# DO INNOVATIVE FIRMS FIND CORRUPTION TO BE A BIGGER PROBLEM THAN NON-INNOVATIVE FIRMS?

## EVIDENCE FROM AFRICAN, LATIN AMERICAN AND CARIBBEAN COUNTRIES

Andrew Wong
(5176793)

Major Paper presented to the Department of Economics of the University of Ottawa
in partial fulfillment of the requirements of the M.A. Degree

Supervisor: Professor Alberto Chong

ECO6999

Ottawa, Ontario, Canada

April 2015

# Table of Contents

# Abstract

The goal of this research is to measure the difference in degree by which corruption presented an obstacle to firms that did or did not innovate. Using cross sectional data from the World Bank Enterprise Survey covering 26 African and Latin American/Caribbean countries in 2006, this study looks at 7,776 innovative firms, defined as a firm that has introduced a new product or service in the past three years. This study finds that when a non-innovating firm decides to innovate, it will likely find corruption to be a bigger obstacle to their operations. This discovery is robust when controlling for country level heterogeneity through fixed effects. The addition of control variables concerning education and the firm characteristics of size, access to finance, exports and market competition did not result in a large change in results.

# Introduction

Innovation is generally accepted to be the driver of economic growth (Romer, 1990). It encourages economic development, playing a key role in the growth of the most successful developing countries, moving some into developed country status (Mowery and Oxley, 1995). Up until recently, however, research and development (R&D) and its associated activities such as innovation were, for the most part, ignored by the majority of economists (Cohen, 2010). Prior to Solow's seminal paper *Technical Change and the Aggregate Production Function*, increased economic welfare was thought to be due to the use of more inputs, specifically capital inputs. Solow however, showed that increases in capital and labour inputs can explain only 10% of the two-fold increase in US per capita output between 1909 and 1949 (Solow, 1957). Solow did not include technological change in his model , despite making it clear that it was a factor in economic growth. Solow did not delve further into the factors which caused technological change.

Research has shown that innovation has positive implications since it can help address socio-economic challenges such as poverty and health, which can in turn encourage entrepreneurship and economic growth (OECD, 2012). Competitiveness depends on the ability of firms to not only upgrade skills and machinery, but also innovate (Porter, 1990). This involves investments in skills, knowledge, and physical assets.

If the laws of decreasing marginal returns holds for technology innovative activity in the same way as other economic inputs such as labour and physical capital, it would be expected that places with low levels of development would benefit greatly from innovation. The evident next

question is of course: why don't firms in developing countries innovate more? If innovation resultsin great leaps of growth, firms would be innovating as much as possible.

Although it stands to reason that developing countries should implement policies to increase innovation for its positive welfare and economic benefits, it is possible that increased levels of corruption in developing countries could pose problems to firms who attempt to innovate. Murphy, Shleifer and Vishny (1993) ask why rent-seeking is so harmful to growth, and find that rent-seeking is likely to attack the innovation sector more severely than the production sector. Innovation makes a firm more susceptible to extortion by corrupt government officials, since such firms are more likely to have a high and inelastic demand for government supplied goods like permits and licenses (Murphy, Shleifer and Vishny, 1993). This study builds on the work of Murphy et al. by looking at whether innovation affects how big of an obstacle corruption poses to firms.

Using cross sectional innovation data from the World Bank Enterprise Survey covering 26 African and Latin American/Caribbean countries in 2006, this study looks at 7776 firms. We define innovation as the introduction of a new product or service in the past three years. This study finds that when a non-innovating firm decides to innovate, it is likely that it will find corruption to be a bigger obstacle to their operations after the act of innovation than prior to it. This discovery is robust when controlling for country level heterogeneity through fixed effects as well as firm characteristics.

