into account by the empirical framework. We will test whether this hypothesis is correct in our empirical analysis.

4. Empirical Framework

The following describes a baseline approach to analyzing the impacts of corruption, which has been applied in the past at the country level to analyze the impacts of a variety of institutional characteristics on various performance indicators (including for corruption e.g. Mauro, 1995; Wei, 2000; Méon and Weill, 2010):

$$IP_{icy} = \alpha_0 + \beta_c corruption_{cy} + \beta_X X_{icy} + \lambda_j + \beta_Z Z_{cy} + \varepsilon_{icy} \quad (1)$$

where *IP* is a measure of IP ownership (that is, either patents or quality certificates) of firm *i* in country *c* in year *y*, *corruption* is an indicator of corruption at the country level, *X* are sets of controls for firm characteristics while λ_j are industry fixed effects and *Z* is a set of country level controls in year *y*, and ε is the error term. Regarding firm controls, we will systematically account for employment, as well as research capacities by introducing a measure of the share of skilled labor, controlling for the use of foreign technology, a potentially important channel for access to technology in emerging countries, as well as another measure of technology capacities (which can also serve as an indicator of "connectedness"): an indicator on whether the firm has its own website or not. We will also control for firms' labor productivity and for ownership status – whether the firm is foreign or publicly owned, to what extent ownership is concentrated and firm age. Finally, we control for whether the firm is involved in exports in all of our specifications.

In order to test for heterogeneous impacts of firm size we could then rely on the following simple set-up:

$$IP_{icy} = \alpha_0 + \beta_{cs'} corruption_{cy} * size_{icy} + \beta_{c'} corruption_{cy} + \beta_x X_{icy} + \lambda_j + \beta_z Z_{cy} + \varepsilon_{icy} \quad (2)$$

where *size* is a measure of firm size. We add the interaction term only as firm size – measured based on employment – is already one of the firm controls included in our specification.

A substantial shortcoming of the proposed analysis is that the set-up allows controlling for a few selected country control variables but not systematically as is possible for industry characteristics by including industry fixed effects. However, many country factors likely affect IP ownership ranging from features of IP systems beyond purely legal characteristics to countries' levels of development, all of which can only imperfectly be controlled for by introducing a set of specific country control variables. The list of potential omitted variables that the corruption variable might be proxying for is large, and the explanatory variables to include a matter of conjecture. It is difficult to have measures of every conceptual country factor one would like to control for and degrees of freedom are naturally limited at the country level. Therefore, a critical element for identification requires introducing country fixed effects in our estimation approach. A further challenge is that a country-level indicator of corruption likely masks location differences that can be substantial. Whether or not the firm operates in the capital city can make a difference, for instance, in the extent to which a system of checks and balances that restrains corruption is in place. More generally the size of regional agglomerations of firms will likely make a substantial difference that is not accounted for in aggregate country-level indicators but that do play a role in firms' business environment. This is also the case for IP registration procedures as regional services will likely operate quite differently from centralized processes. Two different country examples illustrate such differences in services by location: The nature of IP services differs substantially across regions; particularly strong is the contrast between services provided at the IP office's headquarters and those offered elsewhere in the country (OECD, 2014).[16]

In order to address these potential shortcomings we use an alternative estimation strategy. First, we choose a strategy that allows introducing country fixed effects and, in that way, address the omitted variables problem. We exploit the fact that the extent to which IP is used to protect inventions differs substantially across different industries. This is due to differences in technological progress and innovation dynamics across sectors. We then test whether firms operating in sectors that are relatively more in need of IP, are more likely to adopt IP if they face a less corrupt business environment than firms operating in sectors that rely less on IP. That is, we exploit variation across countries and sectors to isolate confounding factors at the country level. This approach has been used extensively to investigate questions on how financial constraints affect performance following Rajan and Zingales (1998) (see e.g. Nunn, 2007; Manova, 2008; Chor, 2010; Chor and Manova, 2012 for a recent application). A critical assumption for this identification is that there is a technological reason why some industries depend more on IP titles than others. That is, these industry differences persist across countries: If pharmaceuticals rely more on IP than textiles in the United States, this is also the case in other countries including emerging and developing economies.

Such an analysis is warranted as the use of IP varies across industries due industry characteristics including, among others, i) the speed of innovation cycles and ii) the nature of the invention and innovation.[17] First, high turnover rates of inventions can render IP registration processes less valuable as, once granted, inventions might quickly be rendered obsolete by new inventions thus giving their owners only a very limited period for enjoying monopoly returns on their inventions. In industries where those turnover rates are particularly high other strategies beyond IP such as lead-time (i.e. competing to gain first-mover advantage on markets), secrecy or, what is related to the latter, complex design of products can be more interesting. The fashion industry is an example where

[16] Since arguments can be made to consider country-level indicators of corruption faced by firms we will also conduct regressions at the country level as report in our robustness.

[17] Two other characteristics also have impacts on differential needs for IP across industries: the importance of complex vs. simple technologies across industries and differences in the distance from protected inventions to commercialised products. First, complex technologies (e.g. electronics) result in innovative products that are based on hundreds of patentable elements, whereas simple technologies (e.g. chemicals) will involve a relatively small number of patentable elements. Complex technologies require cross-licensing agreements to address potential challenges posed by so-called patent thickets. It is those technologies in-between complex and simple technologies for which patenting is potentially least attractive. Second, the distance from the product that is patented to the product that is sold on markets, and ultimately provides returns to companies for their investments, differs. In the case of pharmaceutical inventions, the patent specification corresponds to the manufactured product. In the case of engineering, the link between the patented invention and the innovation process is more complex, as incremental changes normally occur from the development stage to product release. While the former renders patents potentially more relevant, the latter might render IP useful to the extent that IP can provide financing to commercialise the product.

turnover rates are likely substantial; registering IP is in consequence less attractive. Second, industries differ in the type of inventions/innovations they produce. Those characteristics also shape to what extent patents and/or trademarks are relevant forms of IP protection or not. In that respect, the type of IP studied, whether it is patents or quality certificates, also differs and, therefore, the intensity of IP use has to be analyzed separately for different types of IP. There are also differences in that in some cases more innovations can be kept secret than others. For instance, process innovations more generally might lend themselves more to such types of protection. The need to signal product quality will also differ across industries, leading to differential industry needs for quality certificates. The differential reliance on IP across industries is also supported by empirical evidence for different periods and countries; one of the consistent findings is, for example, the strong reliance on patents by pharmaceutical and chemical industries compared to others (Levin, 1988; Cohen et al. 2000). We are, therefore, warranted to use the identification strategy specified above. A few papers in the literature have exploited the differential use of IP across industries. These include Aghion et al. (2013) and Sakakibara and Branstetter (2001). Branstetter et al. (2006) use a similar methodology at the firm level based on the observation that those relying more on intellectual property rights should respond more to IP rights reforms.

In order to ensure that we use an exogenous measure, we rely on a measure of patent intensity for the US economy, i.e. one that could be seen as a benchmark, used by Aghion et al. (2013). For quality certificates we do not have comparable data for the US economy. We use the average intensity of quality certificates by industry of the 63,205 observations available in the full WBES. As part of our robustness tests we check whether results hold for alternative weights used for both quality certificates and patents. Moreover, in order to overcome the challenge of potentially substantial variation in corruption across regions, we take advantage of the available data and define corruption at the location-country (3 and 4 below) and country level (3' and 4' below). Our modified baseline estimating equations are, therefore, the following:

$$IP_{icy} = \alpha_0 + \beta_{c1}(IP\_Int_j * corruption_{lcy}) + \beta_X X_{icy} + \lambda_j + \lambda_r + \lambda_{cy} + \varepsilon_{icy} \tag{3}$$

$$IP_{icy} = \alpha_0 + \beta_{c2}(IP\_Int_j * corruption_{cy}) + \beta_X X_{icy} + \lambda_j + \lambda_r + \lambda_{cy} + \varepsilon_{icy} \tag{3'}$$

$$IP_{icy} = \alpha_0 + \beta_{cs1'}(IP\_Int_j * corruption_{lcy}) * size_{icy} + \beta_{c1'}(IP\_Int_j * corruption_{cy}) + \beta_X X_{icy} + \lambda_j + \lambda_r + \lambda_{cy} + \varepsilon_{icy} \tag{4}$$

$$IP_{icy} = \alpha_0 + \beta_{cs2'}(IP\_Int_j * corruption_{cy}) * size_{icy} + \beta_{c2'}(IP\_Int_j * corruption_{cy}) + \beta_X X_{icy} + \lambda_j + \lambda_r + \lambda_{cy} + \varepsilon_{icy} \tag{4'}$$

where $IP_{intensity,j}$ is an indicator of the intensity of patent or certificate use for industry j. The other controls are as specified before with the addition of λ_r which controls for region fixed effects (i.e. the type of location firm *i* operates in), and, importantly λ_{cy}, a control at the country-year level. It is worth noting that our approach poses weak endogeneity concerns: We are assessing the impacts of corruption at the region-country and country rather than at the firm level on firm performance. It is unlikely that specific firm performance drives corruption at this aggregated level. Nonetheless, we test in our robustness whether results hold when we instrument for corruption.

A challenge with interpreting estimates of β_c of equations (3) and their equivalents in (4) as causal evidence of corruption's effect on IP ownership is that various determinants of comparative advantage omitted from the estimation may bias results. Notably, it may be the case that more IP-intensive industries are not only likely to be more affected by corruption but also by shortages in skilled labor, reduced opportunities for accessing finance and, more generally, lower business development levels. The level of investment undertaken may also shape IP ownership. In addition, industry conditions in specific country contexts such as the levels of competition, technology availabilities and productivity may shape impacts more specifically. To ensure we effectively pick up impacts of corruption we add in controls for firms' business environment including factors relating to development levels and framework conditions. Finally, we also add corruption at location-country level to pick up any other factors that might be picked up aside from those that affect specifically industries that heavily rely on IP. Our final estimation model is, therefore, the following:

$$IP_{icy} = \alpha_0 + \beta_{c1}(IP\_Int_j * corruption_{lcy}) + \beta_I(IND\_Int_j * characteristic_{lcy}) + \beta_X X_{icy} + \beta_y Y_{jcy} + \lambda_j + \lambda_l + \lambda_{cy} + \varepsilon_{icy} \quad (5)$$

$$IP_{icy} = \alpha_0 + \beta_{cs1'}\left(IP\_Int_j * corruption_{lcy}\right) * size_{ict} + \beta_{c1'}(IP\_Int_j * corruption_{lcy}) + \beta_I(IND\_Int_j * characteristic_{lcy}) + \beta_X X_{icy} + \beta_y Y_{jcy} + \lambda_j + \lambda_l + \lambda_{cy} + \varepsilon_{icy} \quad (6)$$

where *IND_Int* are characteristics of industry *j* and *characteristic* are characteristics of location *l* in country *y*, and Y_{jcy} are characteristics of industry *j* in country *c*. The equivalent additions are applied to country-level corruption models specified in (3') and (4').

Finally, we apply the linear probability model for our estimations. Standard errors are clustered by country, location, industry and year and, for alternative regressions, by country, industry and year taking into account that firms' IP ownership is explained by more aggregate measures of corruption (Moulton, 1990). Specific detail about the variables used for the empirical analysis is provided in Appendix Table 1.

5. Results

5.1. Baseline Results

Panel A of Table 2 shows baseline regressions results implementing the framework described in equation (5). Column (1) includes a set of firm-level controls showing a negative significant effect of corruption on firm ownership of quality certificates. Regarding firm characteristics unsurprisingly our results indicate larger and older firms are more likely to hold certificates than their smaller and younger counterparts. This is also the case for foreign-owned firms and exporters. Moreover, more productive firms that use foreign technology are also more likely to hold certificates. Column (2) shows results if a set of controls describing firms' business conditions and factors related to development levels in particular. These include the overall GDP per capita as well as industry's competition, productivity and technology levels. We find for firms in R&D-intensive industries that operating in richer economies positively relates to IP ownership for a variety of factors relating to context and probably also differences in demand for quality certificates. We do not find industry characteristics to be significant, which might be partly as industry fixed effects control for general industry-specific characteristics already.

Moreover, column (3) adds controls covering critical framework conditions for firms: i) access to finance, ii) the availability of skills, iii) infrastructure conditions and iv) investment intensities. The evidence suggests that indeed credit availability as well as investment intensities have a positive effect. By contrast, we do not find significant effects for skills and power outages. Column (4) adds our measure of corruption directly and interacted with contract intensity. Column (5) includes the same controls but assesses impacts of corruption using a measure at the country rather than the country-location level. The result confirms findings shown throughout of a negative significant effect of corruption on the ownership of quality certificates.

Finally, Panel B of Table 2 shows results for patent ownership. In this case we do not find an effect of corruption. This indicates possibly few "opportunities" for corruption protect patenting activities of firms while they strongly affect the likelihood of obtaining quality certificates. We will test whether this holds when controlling for firm heterogeneity.

5.2. Main Results

In order to test our main hypothesis, that the effects of IP ownership are in fact heterogeneous across differently sized firms firms, we present in Table 3 results of estimations of equation (6). Columns (1)-(2) show results for employment size, with corruption measured at location-country and country level respectively. Columns (3)-(4) report results estimating impacts for distinct firm size categories as in Beck et al. (2005). Our results indicate negative significant effects of corruption on firms' ownership of quality certificates, with stronger impacts on smaller firms. Results for patents are reported in Panel B. Our findings show a negative but insignificant effect of corruption on patent ownership confirming findings reported for Table 2.

Regarding the magnitude of impacts, an increase of corruption by one-standard deviation (i.e. a decrease in the composite measure of 0.25) would lead to a reduction in the share of firms holding quality certificates ranging from 6.3% to 7.3% for the estimates of columns (1) and (2) respectively. As larger firms face fewer obstacles from corruption, for a given average firm size those effects are reduced to by 2.4% (column (1)) to 3.5% (column (2)), all else constant. For patents, the corresponding decrease (of 0.02 for the composite measure) is of less than 1% for estimates of column (1) and slightly above the value for column (2), with offsetting effects with average firm size.

5.3. Robustness

Panel A of Table 4 presents results of several robustness checks of our results on quality certificates. First, we test whether findings are robust to the use of alternative measures of corruption. In column (1) as an alternative to our measure of corruption we use a widely used country-level indicator of corruption: Transparency International's Corruption Perception Index. Our results are qualitatively maintained. The same holds for results shown in column (2) where corruption is measured based on firms' perception of corruption as an obstacle to their current business operations. A major disadvantage of this indicator is that it is highly subjective. For this reason we prefer to rely on our chosen measure of corruption to assess the impacts of corruption. .

Second, we test the other component of our variable of interest: the measures of industry IP intensities used in our estimation. We use a measure of industry R&D-intensity, an alternative proxy for differences in industries' innovation intensities and, thus, their need for IP to protect those innovations, and find as shown in column (3) similarly a negative effect of corruption particularly for smaller businesses. We also use another industry weight, which is based on differences in the trademark application intensity. Results, as shown in column (4), corroborate our findings. Third, we test whether our results are maintained using an alternative estimation method, probit and logistic regressions. Results reported in columns (5) and (6) show our results are robust to the use of these alternative estimation techniques. Fourth, we check whether our results hold for an alternative firm size measure, based on firms' sales size rather than employment. Results reported in column (7) confirm main findings of Panel A of Table 3.

With regards to patents, while we find strong evidence on negative effects for the two alternative corruption measures, the CPI and subjective corruption index, as shown in columns (1) and (2) of Panel B of Table 4, we do not find supportive evidence for several of the other tests. Panel B of Appendix Table 3 shows similar findings hold for corruption measured at the country level.

Moreover, additional concerns might be raised regarding the findings regarding reverse causality and omitted variable biases. First, reverse causality might drive results. This would be the case if IP ownership had effects on corruption, for instance, if an environment where innovation, reflected in high levels of IP ownership, is more prevalent affected opportunities for corruption. While possible if we think about innovation at the aggregate it is less of an issue in our context where we analyze how corruption measured at the country-location and country levels affects firm-level IP ownership. Notwithstanding, we test whether our results hold if we instrument corruption with a more exogenous variable to account for country-level corruption: We use a measure computed by Blockstette et al. (2002) which captures countries' depth of historical experience with state-level institutions and scores according to whether governments above tribal levels existed, whether government was foreign or locally based and how much of today's territory that was ruled by the current government. In order to avoid endogeneity concerns over controls, we have excluded them from those regressions (with the only exception of employment size used in the interactions). Results shown in column (1) of Table 5 show effects remain significant as before.

In addition, while our controls ensure we do not pick a variety of business conditions our results might be picking up other institutional shortcomings that may be correlated with corruption and be the "true" impact factor of negative effects on firms' ownership of quality certificates. In columns (2)-(7) of Table 5 we introduce different governance indicators obtained by the World Bank to explicitly cover various governance strengths and/or weaknesses. These are, i) rule of law, ii) voice and accountability, iii) political stability, iv) regulatory quality, v) governance effectiveness as well as vi) control of corruption. We find our results are qualitatively maintained as those different controls are included, indicating it is effectively corruption rather than other institutional factors that drive effects. We find, however, governance effectiveness to have a positive significant effect. We also find our results are not affected by introducing a measure of the legal quality of trademarks, reported in column (8) of Table 5. The fact that we find corruption to have significant negative impacts once the legal quality of the IP system is controlled for (i.e. once the *de jure* protection is taken into account) illustrates a specific dimension how the actual implementation of IP (i.e. a dimension of the *de facto* protection) has substantial effects on firm IP ownership. Unreported results on patent ownership confirm weak evidence documented in Tables (3) and (4).

Overall, we conclude robust evidence on strong negative effects of corruption on certificate ownership and weak indicative evidence of effects on patents, probably due to the differential opportunities for corruption for quality certificates compared to patents. We also confirm small firms are more affected by corruption than larger businesses.

5.4. Extensions

Firm Characteristics and Quality Certificate Ownership

There might be other characteristics than firm size that drive the way corruption affects firms' certificate ownership differentially. First, exporting firms – who often are among the leading firms in a country – might well face fewer challenges than other firms. One reason why exporters should be less affected could be that these have larger capacities and resources to deal with corruption. Columns (1)-(2) and (3)-(4) of Panel A of Table 6 show results separating the sample of exporter and non-exporters for equation (5). The evidence shows that the negative effect of corruption on certificate ownership only holds for non-exporters.

Another condition that might likely have impacts is firms' ownership status. Firms that are foreign-owned may have a very different status from national business. They might, for instance, have privileged relations with host institutions and receive different treatment in consequence. Similarly state-owned firms will have very different relations with public institutions and might have a different level of exposure to corruption. We, therefore, split the estimating samples into two categories, foreign and public firms vs. private national firms, and estimate equation (5) for each group. Results for certificates, shown in columns (5)-(6) and (7)-(8) of Panel A of Table 6 indicate that it seems indeed the case that corruption only has a negative significant effect for private national firms but not for foreign and public firms.

Moreover, there may be a difference in effects depending on whether firms are operating in manufacturing or services sectors. Unfortunately, we do not have observations for several business environment conditions we control for. In consequence, for the comparisons across both sectors we omit them from the estimations shown in Panel B of Table 6. We find that both types of firms are affected by corruption, but the impact on services firms is somewhat larger (columns (1)-(2) and (3)-(4)). In both cases, as shown in columns (5)-(6) and (7)-(8) effects are stronger for smaller firms. A possible explanation why effects are stronger for services as in those cases there might be wider "opportunities" for corruption as, differently from manufacturing, there is more scope for subjective evaluation of standards being attained and, therefore, it is harder to for firms to protest against corruption making it more likely.

Impacts on Machinery Investment

The impacts of corruption on IP provide evidence of negative impacts of this type of institutional weakness on innovation. It is relevant to see whether negative effects also hold for other innovation activities those that are more widely accessible across firms in developing countries than is the case for patents, which require substantial R&D capacities few firms may have. Unfortunately, the dataset does not cover core innovation indicators such as firms' R&D investments. However, the dataset provides information on firms' investments in new machinery, providing information that relates closely to firms' efforts at introducing process innovations. As shown in columns (1) and (2) of Table 7 we identify negative effects. Differently from our results for quality certificates, we do not find unequal effects across differently sized firms, as reported in columns (3)-(4) and (5)-(6).

IP Ownership and Trust

Another force that might affect IP ownership is the level of trust existent in a specific business environment. The effects of trust on various factors including economic growth (Knack and Keefer, 1997) and financial development (Guiso et al., 2004) have been shown to be significant. The issue is related to corruption to the extent that the latter has negative effects on trust. As is the case for corruption, trust is a difficult concept to measure and has multiple interpretations. An interesting measure we exploit for this purpose is information on the average share of sales that firms are paid for after delivery, an indicator of the level of trust in contracts in a given context ($trust_{rcy}$). McMillan and Woodruff (1999) previously used the amount of trade credit granted by a firm as a measure of business trust. The rationale behind this type of measure is that firms will only allow for payments after delivery to the extent that they have confidence customers will not default on their payment promise. The idea to use "informal" borrowing relationships as an indicator of trust has also been used to measure trust in social networks (Karlan et al., 2009). Table 8 reports results for the following estimations for certificates where we adopt the same approach as in (5) and (6) but instead of a measure of corruption we include a measure of trust, aggregated in the same way as the measure of corruption:

$$IP_{icy} = \alpha_0 + \beta_{c1}\left(IP\_Int_j * trust_{lcy}\right) + \beta_I(IND\_Int_j * characteristic_{lcy}) \\ \beta_X X_{icy} + \beta_y Y_{jcy} + \lambda_j + \lambda_l + \lambda_{cy} + \varepsilon_{icy} \quad (7)$$

$$IP_{icy} = \alpha_0 + \beta_{cs1'}\left(IP\_Int_j * trust_{lcy}\right) * size_{ict} + \beta_{c1'}\left(IP\_Int_j * trust_{lcy}\right) + \\ \beta_I(IND\_Int_j * characteristic_{lcy}) + \beta_X X_{icy} + \beta_y Y_{jcy} + \lambda_j + \lambda_l + \lambda_{cy} + \varepsilon_{icy} \quad (8)$$

If we just test for the impacts of trust (i.e. (7)), they have a positive significant effect for quality certificates. Integrating interactions, i.e. equation (8), we find that trust has a stronger positive effect for larger firms as shown in columns (3)-(4). The same results hold using firm size categories (columns (5)-(6)). This indicates trust, therefore, is not a homogeneous factor either.