# Literature Review

Research has shown that corruption is a major obstacle to economic development and growth (Shleifer and Vishny, 1993), and that it reduces the incentive to do complex economic activities such as innovation that have payoffs that are difficult or costly to monitor because they are uncertain or temporally distant (Teece, 1981). Corruption increases the risk that a portion or all of the profits will be appropriated by others. This is problematic because a firm decides whether or not to undertake innovation based on their forecasted profits. The implications of this decision are severe. Figure 1 shows a clear connection can be seen between corruption and national income. More corrupt countries tend to be poorer countries, as corruption has a negative and significant effect on productivity (Bentzen, 2012). Countries with a more efficient bureaucracy grow faster, and it has been shown that a single standard deviation improvement in the corruption index is associated with in investment of 2.9% of GDP (Mauro, 1995). Indeed, GDP per capita is strongly positively correlated with quality of governance, as measured by control of corruption, protection of property rights or rule of law, and voice and accountability (Kaufmann and Kraay 2003).

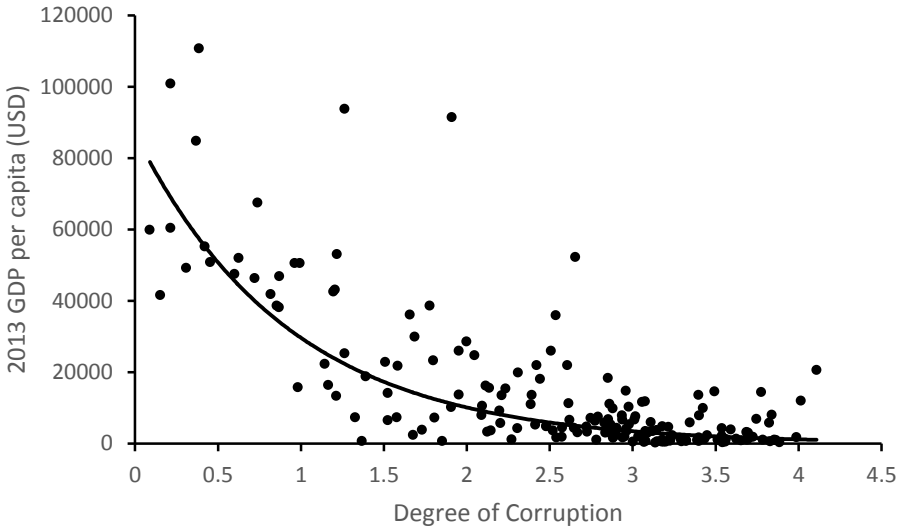


Figure 1: Degree of corruption measures perception of corruption, defined as the use of public power for private gain. I adapted degree of corruption from the World Bank's Worldwide Governance Indicators, and ranges from 0 (no corruption) to 5 (high corruption).

Previous research has suggested that corruption might "grease the wheels" of economic growth, by giving those who had a higher willingness to pay a method to cut through bureaucratic red tape (Leff, 1964). A recent review finds this theory to be problematic, and that corruption generally reduces firm growth and increases the amount of time managers must deal with government officials (De Rosa, Gooroochurn and Gorg, 2010). Corruption is sometimes viewed as a tax on business (de Waldemar, 2012), but it has been shown to be even more damaging and distortionary than taxes because of its illegal nature (Shleifer and Vishny, 1993).

Economic theory suggests that if higher returns can be obtained through corruption than through free market activities, then talented individuals would rather work for the government than the private sector. Research has supported this, finding that when corruption gives a higher return to rent seekers, talent flows from the innovation sector to the rent seeking sector (Li, Xu and Zou, 2000). Using college enrollment in law as a proxy for level of rent seeking and engineering as a proxy for innovation in an economy, it was found that countries with more

engineering majors grow faster than countries with more law majors (Murphy, Shleifer and Vishny 1991). The mechanism by which this occurs can be described as follows: engineers and entrepreneurs improve technology in their line of business, leading to productivity and income growth. Rent-seekers obtain private returns from redistribution of wealth from others, and not from wealth creation. Entering the rent seeking sector allows individuals to take from the firms they would have worked for, which are then further disincentivized from innovating. Rent seeking from innovating firms is likely to be higher than from established producers, since established producers are often more closely linked to the government. If the interests of the new and established producers are in opposition, the government may even step in and stop the innovative firms entirely (Murphy, Shleifer and Vishny, 1993). Building on this, De Rosa et al. (2010), show that bribery is more harmful in countries with higher corruption and a weaker legal system.