Country IP Intensity

Finally, we explore whether and to what extent our evidence on negative impacts of corruption on the ownership of quality certificates differs across countries depending on how intensively the economy relies on IP. Results reported in Table 9 show differentiated impacts by splitting countries into quartiles of IP intensity use, proxied by the use of trademarks relative to population size. While we find no significant effect for the lowest quartile, our findings point to negative significant effects for all other country groups. This suggests that the intensity of IP use within economies makes little difference overall to the effects of corruption. In countries that use IP least intensively corruption seems to be a negligible factor with regards to IP ownership.

6. Conclusion

This paper documents that corruption thwarts firms' innovation efforts, revealing an additional channel how corruption reduces development opportunities. The effects are heterogeneous and hurt smaller firms more than larger businesses while exporters and firms with foreign- or public ownership status are not affected. Corruption thus reduces opportunities for the democratization of innovation. Policies aimed at corruption are valuable as they help create an effective level-playing field for different types of firms. This is critical in emerging and developing countries that are characterized by "islands of excellence" which impose not only a cost on the distribution of welfare (Paunov, 2013) but also on aggregate performance (Hsieh and Klenow, 2009). With regards to policy solutions, the heterogeneous impacts of corruption across firms identified point to an important challenge for efforts aimed at bringing together the business community to support anti-corruption measures. The difficulties involved in developing effective anti-corruption measures as part of government-led schemes certainly renders this a worthwhile effort (Dixit, 2014). Finally, the weak impacts of corruption on patenting illustrates that objective criteria in awarding public services to firms can reduce negative effects. They act effectively as deterrents for corruption by raising the risk of discovery, benefitting firms in their productive investments and their development prospects.

References

Aghion, P., Howitt, P. and S. Prantl (2013), Patent Rights, Product Market Reforms, and Innovation, National Bureau of Economic Research Working Paper 18854, February 2013.

Aidt, T. (2009), Corruption, Institutions and Economic Development, Oxford Review of Economic Policy, 25(2), 271-291.

Akerlof, G. A. (1970). The market for" lemons": Quality uncertainty and the market mechanism. The Quarterly Journal of Economics, 84(3), 488-500.

Alesina, A., & Angeletos, G. M. (2005). Corruption, inequality, and fairness. *Journal of Monetary Economics*, *52*(7), 1227-1244.

Almeida, R., & Fernandes, A. M. (2008). Openness and technological innovations in developing countries: evidence from firm-level surveys. The Journal of Development Studies, 44(5), 701-727.

Anderson, S. W., Daly, J. D., & Johnson, M. F. (1999). Why firms seek ISO 9000 certification: regulatory compliance or competitive advantage?. Production and Operations Management, 8(1), 28-43.

Ayyagari, M., A. Demirguc-Kunt and V. Maksimovic (2010), Are innovating firms victims or perpetrators? Tax evasion, bribe payments, and the role of external finance in developing countries, The World Bank Policy Working Paper, 2010.

Banerjee, A., R. Hanna, and S. Mullainathan (2012), Corruption. HKS Faculty Research Working Paper Series RWP12- 023, John F. Kennedy School of Government, Harvard University.

Bardhan, P. (1997). Corruption and development: a review of issues. Journal of Economic Literature, 35(3), 1320-1346.

Beck, T., Demirgüç-Kunt, A. and V. Maksimovic (2005), Financial and Legal Constraints to Growth: Does Firm Size Matter?, The Journal of Finance, Vol. LX, No. 1, February 2005.

Blockette, V., Chanda, A. and L. Putterman (2002), States and Markets: The Advantage of an Early Start, Journalof Economic Growth, 7, 347-369.

Branstetter, L., R. Fisman and C. F. Foley (2006), "Do stronger intellectual property rights increase international technology transfer? Empirical evidence from U.S. Firm-Level Panel Data", *Quarterly Journal of Economics*, Vol. 121/1, Oxford University Press, Oxford, pp. 321-349.

Braun, M. (2003). "Financial contractibility and asset hardness." University of California-Los Angeles mimeo.

Brown, A., Van Der Wiele, T., & Loughton, K. (1998). Smaller enterprises' experiences with ISO 9000. International Journal of Quality & Reliability Management, 15(3), 273-285.

Buttle, F. (1997), ISO 9000: Marketing Motivations and Benefits. International Journal of Quality & Reliability Management, 14(9), 936-947.

Chen, Yongmin, and Thitima Puttitanun (2005). "Intellectual property rights and innovation in developing countries." *Journal of Development Economics* 78(2): 474-493.

Chor, D. (2010), Unpacking sources of comparative advantage: A quantitative approach, Journal of International Economics 82 (2010, 152-167.

Chor, D., & Manova, K. (2012). Off the cliff and back? Credit conditions and international trade during the global financial crisis. Journal of International Economics, 87(1), 117-133.

Clausen, B., Kraay, A., & Nyiri, Z. (2011). Corruption and confidence in public institutions: evidence from a global survey. The World Bank Economic Review, 25(2), 212-249.

Cohen, Wesley M., Richard R. Nelson, and John P. Walsh (2000). "Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)." NBER Working Paper 7552.

Dethier, J.-J., Hirn, M., Straub, S. (2011). Explaining Enterprise Performance in Developing Countries with Business Climate Survey Data. World Bank Research Observer 26, 258–309.

De Rosa, D., N. Gooroochurn, and H. Gorg (2010), "Corruption and productivity: firm-level evidence from the BEEPS survey." World Bank Policy Research Working Paper Series.

Diaye, M. A., Jovanović, J., Krivokapić, Z. and A. Vujović (2009). Training during ISO 9001 implementation and workers involvement into the quality management process in Montenegro. International Journal for Quality Research, 3(1), 71-77.

Dixit, A. (2014), How Business Community Institutions Can Help Fight Corruption, World Bank Policy Research Working Paper 6954, June 2014.

Djankov, S., La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (2002). The regulation of entry. The Quarterly Journal of Economics, 117(1), 1-37.

Douglas, A., Coleman, S. and R. Oddy (2003). The case for ISO 9000. The TQM Magazine, 15(5), 316-324.

Dranove, D. and G. Zhe Jin (2010), Quality Disclosure and Certification: Theory and Practice, Journal of Economic Literature, 48(4): 935-63.

Economics and Statistics Administration (ESA) and United States Patent and Trademark Office (USPTO) (2012), Intellectual Property and the U.S. Economy: Industries in Focus, U.S. Department of Commerce, March 2012.

EPO (2010), Study for the EPO on the Economic Dimensions of the Fee Structure in the European Patent System, Final Report, European Patent Office, London.

Fan, C. S., Lin, C. and D. Treisman (2009). Political decentralization and corruption: evidence from around the world. Journal of Public Economics, 93(1), 14-34.

Fisman, R. and J. Svensson (2007), Are corruption and taxation really harmful to growth? Firm level evidence, Journal of Development Economics, 83, 63-75.

Greenhalgh, C. and M. Rogers (2010), “The nature and role of intellectual property”, in Innovation, Intellectual Property, and Economic Growth, Princeton University Press, New Jersey.

Guellec, D. and B. van Pottelsberghe (2007), The Economics of the European Patent System: IP Policy for Innovation and Competition, Oxford University Press, UK.

Guler, I., Guillén, M. F., & Macpherson, J. M. (2002). Global competition, institutions, and the diffusion of organizational practices: The international spread of ISO 9000 quality certificates. Administrative Science Quarterly, 47(2), 207-232.

Guiso, L., Sapienza, P. and Zingales, L. (2004). ‘The role of social capital in financial development’, American Economic Review, vol. 94(3), pp. 526–56.

Hsieh, C. T., & Klenow, P. J. (2009), Misallocation and manufacturing TFP in China and India. *The Quarterly Journal of Economics*, *124*(4), 1403-1448.

International Standards Organisation (ISO) (2013), ISO Survey of Management System Standard Certification 2013, ISO, Geneva.

Karlan, D., Mobius, M., Rosenblat, T., & Szeidl, A. (2009). Trust and social collateral. *The Quarterly Journal of Economics*, *124*(3), 1307-1361.

Khan, B. Z. (2005). The Democratization of Invention: Patents and Copyrights in American Economic Development, 1790-1920. NBER: Cambridge University Press.

Knack, S., & Keefer, P. (1997). Does social capital have an economic payoff? A cross-country investigation. *The Quarterly Journal of Economics*, *112*(4), 1251-1288

Lanjouw, J. O., & Schankerman, M. (2004). Protecting Intellectual Property Rights: Are Small Firms Handicapped?. Journal of Law and Economics, 47(1), 45-74.

Levin, R. C. (1988). Appropriability, R&D spending, and technological performance. *The American*

Economic Review, *78*(2), 424-428

Malmberg, C. (2005), "Trademark Statistics as Innovation Indicators? - A Micro Study". CIRCLE Electronic Working Paper No. 2005-17.

Manova, K. (2008), Credit constraints, equity market liberalizations and international trade. Journal of International Economics, 76(1), 33-47.

Mansfield, E., Schwartz, M., & Wagner, S. (1981). Imitation costs and patents: an empirical study. The Economic Journal, 907-918.Maskus, K.E., 2000. Intellectual Property Rights in the Global Economy. Institute for International Economics, Washington, DC.

Mauro, P. (1995). Corruption and growth. The Quarterly Journal of Economics, 110(3), 681-712.

McMillan, J. and C. Woodruff (1999). Interfirm relationships and informal credit in Vietnam. The Quarterly Journal of Economics, 114(4), 1285-1320.

Mendonça, S., Pereira, T. S., & Godinho, M. M. (2004). Trademarks as an indicator of innovation and industrial change. Research Policy, 33(9), 1385-1404.

Méon, P. G., & Weill, L. (2010). Is corruption an efficient grease?. World Development, 38(3), 244-259.

Millot, V. (2009). Trademarks as an indicator of product and marketing innovations, OECD Science, Technology and Industry Working Paper No. 2009/6.

Millot, V. (2012), Trade mark strategies and innovative activities, PhD Thesis, University of Strasburg.