Ensuring an environment free of rent seeking is important, since taxation and bribery are negatively correlated with firm growth (Fisman and Svensson 2007). Furthermore, it has been found that increases in entrepreneurial activity leads to higher growth rates and a drop in unemployment (Audretsch and Thurik 2001). This is because entrepreneurship allows knowledge to move from the source of discovery or development to commercialization.

In discussing the importance of corruption and development, we must make note of the intricate and developing relationship between corruption and innovation. Research over the years has shown linkages between corruption and innovation involving such factors as: inequality, education, firm size, credit markets, market structure and international trade. We will discuss the evolution of the research that describes the relationships between each of these factors.

Studies show that corruption explains a large proportion of the Gini differential across countries, generally indicating that inequality is aggravated by corruption. Inequality is low when levels of corruption are high or low, but high when corruption is intermediate (Li, Xu and Zou 2000). This affects innovation, because countries with a large poor population are more concerned with basic necessities and do not have the funds to allocate to R&D (Cozzens 2008). In developing countries, new-to-the-world innovation is rather unlikely, and early stage innovation often involves adapting foreign technology and adapting it to local needs. Stated differently, innovation must be tailored to the specific challenges of the region, regardless of its size or stage of development. Firms that do this type of innovation are sometimes considered "imitators" (Schumpeter, 1943). However, they can also be considered innovators since they are operating under a different context.

A distinction must be made between invention and innovation. Invention is when an idea for a product or service is first thought of, while innovation involves putting that idea into practice (Fagerberg, 2006). There is often a time lag between the two, during which implementation problems are solved. This nevertheless requires the firm to have employees with knowledge and skills in various domains, a sturdy distribution system as well as sufficient financing. This gives clues as to what factors must be considered when looking at the effect of innovation on the degree of corruption a firm faces.

It has been shown that education is one of the key factors of innovation, and low education levels are problematic in poorer countries. Accumulation of human capital in the form of education is a key determinant of growth, and that differences in education levels can explain disparities in country income (Mankiw, Romer and Weil, 1992). This is important since innovative activity is dependent on the stock of educated and skilled workers, and more educated

workers tend work in firms that produce higher value added products and services. Because high value added firms tend to be more profitable, they are more attractive targets to rent-seeking corrupt officials. Education however increases a worker's knowledge of poor behavior in government officials, and makes it less likely that corruption is tolerated. Unlike in high and middle education level countries, corruption is unexpectedly lower in low education countries, since although officials can more easily get away with corrupt actions, these actions yield lower returns (Eicher, Garcia-Penalosa and van Ypersele, 2009).

The relationship between innovation and firm size was first discussed by Schumpeter in the classic book *Capitalism, Socialism and Democracy* (Schumpeter, 1943). The Schumpeterian hypothesis states that innovation benefits from the economies of scale that larger firms with market power provide. Many studies have been conducted verifying the Schumpeterian hypothesis comparing firm size with R&D, which has been shown to have a positive correlation (Scherer, 1965; Cohen and Klepper, 1996). While it may have a positive effect on innovative activities, there is evidence that larger firm size makes a firm more susceptible to targeting from corrupt officials. For example, tax collectors are less likely to go after smaller firms because the cost of doing so would be greater than the potential tax revenue collected (Gauthier and Reinikka, 2006). To target larger firms, corrupt tax officials could use banks to help them identify potential targets. This is because banks require proof of ability to repay loans, thus firms cannot easily hide their income and evade taxes. Consequently, corruption may reduce a firm's use of the formal financial system, and force them to look for informal financing or financing from friends and relatives, thus hindering efforts to innovate (Ayyagari, Demirguc-Kunt and Maksimovic, 2010).

Corruption lowers the probability that a firm exports, and increases the chance that a firm only sells domestically. Exporting firms and multinationals have higher productivity than domestic only firms, and report twice as much product or process innovation (Criscuolo, Haskel and Slaughter 2010). This is because consumer demand is the most important source of ideas for new R&D projects. Therefore, the needs of foreign buyers drive innovation. (Cohen, Nelson and Walsh, 2002). Exporting firms that anticipate corruption problems are more likely to use an intermediary that is more knowledgeable in dealing with the logistical issues and red tape associated with corrupt countries, instead of exporting directly themselves (Olney, 2014). This additional barrier reduces the likelihood that a firm would consider exporting or investing into a corrupt country. This has been confirmed, since foreign direct investment (FDI) tends to be lower in more corrupt countries (Castro and Nunes, 2013)

Market structure can be roughly measured through the number of competitors a firm has (Vives, 2008), even though this ignores asymmetries between competitors. Recent evidence using firms' declared number of competitors found no clear relationship between market structure and total R&D (Saljanin and Thorwarth, 2013). In theory, the effect of competition on corruption could be positive or negative. Having market share or lower competition would result in firms with higher rents, so corrupt officials would have more incentive to target them (Bliss and Di Tella 1997). On the other hand, with more competition, there are more firms from which to extract rents, and so depending on the overall tolerance for corruption, the amount of bribes may increase (Straub, 2005). The empirical literature on the connection between market structure is likewise mixed. For example, while research has shown that competition can force firms to reduce costs, from which rents can be extracted, thus increasing targeting by corrupt officials

(Basu et al, 2013; Bliss and Di Tella, 1997). Other research has shown decreases in corruption in the presence of competition. (Alexeev and Song, 2013).

In the context of this literature, questions remain regarding whether the scale of innovation of a firm affects how problematic they find corruption. Of particular interest is whether a firm that was not innovating before will find corruption to be an issue when they start innovating. If governments aim to increase domestic R&D, this research will provide important information for policy formulation concerning the issue of corruption.

## Data

This study uses data from the Enterprise Surveys, which are administered by the World Bank. The Enterprise Surveys are firm level surveys that collects from all regions of the world and is a representative sample of manufacturing and service firms. It employs stratified random sampling and covers general firm characteristics, infrastructure and services, sales and supplies, competition, capacity, land, crime, finance, business-government relations, labour, performance and the business environment. To ensure consistent data, a standardized questionnaire is used to allow for comparable data between countries (World Bank, 2011).

The World Bank Enterprise Surveys were used over other well-known corruption data such as Transparency International's Corruption Perception Index because it contains firm level data from over 130 000 companies in 135 economies, as opposed to only country level data. Responses that did not include answers to the innovation question were dropped. Furthermore, non-responses and responses such as "Do Not Know" and "Does Not Apply" were also excluded

from the dataset. This resulted in cross sectional data from the year 2006 which includes 7,776 firms in 27 developing countries throughout Africa, Latin America and the Caribbean region.

## Dependent Variable

The dependent variable ***Corruption Obstacle*** is an ordinal variable with values ranging from 0 to 4. This variable is the answer to the question: "Is corruption No Obstacle, a Minor Obstacle, a Major Obstacle, or a Very Severe Obstacle to the current operations of this establishment?". This variable was chosen because it represents the firm's perception of corruption.

## Core Explanatory Variable

The independent variable*, Innovation*, was chosen to distinguish between an innovating and non-innovating firm. *Innovation* is a dummy variable that takes a value of 1 if a firm has introduced a new or significantly improved product or service, and a value of 0 if not. This covers three of the four types of innovation as defined in the Oslo Manual (OECD, 2005). This is a reasonable proxy for innovation because what is referred to as innovation in developing countries is not necessarily the same as in developed countries, where cross-country data on innovation typically uses measures such as patent counts or R&D spending. Progress in developing countries is thus better measured by new-to-firm innovation (Ayyagari, Demirguc-Kunt and Maksimovic, 2010).