Moulton, B. R. (1990). An illustration of a pitfall in estimating the effects of aggregate variables on micro units. The review of Economics and Statistics, 334-338.

Murphy, K. M., Shleifer, A. and R.W. Vishny (1993). Why is rent-seeking so costly to growth?. The American Economic Review, 83(2), 409-414.

Nunn, N. (2007), Relationship-Specificity, Incomplete Contracts, and the Pattern of Trade, The Quarterly Journal of Economics, 122(2): 569–600.

OECD (2014), National Intellectual Property Systems, Innovation and Economic Development with perspectives on Colombia and Indonesia, OECD Publishing, Paris.

OECD (2009), OECD Patent Statistics Manual, OECD Publishing, Paris.

OECD/Eurostat (2005), Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, OECD Publishing, Paris.

Olken, B. A. (2009). Corruption Perceptions vs. Corruption Reality. Journal of Public Economics, 93(7), 950-964.

Paunov, C. (2013). *Innovation and Inclusive Development: A Discussion of the Main Policy Issues,* OECD Science, Technology and Industry Working Paper No. 2013/1.

Rajan, R. G. and L. Zingales (1998), "Financial Dependence and Growth." American Economic Review (1998): 559-586.

Rauch, James E., "Networks versus Markets in International Trade," Journal of International Economics, XLVIII (1999), 7–35.

Reynolds, T. (2004), Quantifying the Evaluation of Copyright and Trademark Law, PhD Thesis, College of Arts and Sciences, American University.

Sakakibara, M., and L. G. Branstetter (2001), "Do Stronger Patents Induce More Innovation? Evidence from the 1988 Japanese Patent Law Reforms," RAND Journal of Economics, 32, 77–100.

Schmoch, U. (2003). Service marks as novel innovation indicator. Research Evaluation, 12(2), 149-156.

Sequeira, S. (2012), Advances in Measuring Corruption in the Field, London School of Economics, unpublished manuscript.

Svensson, J. (2003), Who Must Pay Bribes and How Much? Evidence from A Cross Section of Firms, The Quarterly Journal of Economics, 19(3), pp. 19-42.

Terlaak, A., and A. King (2006), The effect of certification with the ISO 9000 Quality Management Standard: A signaling approach. Journal of Economic Behavior and Organization, 60: 579-602.

Terziovski, M. and J.-L. Guerrero (2014), ISO 9000 quality system certification and its impact on product and process innovation performance, International Journal of Production Economics,158, 197-207.

Terziovski, M., Power, D. and A. Sohal (2003). The longitudinal effects of the ISO 9000 certification process on business performance. European Journal of Operational Research, 146(3), 580-595.

Ullah, S. M. B., & Wei, Z. (2013). ISO Certification, Corruption and Firm Performance: A Cross-Country Study, unpublished manuscript.

Vial, V. and J. Hanoteau (2010), "Corruption, manufacturing plant growth, and the Asian paradox: Indonesian evidence." World Development 38.5 (2010): 693-705.

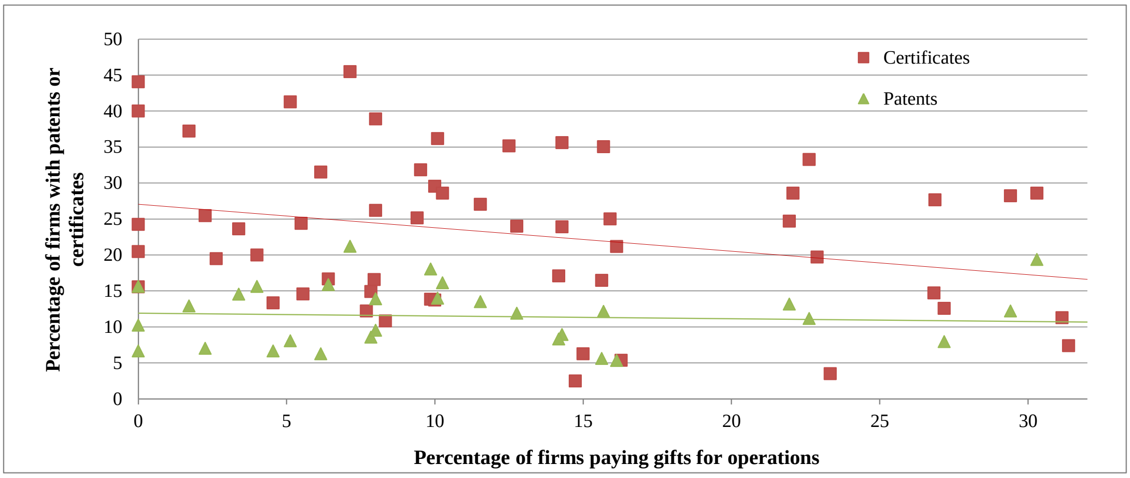
Wei, S. J. (2000). How taxing is corruption on international investors?. *Review of Economics and Statistics*, *82*(1), 1-11.

WIPO (2013), World Intellectual Property Report: Brands – Reputation and Image in the Global Marketplace, WIPO, Geneva.

Withers, B. E., & Ebrahimpour, M. (2001). Impacts of ISO 9000 registration on European firms: A case analysis. *Integrated Manufacturing Systems*, 12(2), 139-151.

Figures and Tables

Figure 1: Correlation of country-location averages of firms paying gifts for operating licenses and the share of firms owning patents or certificates (in percentages)



Note: Percentage averages are computed based on the countries included in the estimating sample described in Table 1.

Table 1: Estimating sample characteristics

	Number of Observations
Region	
Africa	2,361
Asia	2,322
Eastern Europe and Central Asia	2,079
Latin America and Caribbean	4,567
Industry	
Food, Beverages and Tobacco	2,460
Textiles	797
Garments	1,810
Leather	137
Wood	240
Paper	118
Publishing and Printing	293
Chemicals	1,089
Rubber and Plastics	746
Other Non-Metallic Mineral Products	729
Basic Metals	157
Fabricated Metal Products	1,180
Other Machinery and Equipment	525
Other Electrical Machinery and Apparatus	215
Radio, Television and Communication Equipment	34
Motor Vehicles, Trailers and Semi-trailers	140
Furniture and Other Manufacturing	659
Size	
Micro (1-10 Employees)	2,656
Small (11-50 Employees)	4,493
Medium (51-150 Employees)	2,246
Large (more than 150 Employees)	1,934
Year	
2007	2,183
2008	797
2009	3,529
2010	4,166
2011	654
Income Level	
High Income	1,171
Upper Middle Income	4,894
Lower Middle Income	4,287
Low Income	977
Full Sample	**11,329**

Note: The dataset includes firm data of the following countries: a) for Africa from Botswana, Ghana, Mali, Mozambique, Senegal, South Africa, Zambia, Zimbabwe; b) for Asia from Indonesia, the Philippines, Sri Lanka and Vietnam; c) for Eastern Europe and Central Asia from Afghanistan, Albania, Armenia, Belarus, Bulgaria, Estonia, Iraq, Kazakhstan, Kosovo, Moldova, Mongolia, Romania, the Russian Federation, Slovenia, Tajikistan, Turkey, Ukraine, Uzbekistan and Yemen; d) for Latin America from Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Paraguay, Peru, Uruguay and Venezuela. Industry information is based on the 2-digit ISIC Rev. 3 2-digit level. The income levels correspond to the World Bank's country lending categories.

Table 2: Baseline regressions of firms' IP ownership

Panel A: Quality certificates

	(1)	(2)	(3)	(4)	(5)
Corruption					
Corruption $_{\text{loc-country, y}}$ * Certificate Intensity $_{j}$	-0.097***	-0.085***	-0.085***	-0.072*	
	(0.032)	(0.032)	(0.031)	(0.039)	
Corruption $_{\text{country, y}}$ * Certificate Intensity $_{j}$					-0.130***
					-0.0455
Firm Controls					
Employment	0.056***	0.057***	0.058***	0.058***	0.058***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)
Age	0.023***	0.024***	0.024***	0.024***	0.024***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Foreign Ownership Status	0.114***	0.114***	0.114***	0.114***	0.114***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Public Ownership Status	0.101***	0.108***	0.108***	0.108***	0.109***
	(0.036)	(0.036)	(0.036)	(0.036)	(0.034)
Ownership Concentration	-0.002	-0.002	-0.002	-0.002	-0.002
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Share of Skilled Labor	0.006	0.005	0.006	0.006	0.006
	(0.019)	(0.019)	(0.019)	(0.019)	(0.018)
Indicator of Foreign Technology Use	0.119***	0.119***	0.119***	0.119***	0.119***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Share of Exports in Total Sales	0.104***	0.108***	0.111***	0.112***	0.111***
	(0.021)	(0.021)	(0.021)	(0.021)	(0.023)
Website Ownership	0.111***	0.109***	0.109***	0.109***	0.109***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.011)
Labor Productivity	0.030***	0.031***	0.031***	0.031***	0.031***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Controls for Business Environment Conditions					
(a) Development Level and Industry Conditions					
GDP per Capita $_{\text{country,y}}$ * R&D Intensity$_{j}$		0.172**	0.147**	0.150**	0.138**
		(0.073)	(0.071)	(0.072)	(0.065)
Herfindahl Index		0.000	0.002	0.002	0.002
		(0.029)	(0.029)	(0.029)	(0.031)
Intensity of Foreign Technology Use		-0.001	0.008	0.008	0.008
		(0.055)	(0.055)	(0.055)	(0.056)
Industry Productivity		-0.015	-0.013	-0.013	-0.013
		(0.009)	(0.009)	(0.009)	(0.009)
(b) Framework Conditions					
Credit Availability $_{\text{loc-country, y}}$ * Financial Dependence $_{j}$			0.243***	0.242***	0.246***
			(0.087)	(0.088)	(0.092)
Power Outages $_{\text{loc-country, y}}$ * Asset Tangibility $_{j}$			-0.527	-0.57	-0.499
			(0.421)	(0.414)	(0.400)
Investment Intensity $_{\text{loc-country, y}}$ * Physical Capital Intensity $_{j}$			0.429*	0.425*	0.434*
			(0.251)	(0.250)	(0.254)
Skills Availability $_{\text{loc-country,y}}$ * Human Capital Intensity $_{j}$			0.298	0.313	0.276
			(0.208)	(0.216)	(0.218)
(c) Additional Controls					
Graft$_{\text{loc-country,y}}$ * Contract Intensity $_{j}$				0.003	0.006
				(0.029)	(0.029)
Graft$_{\text{loc-country,y}}$				-0.011	-0.029
				(0.029)	(0.027)
Country-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
Location Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	11,215	11,104	11,104	11,104	11,104
R^2	0.33	0.33	0.33	0.33	0.33

Panel B: Patents

	(1)	(2)	(3)	(4)	(5)
Corruption					
Corruption $_{\text{loc-country, y}}$ * Patent Intensity $_{j}$	-0.077	-0.051	-0.006	0.066	
	(0.108)	(0.112)	(0.119)	(0.148)	
Corruption $_{\text{country, y}}$ * Patent Intensity $_{j}$					0.057
					(0.183)
Firm-Level Controls	Yes	Yes	Yes	Yes	Yes
Controls for Business Environment Conditions					
(a) Development Level and Industry Conditions	No	Yes	Yes	Yes	Yes
(b) Framework Conditions	No	No	Yes	Yes	Yes
(c) Additional Controls	No	No	No	Yes	Yes
Country-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
Region Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	5,882	5,850	5,850	5,850	5,850
R^2	0.18	0.18	0.18	0.18	0.18

Note: Industry fixed effects are at the 2-digit ISIC Rev. 3 level. Region fixed effects account for whether the firm is located in i) the capital city or areas ii) with more than 1 million inhabitants, iii) with 250,000 to 1 million inhabitants, iv) with 50,000 to 250,000 inhabitants or v) with less than 50,000 inhabitants. Clustered standard errors clustered by country, location, industry and year for columns (1) to (4) and country, industry and year for column (5) in parentheses. *, **, and *** indicate significance at 10%, 5% and 1% levels respectively.

Table 3: Main results: IP ownership, corruption and the effect of firm size

Panel A: Quality certificates

	(1)	(2)	(3)	(4)
Corruption				
Corruption $_{loc\text{-}country,\ y}$ * Certificate Intensity $_j$	-0.252***			
	(0.052)			
Corruption $_{country,\ y}$ * Certificate Intensity $_j$		-0.338***		
		(0.061)		
Linear Size Interactions				
Corruption $_{loc\text{-}country,\ y}$ * Certificate Intensity $_j$ * Size	0.043***			
	(0.009)			
Corruption $_{country,\ y}$ * Certificate Intensity $_j$ * Size		0.049***		
		(0.011)		
Size Categories Interactions				
Corruption $_{loc\text{-}country,y}$ * Certificate Intensity $_j$ * Small			-0.123***	
			(0.039)	
Corruption $_{country,y}$ * Certificate Intensity $_j$ * Small				-0.186***
				(0.045)
Corruption $_{loc\text{-}country,y}$ * Certificate Intensity $_j$ * Median			-0.059	
			(0.039)	
Corruption $_{country,y}$ * Certificate Intensity $_j$ * Median				-0.114**
				(0.046)
Corruption $_{loc\text{-}country,y}$ * Certificate Intensity $_j$ * Large			0.085*	
			(0.048)	
Corruption $_{country,y}$ * Certificate Intensity $_j$ * Large				0.032
				(0.055)
P-Value for Difference in Coefficients Small-Large			0.00	0.00
Firm-Level Controls	Yes	Yes	Yes	Yes
Controls for Business Environment Conditions	Yes	Yes	Yes	Yes
Country-Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Location Fixed Effects	Yes	Yes	Yes	Yes
Observations	11,104	11,104	11,104	11,104
R^2	0.33	0.34	0.34	0.34

Panel B: Patents

	(1)	(2)	(3)	(4)
Corruption				
Corruption $_{loc\text{-}country,\ y}$ * Patent Intensity $_j$	-0.082			
	(0.180)			
Corruption $_{country,y}$ * Patent Intensity $_j$		-0.133		
		(0.224)		
Interactions				
Corruption $_{loc\text{-}country,\ y}$ * Patent Intensity $_j$ * Size	0.039			
	(0.034)			
Corruption $_{country,\ y}$ * Patent Intensity $_j$ * Size		0.051		
		(0.039)		
Corruption $_{loc\text{-}country,y}$ * Patent Intensity $_j$ * Small			0.030	
			(0.147)	
Corruption $_{country,y}$ * Patent Intensity $_j$ * Small				0.001
				(0.184)
Corruption $_{loc\text{-}country,y}$ * Patent Intensity $_j$ * Median			0.038	
			(0.156)	
Corruption $_{country,y}$ * Patent Intensity $_j$ * Median				0.031
				(0.196)
Corruption $_{loc\text{-}country,y}$ * Patent Intensity $_j$ * Large			0.531*	
			(0.287)	
Corruption $_{country,y}$ * Patent Intensity $_j$ * Large				0.608*
				(0.354)
P-Value for Difference in Coefficients Small-Large			0.02	0.03
Firm-Level Controls	Yes	Yes	Yes	Yes
Controls for Business Environment Conditions	Yes	Yes	Yes	Yes
Country-Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Location Fixed Effects	Yes	Yes	Yes	Yes
Observations	5,850	5,850	5,850	5,850
R^2	0.18	0.18	0.18	0.18

Note: Industry fixed effects are at the 2-digit ISIC Rev. 3 level. Region fixed effects account for whether the firm is located in i) the capital city or areas ii) with more than 1 million inhabitants, iii) with 250,000 to 1 million inhabitants, iv) with 50,000 to 250,000 inhabitants or v) with less than 50,000 inhabitants. Clustered standard errors clustered by country, location, industry and year for columns (1) and (3) and country, industry and year for columns (2) and (4) in parentheses. *, **, and *** indicate significance at 10%, 5% and 1% levels respectively. Firm- and industry-level controls are the same reported in columns (4) and (5) of Table 2.

Table 4: Robustness

Panel A: Quality certificates

	CPI index	Subjective Corruption	R&D Intensity	Trademark Weights	Logit	Probit	Sales-Size
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Corruption							
Corruption Index $_{country,y}$ * Certificate Intensity $_j$	-0.167***						
	(0.052)						
Corruption Perception $_{loc\text{-}country,y}$ * Certificate Intensity $_j$		-0.368***					
		(0.067)					
Corruption $_{loc\text{-}country,y}$ * R&D Intensity $_j$			-0.216***				
			(0.082)				
Corruption $_{loc\text{-}country,y}$ * Trademark Intensity $_j$				-0.005***			
				(0.002)			
Corruption $_{loc\text{-}country,y}$ * Certificate Intensity $_j$					-0.895**	-0.588***	-0.296***
					[-0.155]	[-0.173]	
					(0.411)	(0.222)	(0.100)
Interactions							
Corruption Index $_{country,y}$ * Certificate Intensity $_j$ * Size	0.065***						
	(0.009)						
Corruption Perception $_{loc\text{-}country,y}$ * Certificate Intensity $_j$ * Size		0.085***					
		(0.013)					
Corruption $_{loc\text{-}country,y}$ * R&D Intensity $_j$ * Size			0.037***				
			(0.014)				
Corruption $_{loc\text{-}country,y}$ * Trademark Intensity $_j$ * Size				0.001***			
				(0.000)			
Corruption $_{loc\text{-}country,y}$ * Certificate Intensity $_j$ * Size					0.268***	0.152***	
					[0.036]	[0.036]	
					(0.070)	(0.038)	
Corruption $_{loc\text{-}country,y}$ * Certificate Intensity $_j$ * Sales-Size							0.011**
							(0.005)
Firm-Level Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for Business Environment Conditions	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,059	11,104	11,111	11,111	11,104	11,104	10,389
R^2	0.34	0.34	0.33	0.33			0.32
Pseudo-R^2					0.34	0.34	

Table 4: Robustness tests

Panel B: Patents

	CPI index	Subjective Corruption	R&D Intensity	Alternative Patent	Logit	Probit	Sales-Size
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Corruption							
Corruption Index $_{country,y}$ * Patent Intensity $_j$	-0.331**						
	(0.136)						
Corruption Perception $_{loc\text{-}country,y}$ * Patent Intensity $_j$		-0.699***					
		(0.201)					
Corruption $_{loc\text{-}country,y}$ * R&D Intensity $_j$			-0.056				
			(0.068)				
Corruption $_{loc\text{-}country,y}$ * Alternative Patent Intensity $_j$				-0.178			
				(0.223)			
Corruption $_{loc\text{-}country,y}$ * Patent Intensity $_j$					-0.415	-0.237	-0.442
					[-0.028]	[-0.030]	
					(2.412)	(1.223)	(0.286)
Interactions							
Corruption Index $_{country,y}$ * Patent Intensity $_j$ * Size	0.099***						
	(0.031)						
Corruption Perception $_{loc\text{-}country,y}$ * Patent Intensity $_j$ * Size		0.144***					
		(0.038)					
Corruption $_{loc\text{-}country,y}$ * R&D Intensity $_j$ * Size			0.035**				
			(0.014)				
Corruption $_{loc\text{-}country,y}$ * Alternative Patent Intensity $_j$ * Size				0.059			
				(0.046)			
Corruption $_{loc\text{-}country,y}$ * Patent Intensity $_j$ * Size					0.202	0.122	
					[0.014]	[0.016]	
					(0.429)	(0.216)	
Corruption $_{loc\text{-}country,y}$ * Patent Intensity $_j$ * Sales-Size							0.025*
							(0.015)
Firm-Level Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for Business Environment Conditions	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,239	5,850	6,244	6,239	5,845	5,845	5,454
R^2	0.18	0.18	0.18	0.18			0.17
Pseudo-R^2					0.28	0.27	

Note: Industry fixed effects are at the 2-digit ISIC Rev. 3 level. Region fixed effects account for whether the firm is located in i) the capital city or areas ii) with more than 1 million inhabitants, iii) with 250,000 to 1 million inhabitants, iv) with 50,000 to 250,000 inhabitants or v) with less than 50,000 inhabitants. Clustered standard errors clustered by country, location, industry and year in parentheses. *, **, and *** indicate significance at 10%, 5% and 1% levels respectively. Firm- and industry-level controls are the same reported for columns (4) and (5) of Table 2.

Table 5: Additional robustness tests

	Dependent Variable: Quality Certificates							
	IV Regression	World Bank Governance Indicators						Legal IP Context
	Institutional History	Rule of Law	Control of Corruption	Voice and Accountability	Political Stability	Regulatory Quality	Governance Efficiency	Trademark Legal Quality
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Corruption								
Corruption $_{country,\ y}$ * Certificate Intensity $_{j}$	-0.550***	-0.305***	-0.301***	-0.332***	-0.371***	-0.309***	-0.268***	-0.297***
	(0.163)	(0.071)	(0.072)	(0.065)	(0.067)	(0.068)	(0.072)	(0.067)
Interactions								
Corruption $_{country,\ y}$ * Certificate-Intensity $_{j}$* Size	0.132***	0.049***	0.049***	0.049***	0.049***	0.049***	0.048***	0.042***
	(0.020)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)
World Governance Indicators								
Rule of Law $_{country,\ y}$ * Certificate-Intensity $_{j}$		0.120						
		(0.110)						
Control of Corruption $_{country,\ y}$ * Certificate-Intensity $_{j}$			0.109					
			(0.105)					
Voice and Accountability $_{country,\ y}$ * Certificate-Intensity $_{j}$				0.024				
				(0.091)				
Political Stability $_{country,\ y}$ * Certificate Intensity $_{j}$					-0.092			
					(0.061)			
Regulatory Quality $_{country,\ y}$ * Certificate Intensity $_{j}$						0.128		
						(0.112)		
Governance Effectiveness $_{country,\ y}$ * Certificate Intensity $_{j}$							0.267**	
							(0.125)	
Trademark Index $_{country,\ 2002}$ * Certificate Intensity $_{j}$								0.063
								(0.371)
Firm-Level Controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for Business Environment Conditions	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	20,111	11,104	11,104	11,104	11,104	11,104	11,104	8,944
R^2	0.23	0.34	0.34	0.33	0.33	0.34	0.34	0.34

Note: Industry fixed effects are at the 2-digit ISIC Rev. 3 level. Region fixed effects account for whether the firm is located in i) the capital city or areas ii) with more than 1 million inhabitants, iii) with 250,000 to 1 million inhabitants, iv) with 50,000 to 250,000 inhabitants or v) with less than 50,000 inhabitants. Standard errors clustered by country, industry and year in parentheses. *, **, and *** indicate significance at 10%, 5% and 1% levels respectively. Firm- and industry-level controls are the same reported columns (4) and (5) of Table 2.