## Control Variables

The control variables *Education*, *Size*, *Competition*, *Finance* and *Exports* were chosen due to their relation to innovation and corruption. *Education* is an ordinal variable that measures the education level of the average production worker of the firm. *Education* takes a value of 1 for 0-3 years, 2 for 4-6 years, 3 for 7-9 years, 4 for 10-12 years, or 5 for 13 or more years of education. *Size* is an ordinal variable that measures firm size using a scale of 1 to 3. *Size* takes a value of 1 if the firm is small with less than 20 employees, 2 if the firm is medium sized with 20 to 99 employees, and 3 if the firm is large with 100 or more employees. *Competition* is a dummy variable that measures competitive pressure, and takes a value of 1 if it faces more than 5 competitors. *Finance* is a dummy variable that looks at a firm's access to formal finance, taking a value of 1 if a firm has a line of credit or a loan from a financial institution. *Exports* is an ordinal variable going from 1 to 10 that corresponds to the percentage decile of a firm's sales outside of the country.

Because cross-sectional data were used, fixed effects in the form of country dummies were added to control for unobserved heterogeneity. These were included since omitted variable bias can result from not including country dummies (Ferrer-i-Carbonell and Frijters, 2004), especially since institutional quality and country characteristics are closely linked.

## Multicollinearity

Unreliable regression estimates can arise in the presence of multicollinearity. This is defined as high correlation between explanatory variables, on a scale of 0 to 1, where a value above 0.8 is considered high. Correlation between variables was tested, with listwise deletion of

missing data done automatically. The results of this testing, shown in Table 2, revealed no significant multicollinearity issues. The one exception is between education and its squared counterpart, which is to be expected, and can be safely ignored.

## Summary statistics

Summary statistics of all variables are given in Table 3. The overall sample is made up of 7776 firms, but the subsamples for the variables *Education*, *Competition* and *Finance* have missing data and as such their sample size is smaller.

The results of the summary statistics show that 25% of firms state that corruption is a very severe obstacle to their current operations. On the other hand, 24% of firms report that it is no obstacle at all. In between the two extremes, 13%, 15% and 23% of firms consider corruption to be a minor, moderate and major obstacle to their operations, respectively. In terms of having released a new product or service, 62% of firms in the sample are innovative firms. In terms of education, it was found that in most firms, the average employee has barely made it to secondary school. 78% of firms in the sample have workers where the average level of education is less than 9 years. In terms of firm size, firms with over 100 workers make up only 16% of the sample. Almost half (49%) of firms in the sample are small, with fewer than 20 workers. In terms of access to credit, less than half (44%) of firms has a loan or line of credit from a financial institution. Only 31% of these small firms have a line of credit or a loan, compared to 63% of large firms. In terms of market structure, over 56% of firms operate in a competitive market, with more than 5 competitors. In terms of exports, 78% of firms report that exports represent

only 10% or less of total sales. For only 5% of firms do 90% or more of their sales come from exports.

## Empirical Methodology

This paper studies whether firms that innovate find corruption to be a bigger obstacle than firms that do not innovate. To do this, an ordered logit model is used to estimate the effect of introducing a new product, service or production process on how big of an obstacle a firm finds corruption to be. Despite fundamental theoretical differences concerning the distribution of the error term, an ordered probit model can be used instead of the ordered logit, since in practice it can be difficult to justify the use of one model over the other (Boorah, 2002, pg *v*). With data from the Latin America and Caribbean region Enterprise Surveys, the following model is estimated:

$$Corruption\_Obstacle = \beta_0 + \beta_1 Innovation + \beta_2 Education + \beta_3 Education^2 + \beta_4 Size + \beta_5 Finance + \beta_6 Exports + \beta_7 Competition + u$$

*Corruption Obstacle* is an ordinal variable with values ranging from 0 to 4. Because the dependent variable is of an ordinal nature, the estimation method used in this study is the ordered logistic regression model, which is also known as the proportional odds model. This *Corruption Obstacle* variable estimates the degree to which a firm finds corruption to be an obstacle to its innovative operations.

The *Corruption Obstacle* variable is structured as a scale divided into 5 categories. These categories describe the relation between the *Corruption Obstacle* and *Corruption Obstacle*,*

which is defined as the true continuous measure of how big an obstacle a firm could find corruption to be.

$$Corruption\_Obstacle_i = 0 \; if \; Corruption\_Obstacle_i^* < a_1$$

$$Corruption\_Obstacle_i = 1 \; if \; a_1 \leq Corruption\_Obstacle_i^* < a_2$$

$$Corruption\_Obstacle_i = 2 \; if \; a_2 \leq Corruption\_Obstacle_i^* < a_3$$

$$Corruption\_Obstacle_i = 3 \; if \; a_3 \leq Corruption\_Obstacle_i^* < a_4$$

$$Corruption\_Obstacle_i = 4 \; if \; a_4 \leq Corruption\_Obstacle_i^*$$

The categories are separated by threshold parameters denoted $a_j$, where j+1 is the number of ordered categories. *Corruption Obstacle** is unmeasurable, but in estimating the *Corruption Obstacle* variable, we are able to approximate *Corruption Obstacle**.

The ordered logit model estimates not only the coefficients of the explanatory variables, but also the threshold parameters. As such, there are regression lines for each category of the dependent variable, each with a different intercept. Because this model assumes that the coefficients of the explanatory variables are the same for each category of corruption but with different intercepts, we obtain parallel regression lines. The assumption of parallel regression lines can be tested using the omodel test. Furthermore, because intraclass correlation is likely to be found within industry sectors, these regressions are estimated using clustered robust standard errors.

It should be noted that there is always the possibility of an endogeneity problem, where:

$$E(u|x) \neq 0$$

There are three generally accepted sources of endogeneity. The first is that of omitted variable bias, where variables that are correlated with the explanatory variables may have been excluded from the model. The second is that of measurement error, due to state-dependent reporting bias or scale of reference bias, where the understanding of the values of the relevant variables may differ between respondents. Finally, there may be reverse causality, or simultaneity. If innovation and corruption are codetermined, then not only does innovation lead to the problem of being targeted by corrupt officials as implied by the model, but the problem of corruption may affect innovation as well. Testing for endogeneity is outside the scope of this study.

## Results

This study measures the difference in degree by which corruption presented an obstacle to firms that did or did not innovate. As control variables are added for robustness, the effect of introducing a new product or service consistently results in the firm reporting corruption to be a bigger obstacle. The signs on all the coefficients are in the expected direction. The coefficients are ordered log-odds coefficients, and can be interpreted as the expected change in the dependent variable in the ordered log-odds scale given a one unit increase in that explanatory variable, with all other variables held constant. By exponentiating the estimated regression coefficients, one can compute the odds-ratio. Practically speaking, odds ratios are more often used than ordered log-odds, since they are more easily interpreted. The odds ratio can be interpreted as the odds in favour of corruption becoming a bigger problem (moving up to the next *corruption obstacle* category) when the explanatory variable is increased by one unit. For example, an odds ratio of 2 means that when the explanatory variable increases by one unit, the dependent variable is twice

as likely as before to go up to the next category. On the other hand, an odds ratio of 0.5 means that when the explanatory variable increases by one unit, the dependent variable is twice as likely as before to go down to the lower category. An odds ratio that is greater than one is equivalent to the coefficient being positive, while an odds ratio smaller than one is equivalent to the coefficient being negative.

The ordinal logit regression results presented as odds ratios are displayed in Table 4. The first column shows the results of running a logit model with only the corruption dependent variable and the innovation explanatory variable (Model 1). To control for country level heterogeneity, country dummies were added (Model 2). The odds ratio fell slightly, but retained the same sign. The pseudo R-squared increased by an order of magnitude. When the education control variable is added (Model 3), the innovation coefficient retains the same sign and magnitude, falling slightly. The effect of education is increasing with diminishing marginal returns.