Table 6: Firm characteristics and the corruption-certificate ownership relationship

Panel A: Exporter and ownership status

	Dependent Variable: Quality Certificates							
	Exporters		Non-Exporters		Foreign and Public Firms		Private National Firms	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Corruption								
Corruption $_{loc\text{-}country,\, y}$ * Certificate Intensity $_j$	0.109		-0.146***		0.156		-0.120***	
	(0.071)		(0.044)		(0.111)		(0.039)	
Corruption $_{country,\, y}$ * Certificate Intensity $_j$		0.128		-0.226***		0.132		-0.180***
		(0.082)		(0.046)		(0.122)		(0.046)
Firm-Level Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for Business Environment Conditions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,556	3,556	7,548	7,548	1,495	1,495	9,609	9,609
R^2	0.31	0.31	0.22	0.23	0.35	0.35	0.28	0.28

Panel B: Services vs. manufacturing firms

	Dependent Variable: Quality Certificates							
	Services		Manufacturing		Services		Manufacturing	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Corruption								
Corruption $_{loc\text{-}country,\, y}$ * Certificate Intensity $_j$	-0.265**		-0.076**		-0.407***		-0.249***	
	(0.115)		(0.038)		(0.126)		(0.054)	
Corruption $_{country,\, y}$ * Certificate Intensity $_j$		-0.436***		-0.109**		-0.628***		-0.304***
		(0.130)		(0.046)		(0.141)		(0.063)
Interactions								
Corruption $_{loc\text{-}country,\, y}$ * Certificate Intensity $_j$ * Size					0.035*		0.040***	
					(0.020)		(0.009)	
Corruption $_{country,\, y}$ * Certificate Intensity $_j$ * Size						0.047**		0.046***
						(0.023)		(0.011)
Firm-Level Controls'''	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Legal and Industry-Country Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,919	4,919	9,570	9,570	4,919	4,919	9,570	9,570
R^2	0.17	0.18	0.33	0.33	0.17	0.18	0.33	0.33

Note: Industry fixed effects are at the 2-digit ISIC Rev. 3 level. Region fixed effects account for whether the firm is located in i) the capital city or areas ii) with more than 1 million inhabitants, iii) with 250,000 to 1 million inhabitants, iv) with 50,000 to 250,000 inhabitants or v) with less than 50,000 inhabitants. Standard errors clustered by country, location, industry and year for columns (1), (3), (5) and (7) and country, industry and year for columns (2), (4), (6) and (8) in parentheses. *, **, and *** indicate significance at 10%, 5% and 1% levels respectively. Firm- and industry-level controls of Panel A are the same reported for columns (4) and (5) of Table 2. '''Firm-level controls included in regressions shown in panel B are employment and age, labor productivity, ownership concentration, website ownership, share of exports and foreign as well as public ownership status. Legal and industry-country controls include the trademark index, the logarithm of corruption at location-country level, industry competition and labor productivity.

Table 7: The impacts of corruption on machinery investment

	Dependent Variables: Machinery Investment Ratio					
	(1)	(2)	(3)	(4)	(5)	(6)
Corruption						
Corruption $_{loc\text{-}country,\ y}$ * Physical Capital Intensity $_j$	-0.991*		-1.061			
	(0.562)		(0.650)			
Corruption $_{country,\ y}$ * Physical Capital Intensity $_j$		-1.449**		-1.696**		
		(0.681)		(0.743)		
Interactions						
Corruption $_{loc\text{-}country,\ y}$ * Physical Capital Intensity $_j$ * Size			0.018			
			(0.089)			
Corruption $_{country,\ y}$ * Physical Capital Intensity $_j$ * Size				0.064		
				(0.100)		
Corruption $_{loc\text{-}country,y}$ * Physical Capital Intensity $_j$ * Small					-1.040*	
					(0.567)	
Corruption $_{country,y}$ * Physical Capital Intensity $_j$ * Small						-1.556**
						(0.662)
Corruption $_{loc\text{-}country,y}$ * Physical Capital Intensity $_j$ * Median					-0.866	
					(0.579)	
Corruption $_{country,y}$ * Physical Capital Intensity $_j$ * Median						-1.268*
						(0.680)
Corruption $_{loc\text{-}country,y}$ * Physical Capital Intensity $_j$ * Large					-1.572**	
					(0.641)	
Corruption $_{country,y}$ * Physical Capital Intensity $_j$ * Large						-1.931***
						(0.742)
P-Value for Difference in Coefficients Small-Large					0.14	0.31
Firm-Level Controls	Yes	Yes	Yes	Yes	Yes	Yes
Controls for Business Environment Conditions	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Location Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,850	10,850	10,850	10,850	10,850	10,850
R^2	0.18	0.18	0.18	0.18	0.18	0.18

Note: Industry fixed effects are at the 2-digit ISIC Rev. 3 level. Region fixed effects account for whether the firm is located in i) the capital city or areas ii) with more than 1 million inhabitants, iii) with 250,000 to 1 million inhabitants, iv) with 50,000 to 250,000 inhabitants or v) with less than 50,000 inhabitants. Standard errors clustered by country, location, industry and year for columns (1), (3) and (5) and country, industry and year for columns (2), (4) and (6) in parentheses. *, **, and *** indicate significance at 10%, 5% and 1% levels respectively. Firm- and industry-level controls are the same reported for columns (4) and (5) of Table 2.

Table 8: The impact of trust on certificate ownership

Dependent Variable: Quality Certificates	(1)	(2)	(3)	(4)	(5)	(6)
Corruption						
Trust $_{loc\text{-}country,\ y}$ * Certificate Intensity $_j$	0.593***		0.172			
	(0.115)		(0.118)			
Trust $_{country,\ y}$ * Certificate Intensity $_j$		0.924***		0.441***		
		(0.128)		(0.140)		
Interactions						
Trust $_{loc\text{-}country,\ y}$ * Certificate Intensity $_j$ * Size			0.077***			
			(0.008)			
Trust $_{country,\ y}$ * Certificate Intensity $_j$ * Size				0.076***		
				(0.010)		
Trust $_{loc\text{-}country,y}$ * Certificate Intensity $_j$ * Small					0.480***	
					(0.113)	
Trust $_{country,y}$ *Certificate Intensity $_j$ * Small						0.770***
						(0.130)
Trust $_{loc\text{-}country,y}$ * Certificate Intensity $_j$ * Median					0.578***	
					(0.112)	
Trust $_{country,y}$ * Certificate Intensity $_j$ * Median						0.867***
						(0.128)
Trust $_{loc\text{-}country,y}$ * Certificate Intensity $_j$ * Large					0.673***	
					(0.114)	
Trust $_{country,y}$ * Certificate Intensity $_j$ * Large						0.959***
						(0.128)
P-Value for Difference in Coefficients Small-Large					0.00	0.00
Firm-Level Controls	Yes	Yes	Yes	Yes	Yes	Yes
Controls for Business Environment Conditions	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Location Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,104	11,104	11,104	11,104	11,104	11,104
R^2	0.33	0.34	0.34	0.34	0.34	0.34

Note: Industry fixed effects are at the 2-digit ISIC Rev. 3 level. Region fixed effects account for whether the firm is located in i) the capital city or areas ii) with more than 1 million inhabitants, iii) with 250,000 to 1 million inhabitants, iv) with 50,000 to 250,000 inhabitants or v) with less than 50,000 inhabitants. Standard errors clustered by country, location, industry and year for columns (1), (3), (5) and (7) and country, industry and year for columns (2), (4), (6) and (8) in parentheses.. *, **, and *** indicate significance at 10%, 5% and 1% levels respectively. Firm- and industry-level controls are the same reported for columns (4) and (5) of Table 2.

Table 9: The impact of IP intensity on the corruption-certificate-ownership relationship

Dependent Variable: Quality Certificates		
	(1)	(2)
Corruption		
Corruption $_{loc\text{-}country, y}$ * Certificate Intensity $_j$	-0.137	
* Q1 IP Intensity	(0.128)	
Corruption $_{country, y}$ * Certificate Intensity $_j$		-0.223
* Q1 IP Intensity		(0.149)
Corruption $_{loc\text{-}country, y}$ * Certificate Intensity $_j$	-0.395***	
* Q2 IP Intensity	(0.088)	
Corruption $_{country, y}$ * Certificate Intensity $_j$		-0.491***
* Q2 IP Intensity		(0.103)
Corruption $_{loc\text{-}country, y}$ * Certificate Intensity $_j$	-0.250***	
* Q3 IP Intensity	(0.070)	
Corruption $_{country, y}$ * Certificate Intensity $_j$		-0.320***
* Q3 IP Intensity		(0.083)
Corruption $_{loc\text{-}country, y}$ * Certificate Intensity $_j$	-0.198***	
*Q4 IP Intensity	(0.056)	
Corruption $_{country, y}$ * Certificate Intensity $_j$		-0.275***
* Q4 IP Intensity		(0.065)
P-Value for Difference in Coefficients Q1-Q2	0.06	0.12
P-Value for Difference in Coefficients Q1-Q3	0.42	0.55
P-Value for Difference in Coefficients Q1-Q4	0.65	0.75
Interactions		
Corruption $_{loc\text{-}country, y}$ * Certificate Intensity $_j$	0.007	
* Q1 IP Intensity * Size	(0.027)	
Corruption $_{country, y}$ * Certificate Intensity $_j$		0.012
* Q1 IP Intensity * Size		(0.028)
Corruption $_{loc\text{-}country, y}$*Certificate Intensity $_j$	0.048***	
* Q2 IP Intensity * Size	(0.017)	
Corruption $_{country, y}$ * Certificate Intensity $_j$		0.056***
* Q2 IP Intensity * Size		(0.019)
Corruption $_{loc\text{-}country, y}$ * Certificate Intensity $_j$	0.065***	
* Q3 IP Intensity * Size	(0.012)	
Corruption $_{country, y}$ * Certificate Intensity $_j$		0.071***
* Q3 IP Intensity * Size		(0.015)
Corruption $_{loc\text{-}country, y}$ * Certificate Intensity $_j$	0.030***	
* Q4 IP Intensity * Size	(0.010)	
Corruption $_{country, y}$ * Certificate Intensity $_j$		0.035***
* Q4 IP Intensity * Size		(0.012)
Firm-Level Controls	Yes	Yes
Controls for Business Environment Conditions	Yes	Yes
Country-Year Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Location Fixed Effects	Yes	Yes
Observations	9,954	9,954
R^2	0.33	0.33

Note: Industry fixed effects are at the 2-digit ISIC Rev. 3 level. Region fixed effects account for whether the firm is located in i) the capital city or areas ii) with more than 1 million inhabitants, iii) with 250,000 to 1 million inhabitants, iv) with 50,000 to 250,000 inhabitants or v) with less than 50,000 inhabitants. Standard errors clustered by country, location, industry and year for column (1) and country, industry and year for column (2) in parentheses.. *, **, and *** indicate significance at 10%, 5% and 1% levels respectively. Firm- and industry-level controls are the same reported for columns (4) and (5) of Table 2.