Next, controls are added to take firm characteristics into account (Model 4). These controls are: firm size, access to formal finance, level of exports and degree of competition. The results show that with these controls, the sign on the innovation coefficient stays the same, but the odds ratio falls slightly. Despite this, the effect of innovation on corruption as a problem is consistently both positive and highly significant. Furthermore, the coefficients of all the control explanatory variables have the expected signs. The results show that firms that find corruption to be a bigger obstacle tend to have: a more educated workforce, more than 20 employees, access to formal finance, a higher share of exports, and more than 5 competitors.

Of the control variables, *education*, *exports* and *competition* are significant at the 1% level, while neither *finance* nor *size* are significant at the 10% level, but they nevertheless have

the correct sign. Though a larger dataset may be required to confirm these results, they suggest that innovative firms find corruption to be a bigger problem than non-innovating firms.

## Econometric Issues and Robustness

When using a dependent variable of an ordinal nature, ordered logistic regression or ordered probit regression is preferred over ordinary least squares, although as stated before it can be difficult to justify the use of one model over the other since the distribution of the error term is typically unknown. Because the ordered logistic model is a proportional odds model, it requires the assumption of parallel regression lines with different intercepts for each category of the ordinal dependent variable. This assumption was tested using omodel. The results of this test found that the chi-square value was significant. Due to this, the null hypothesis stating that the regression lines are parallel must be rejected, and thus the proportional odds assumption does not hold. This is a common problem, but many researchers simply use the results anyways. To ensure robustness in this study however, further investigation was done.

The generalized ordered logit (gologit2) model was used instead, since it relaxes the parallel lines assumption (Williams, 2006). In addition to the proportional odds model with parallel lines, the gologit2 model can also fit a partial proportional odds model. The autofit option was used to find the best fit for the data at a 5% level of significance. The gamma option was used as well, to show by how much the model deviates from the proportional odds model. Using the gologit2 model, only the *innovation* and *exports* variables fit the proportional odds model. The odds ratio for *innovation* using this model is 1.171277 (0.0687092), compared to 1.171702 (0.0667415) with the ologit model. These results imply that when a non-innovating

firm starts innovating, it is 1.17 times more likely to find corruption to be a greater obstacle than before. In both the gologit and omodel regressions, both estimates are within the standard deviation of each other. Furthermore, they are both significant at the 1% level, adding robustness to the initial ordered logistic model.

## Conclusion

The results of this study provided insight into the effect that a number of variables have on the relationship between innovation and corruption as an obstacle to firms' operations. The result that education has a positive and significant, although decreasing, effect supports previous research showing that as education levels in a firm rise, the issue of corruption is more pronounced. The positive and significant results of exports likewise confirm previous research stating that exporting firms deal more often with corruption. The positive and significant results found in competition are expected, since research has shown that competitive firms find corruption to be a bigger problem.

Previous research has shown that firm size and access to credit markets could affect the level of corruption experienced by firms. Although our results for *size* and *finance* were not significant, it is possibly due to the breadth of this research that included a number of highly unrelated variables. Firm size and access to credit markets could be closely related to corruption levels in more focused studies, but not when taking a macro view as was done in this research.

The overall results of the study indicates that when a non-innovating firm decides to innovate, the odds are positive that it will find corruption to be a bigger obstacle to their

operations then before. This discovery is robust when controlling for country level heterogeneity through fixed effects.

## Policy Implications

The results of this study provide context for policy makers developing initiatives aimed at increasing the innovative capacity in developing countries. R&D and innovation programs that were successful in developed nations may run into problems when implemented in developing countries, where firms may be hesitant to innovate due to fears of being targeted by corrupt officials. Further research should be conducted to examine the effectiveness of such programs empirically and to develop new programs which take into consideration firm fears of corruption.

## Bibliography


Acs, Z. J., & Isberg, S. C. (1991). Innovation, firm size and corporate finance. Economics Letters, 323-326.