Appendix Table 1: Description of computation of variables used

Variable Name	Description	Mean	Std. Dev.
IP Ownership			
Quality Certificates	A dummy equal to one if the establishment has an internationally-recognized quality certification, such as ISO 9000 or 14000 certifications.	24.5%	
Patents	A dummy equal to one if the establishment has a registered patent and zero otherwise.	9.6%	
Corruption and Trust			
Corruption	Average share of establishments that indicated an informal gift or payment was needed to obtain an operating license by country-location or country in a given year.	13.3% (13.2%)	0.11 (0.10)
Subjective Corruption	Average of firms' perception of corruption as an obstacle to their current business operations by country-region in a given year. The scale provided to firms includes 5 categories: 0 (no obstacle), 1 (minor obstacle), 2 (moderate obstacle), 3 (major obstacle), 4 (very severe obstacle).	1.64 (1.62)	0.76 (0.73)
Trust	Average share of establishments' sales paid for after delivery by country-location or country in a given year.	54.1%	0.17
Measures of Industry Intensity			
Certificate Intensity	Average share of establishments holding certificates by industry for the full 2006-2011 establishment sample of the World Bank Enterprise Survey.	0.28	0.14
Patent Intensity	Industry-specific US patent intensity obtained by dividing the fractional patent counts by nominal value added in million US dollars. Source: Aghion et al. (2013)	0.04	0.04
Alternative Patent Intensity	Industry share of utility patents over total utility patents deposited at USPTO for 2004-2008. Source: ESA-USPTO (2012)	0.04	0.07
Trademark Intensity	Share of community trademark applications by French firms in 2005 over the total number of applications. Source: Millot (2012)	1.8%	0.25
R&D Intensity	Measure of R&D intensity by 2-digit ISIC sector computed as the share of sectoral R&D investment over total R&D investments for the United States for 2000-2010. Source: OECD STAN Database.	0.07	0.10
Financial Dependence	Measure of external financial dependence by industry computed as ratio of capital expenditures minus cash flow from operations to capital expenditures of US firms for 1986-1995 using Compustat's Annual Industrial files. Source: Braun (2003)	0.30	0.33
Asset Tangibility	Measure of asset tangibility by industry calculated as the median tangibility of US firms in the 1986-1995 period using Compustat's Annual Industrial files. Tangibility is defined as net property, plant and equipment divided by book value of assets. Source: Braun (2003)	0.29	0.12
Physical Capital Intensity	Measure of physical capital intensity corresponds to the median of the gross fixed capital formation to value added ratio in the U.S. for the 1986-1995 period in each industry using Compustat's Annual Industrial files. Source: Braun (2003)	0.07	0.03
Human Capital Intensity	Measure of human capital intensity is the median from 1986 to 1995 of the industry's mean wage over that of the whole manufacturing sector in the U.S for 1986-1995. Source: Braun (2003)	1.02	0.26
Contract Intensity	Indicator of contract intensity of industries using the 1997 United States I-O Use Table to identify intermediate input needs and information from Rauch (1999) on non-homogeneous sectors as indicating relationship-specific investments. Source: Nunn (2007)	0.88	0.14
Firm-Level Variables			
Employment	Logarithm of the establishment's full time employment.	3.60	1.44
Age	Logarithm of the difference between the year the survey was conducted and the year the firm was created.	2.81 [17]	0.77
Foreign Ownership Status	A dummy equal to one if the establishment's share of foreign ownership is bigger or equals to 40% and zero otherwise.	12.4%	
Public Ownership Status	A dummy equal to one if the government or state own a share of the establishment and zero otherwise.	1.4%	
Ownership Concentration	Logarithm of the percentage of the firm owned by the largest owner(s).	4.22 [67.9%]	0.50
Sales	Logarithm of the establishment's total sales.	6.83	2.72
Share of Skilled Labor	Share of non-production workers in an establishments total full-time employment.	27.0%	0.19
Indicator of Foreign Technology Use	Dummy equal to one if the establishment uses technology licensed from a foreign-owned company and zero otherwise.	16.1%	
Share of Exports in Total Sales	Share of an establishment's total sales that are exported.	13.1%	0.28
Website Ownership	A dummy equal to one if a firm communicates with clients and suppliers via its own website and zero otherwise.	48.2%	
Labor Productivity	Measure computed as the logarithm of the sales to total full-time employment ratio.	5.66	2.42
Machinery Investment Ratio	Logarithm of the share of firm *i* 's investment in machinery over its total employment.	0.87	0.14
Business Condition Controls			
Herfindahl Index	The normalized Herfindahl Index is computed at the 2-digit ISIC country level.	0.34	0.28
Industry Productivity	Average labor productivity by 2-digit ISIC industry-country.	6.69	2.18
Intensity of Foreign Technology Use	Average share of firms using technology licensed from a foreign-owned company by 2-digit ISIC industry-country.	18.7%	0.18
GDP per Capita	Logarithm of the gross domestic product in USD divided by the mid-year population. Source: World Development Indicators.	7.76	1.02
Rule of Law	Measure reflecting perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Source: World Bank World Governance Indicators.	-0.49	0.71
Control of Corruption	Measure reflecting perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. Source: World Bank World Governance Indicators	-0.41	0.68
Voice and Accountability	Measure reflecting perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. Source: World Bank Worldwide Governance Indicators	-0.19	0.78
Political Stability	Measure reflecting perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism. Source: World Bank Worldwide Governance Indicators	-0.32	0.86
Regulatory Quality	Measure reflecting perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. Source: World Bank Worldwide Governance Indicators	-0.19	0.73
Governance Effectiveness	Measure reflecting perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Source: World Bank Worldwide Governance Indicators	-0.31	0.62
Trademark Index	Indicator of the strength of legal trademark protection for country *c* in 2002 which integrates 3 components: i) coverage of trademark laws, ii) procedures and enforcement mechanisms and iii) membership in international treaties. See Reynolds (2004) for additional detail.Source: Reynolds (2004)	0.55	0.15
Credit Availability	Indicator of the average share of firms having a line of credit or a loan from a bank in location *l* of country *c* for year *y* .	43.6% (43.2%)	0.21 (0.20)
Power Outages	Indicator of the share of firms in location *l* of country *c* experiencing power outages for year y.	42.3% (43.1%)	0.21 (0.20)
Investment Intensity	Indicator of the share of machinery investments over total industrial sales in location *l* of country *c* for year *y* .	4.6% (4.7%)	0.02 (0.03)
Skills Availability	Indicator of the average share of skilled employment over total employment in location *l* of country *c* for year *y* .	28.0% (27.7%)	0.07 (0.07)

Note: Statistics reported are computed on the basis of the baseline estimation survey, except for industry and country-location and country-level indicators where averages are provided for industry, country-location and country respectively. Unless otherwise specified indicators are obtained using the World Bank Enterprise Surveys.

Appendix Table 2: Patent and certificate intensities by industry

Panel A: Certificate intensity

Industry Code	Industry Description	Certificate Intensity
32	Radio, television and communication equipment and apparatus	53.2%
31	Electrical machinery and apparatus n.e.c.	46.6%
34	Motor vehicles, trailers and semi-trailers	44.6%
35	Other transport equipment	43.2%
33	Medical, precision and optical instruments, watches and clocks	42.9%
16	Tobacco products	41.1%
30	Office, accounting and computing machinery	36.8%
24	Chemicals and chemical products	35.1%
29	Other machinery and equipment	31.8%
25	Rubber and plastics products	31.0%
27	Basic metals	28.6%
28	Fabricated metal products, except machinery and equipment	27.4%
21	Paper and paper products	24.1%
15	Food products and beverages	23.1%
26	Other non-metallic mineral products	20.5%
17	Textiles	16.2%
22	Publishing, printing and reproduction of recorded media	13.1%
20	Wood and products of wood and cork	12.6%
18	Wearing apparel; dressing and dyeing of fur	11.1%
36	Furniture, manufacturing n.e.c.	10.4%
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	9.4%

Panel B: Patent intensity

Industry Code	Industry Description	Patent Intensity
32	Radio, television and communication equipment and apparatus	25.5%
30	Office, accounting and computing machinery	19.0%
31	Electrical machinery and apparatus n.e.c.	11.3%
33	Medical, precision and optical instruments, watches and clocks	18.7%
29	Machinery and equipment n.e.c.	10.0%
24	Chemicals and chemical products	6.4%
36	Furniture, manufacturing n.e.c.	2.3%
25	Rubber and plastics products	1.4%
34	Motor vehicles, trailers and semi-trailers	1.4%
26	Other non-metallic mineral products	0.6%
35	Other transport equipment	0.3%
17	Textiles	0.4%
18	Wearing apparel; dressing and dyeing of fur	0.4%
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	0.4%
28	Fabricated metal products, except machinery and equipment	0.9%
27	Basic metals	0.2%
21	Paper and paper products	0.2%
22	Publishing, printing and reproduction of recorded media	0.2%
16	Tobacco products	0.0%
15	Food products and beverages	0.2%
20	Wood and products of wood and cork	0.1%

Note: Share of businesses with quality certificates by industry based on 63,203 firm observations for 119 countries. Industry codes correspond to the 2-digit ISIC Rev. 3 classification. The construction and services category includes all firms operating in services and construction sectors.

Appendix Table 3: Robustness

Panel A: Quality certificates

	Subjective Corruption	R&D Intensity Weights	Trademark Weights	Logit	Probit	Sales-Size
	(1)	(2)	(3)	(4)	(5)	(6)
Corruption						
Corruption Perception $_{country,y}$ * Certificate Intensity $_j$	-0.402***					
	(0.084)					
Corruption $_{country,y}$ * R&D Intensity $_j$		-0.278***				
		(0.084)				
Corruption $_{country,y}$ * Trademark Intensity $_j$			-0.006***			
			(0.002)			
Corruption $_{country,y}$ * Certificate Intensity $_j$				-1.328***	-0.838***	-0.422***
				[-0.105]	[-0.122]	
				(0.510)	(0.274)	(0.113)
Interactions						
Corruption Perception $_{country,y}$ * Certificate Intensity $_j$ * Size	0.090***					
	(0.016)					
Corruption $_{country,y}$ * R&D Intensity $_j$ * Size		0.037**				
		(0.016)				
Corruption $_{country,y}$ * Trademark Intensity $_j$ * Size			0.001**			
			(0.000)			
Corruption $_{country,y}$ * Certificate Intensity $_j$ * Size				0.309***	0.173***	
				[0.031]	[0.031]	
				(0.087)	(0.047)	
Corruption $_{country,y}$ * Certificate Intensity $_j$ * Sales-Size						0.014***
						(0.005)
Firm-Level Controls	Yes	Yes	Yes	Yes	Yes	Yes
Controls for Business Environment Conditions	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Location Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,104	11,111	11,111	11,104	11,104	10,389
R^2	0.34	0.33	0.33			0.32
Pseudo-R^2				0.34	0.34	

Panel B: Patents

	Subjective Corruption	R&D Intensity Weights	Alternative Patent	Logit	Probit	Sales-Size
	(1)	(2)	(3)	(4)	(5)	(6)
Corruption						
Corruption Perception $_{country,y}$ * Patent Intensity $_j$	-0.726***					
	(0.253)					
Corruption $_{country,y}$ * R&D Intensity $_j$		-0.119				
		(0.090)				
Corruption $_{country,y}$ * Alternative Patent Intensity $_j$			-0.455			
			(0.277)			
Corruption $_{country,y}$ * Patent Intensity $_j$				-1.156	-0.553	-0.469
				[-0.079]	[-0.070]	
				(3.305)	(1.658)	(0.307)
Interactions						
Corruption Perception $_{country,y}$ * Patent Intensity $_j$ * Size	0.153***					
	(0.051)					
Corruption $_{country,y}$ * R&D Intensity $_j$ * Size		0.035**				
		(0.016)				
Corruption $_{country,y}$ * Alternative Patent Intensity $_j$ * Size			0.064			
			(0.044)			
Corruption $_{country,y}$ * Patent Intensity $_j$ * Size				0.246	0.154	
				[0.017]	[0.020]	
				(0.556)	(0.271)	
Corruption $_{country,y}$ * Patent Intensity $_j$ * Sales-Size						0.023
						(0.016)
Firm-Level Controls	Yes	Yes	Yes	Yes	Yes	Yes
Controls for Business Environment Conditions	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Location Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,850	6,244	6,239	5,845	5,845	5,454
R^2	0.18	0.18	0.18			0.17
Pseudo-R^2				0.28	0.28	

Note: Industry fixed effects are at the 2-digit ISIC Rev. 3 level. Region fixed effects account for whether the firm is located in i) the capital city or areas ii) with more than 1 million inhabitants, iii) with 250,000 to 1 million inhabitants, iv) with 50,000 to 250,000 inhabitants or v) with less than 50,000 inhabitants. Clustered standard errors are shown in parentheses. *, **, and *** indicate significance at 10%, 5% and 1% levels respectively. Firm- and industry-level controls are the same reported for columns (4) and (5) of Table 2.

The UNU-MERIT WORKING Paper Series

2014-24 *Millennium Development Goals: Tool or token of global social governance?* by Mueid Al Raee, Elvis Amoateng, Elvis Korku Avenyo, Youssef Beshay, Mira Bierbaum, Charlotte Keijser and Rashmi Sinha

2014-25 *One Europe or several? Causes and consequences of the European stagnation* by Jan Fagerberg and Bart Verspagen

2014-26 *The harmony of programs package: Quasi-experimental evidence on deworming and canteen interventions in rural Senegal* by Théophile Azomahou, Fatoumata Diallo and Wladimir Raymond

2014-27 *Country Terms of Trade 1960-2012: Trends, unit roots, over-differencing, endogeneity, time dummies, and heterogeneity* by Thomas Ziesemer

2014-28 *The structure and comparative advantages of China's scientific research - Quantitative and qualitative perspectives* by Lili Wang

2014-29 *Transition to knowledge-based economy in Saudi Arabia* by Samia Satti Osman Mohamed Nour

2014-30 *Challenges and opportunities for transition to knowledge-based economy in Arab Gulf countries* by Samia Satti Osman Mohamed Nour

2014-31 *Migration of international students and mobilizing skills in the MENA Region* by Samia Satti Osman Mohamed Nour

2014-32 *Beyond product innovation; improving innovation policy support for SMEs in traditional industries* by René Wintjes, David Douglas, Jon Fairburn, Hugo Hollanders and Geoffrey Pugh

2014-33 *The impact of innovation support programmes on SME innovation in traditional manufacturing industries: an evaluation for seven EU regions* by Dragana Radicic, Geoffrey Pugh, Hugo Hollanders and René Wintjes

2014-34 *Beliefs dynamics in communication networks* by Théophile T. Azomahou and Daniel C. Opolot

2014-35 *Stability and strategic diffusion in networks* by Théophile T. Azomahou and Daniel C. Opolot

2014-36 *Epsilon-stability and the speed of learning in network games* by Théophile T. Azomahou and Daniel C. Opolot

2014-37 *Afghan unaccompanied minors in the Netherlands: Far away from home and protected?* by Carla Buil and Melissa Siegel

2014-38 *Multinational production and trade in an endogenous growth model with heterogeneous firms* by Hibret B. Maemir and Thomas Ziesemer

2014-39 *The political economy of research and innovation in organic photovoltaics (OPV) in different world regions* by Serdar Türkeli and René Kemp

2014-40 *Towards the societal system of innovation: The case of metropolitan areas in Europe* by Serdar Türkeli and René Wintjes

2014-41 *To return permanently or to return temporarily? Explaining migrants'* intentions by Özge Bilgili and Melissa Siegel

2014-42 *Catching up and lagging behind in a balance-of-payments-constrained dual economy* by Alejandro Lavopa

2014-43 *An introduction to the economics of rare earths* by Eva Bartekova

2014-44 *The unequal effect of India's industrial liberalization on firms' decision to innovate: Do business conditions matter?* By Maria Bas and Caroline Paunov

2014-45 *Insurgents in motion: Counterinsurgency and insurgency relocation in* Iraq by Pui-hang Wong

2014-46 *Successive leadership changes in the regional jet industry* by Daniel Vertesy
2014-47 *Demand, credit and macroeconomic dynamics: A microsimulation model* by Huub Meijers, Önder Nomaler and Bart Verspagen
2014-48 *Accessibility analysis as an urban planning tool: Gas station location* by D.A. Escobar , C. Cadena-Gaitán, F.J. Garcia
2014-49 *China's economic embrace of Africa - An international comparative perspective* by Tobias Broich and Adam Szirmai
2014-50 *Mapping regional social enterprise ecosystems in India: Framework and indicators* by Lina Sonne
2014-51 *Does shelter assistance reduce poverty in Afghanistan?* By Craig Loschmann, Christopher R. Parsons and Melissa Siegel
2014-52 *How important is innovation? A Bayesian factor-augmented productivity model on panel data* by Georges Bresson, Jean-Michel Etienne and Pierre Mohnen
2014-53 *Does too much work hamper innovation? Evidence for diminishing returns of work hours for patent grants* by Mehmet Güney Celbi¸ Serdar Türkeli
2014-54 *Globalization, the rise of biotechnology and catching up in agricultural innovation: The case of Bt technology in India* Michiko Iizuka and Ajay Thutupalli
2014-55 *Where are innovation indicators, and their applications, going?* by Fred Gault
2014-56 *Productivity in services in Latin America and the Caribbean* by Elena Arias-Ortiz, Gustavo Crespi, Alejandro Rasteletti and Fernando Vargas
2014-57 *Optimal public investment, growth, and consumption: Fresh evidence from African countries* by Augustin Kwasi Fosu, Yoseph Yilma Getachew and Thomas H.W. Ziesemer
2014-58 *International R&D alliances by firms: Origins and development* by Rajneesh Narula and Andrea Martínez-Noya
2014-59 *Appropriability mechanisms, innovation and productivity: Evidence from the UK* by Bronwyn H. Hall and Vania Sena
2014-60 *The size of patent categories: USPTO 1976-2006* by François Lafond
2014-61 *Asset recombination in international partnerships as a source of improved innovation capabilities in China* by Simon C. Collinson and Rajneesh Narula
2014-62 *The viability of sustained growth by India's MNEs: India's dual economy and constraints from location assets* by Rajneesh Narula
2014-63 *The effect of unconditional cash transfers on adult labour supply: A unitary discrete choice model for the case of Ecuador* by Andrés Mideros and Cathal O'Donoghue
2014-64 *Giving in South Africa: Determining the influence of altruism, inequality aversion and social capital* by Nyasha Tirivayi
2014-65 *The impact of food transfers for people living with HIV/AIDS: Evidence from Zambia* by Nyasha Tirivayi and Wim Groot
2014-66 *Size and economies of scale in higher education and the implications for mergers* by Nyasha Tirivayi, Henriette Maasen van den Brink and Wim Groot
2014-67 *Widowhood and barriers to seeking health care in Uganda* by Nyasha Tirivayi
2014-68 *An individual-centered approach to multidimensional poverty: The cases of Chile, Colombia, Ecuador and Peru* by Andrea Franco Correa
2014-69 *Innovation and productivity in services: Empirical evidence from Latin America* by Gustavo Crespi, Ezequiel Tacsir and Fernando Vargas
2014-70 *Analysing global value chains using input-output economics: Proceed with care* by Önder Nomaler and Bart Verspagen

2014-71 *The deposit financing gap: Another Dutch disease* by Huub Meijers, Joan Muysken and Olaf Sleijpen

2014-72 *Do remittances and social assistance have different impacts on expenditure patterns of recipient households? The Moldovan case* by Jennifer Waidler, Jessica Hagen-Zanker, Franziska Gassmann and Melissa Siegel

2014-73 *The role of industry and economic context in open innovation: Evidence from Nigeria* by Abiodun Egbetokun, Omolayo Oluwatope, David Adeyeye and Maruf Sanni

2014-74 *Means to improve access to justice and legally empower victims of domestic violence: An empirical legal study on legislation and legal offices in Buenos Aires, Argentina* by Julieta Marotta

2014-75 *Do remittances not promote growth? A bias-adjusted three-step mixture-of-regressions* by Maty Konte

2014-76 *Structural modernization and development traps: An empirical approach* by Alejandro Lavopa and Adam Szirmai

2014-77 *Democratizing intellectual property systems: How corruption hinders equal opportunities for firms* by Caroline Paunov