Alexeev, M., & Song, Y. (2013). Corruption and product market competition: An empirical investigation. Journal of Development Economics, 154-166.

Audretsch, D. B., & Thurik, R. (2001). Linking Entrepreneurship to Growth. OECD Science, Technology and Industry Working Papers, No. 2001/02. doi:http://dx.doi.org/10.1787/736170038056

Ayyagari, M., Demirguc-Kunt, A., & Maksimovic, V. (2010). Are Innovating Firms Victims or Perpetrators? Tax Evasion, Bribe Payments, and the Role of External Finance in Developing Countries.

Basu, K., McGavock, T., & Zhang, B. (2013). When Competition Corrupts A Theoretical Analysis of Market Structure and the Incidence of Corruption.

Bentzen, J. S. (2012). How Bad is Corruption? Cross-Country Evidence of the Impact of Corruption on Economic Prosperity. Review of Development Economics, p.167-184.

Bliss, C., & Di Tella, R. (1997). Does Competition Kill Corruption. The Journal of Political Economy, 1001-1023.

Borooah, V. (2002). *Logit and Probit.* Thousand Oaks, CA: Sage Publications, *v*.

Castro, C. & Nunes, P. (2013). Does Corruption Inhibit Foreign Direct Investment. Revista de Ciencia Política, 61-83.

Cohen, W. M., & Klepper, S. (1996). A Reprise of Size and R&D. The Economic Journal, 925-951.

Cohen, W. M., Nelson, R. R., & Walsh, J. P. (2002). Links and Impacts: The Influence of Public Research on Industrial R&D. Management Science, 1-23.

Cohen, W. M. (2010). Handbook of the Economics of Innovation, Volume 1. In B. H. Hall, & N. Rosenberg, Fifty Years Of Empirical Studies Of Innovative Activity (pp. 129-213). Amsterdam: Elsevier BV.

Cozzens, S. E. (2008). Innovation and Inequality. Retrieved from http://hdl.handle.net/1853/23051

Criscuolo, C., Haskel, J. E., & Slaughter, M. J. (2010). Global engagement and the innovation of activities of firms. International Journal of Industrial Organization, 191-202.

De Rosa, D., Gooroochurn, N., & Görg, H. (2010). Corruption and Productivity Firm-level evidence from the BEEPS Survey. The World Bank.

De Waldemar, F. S. (2012). New Products and Corruption: Evidence from Indian Firms. The Developing Ecomonies, 268-284.

Eicher, T., García-Peñalosa, C., & van Ypersele, T. (2009). Education, Corruption, and the Distribution of Income. Journal of Economic Growth, 205-231.

Fagerberg, J. (2006). Innovation: A Guide to the Literature. Oxford University Press.

Ferrer-i-Carbonell, A., & Frijters, P. (2004). How Important is Methodology for the Estimates of the Determinants of Happiness? The Economic Journal, 641-659.

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

Gauthier, B., & Reinikka, R. (2006). Shifting Tax Burdens through Exemptions and Evasions: an Empirical Investigation of Uganda. Journal of African Economies, 373-398.

Kaufmann, D., & Kraay, A. (2003). Governance and Growth: Causality which way? --Evidence for the World, in brief. Washington, DC: World Bank.

Leff, N. H. (1964). Economic Development Through Bureaucratic Corruption. The American Behavioral Scientist, 8-14.

Li, H., Xu, C., & Zou, H.-F. (2000). Corruption, Income Distrabution, and Growth. Economics and Politics, 155-180.

Mankiw, N. G., Romer, D., & Weil, D. N. (1992). A Contribution to the Empirics of Economic Growth. The Quarterly Journal of Economics, 407-437.

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

Mowery, D. C., & Oxley, J. E. (1995). Inward technology transfer and competitiveness: the role of national innovation systems. Cambridge Journal of Economics, 67-93.

Murphy, K. M., Schleifer, A., & Vishny, R. W. (1991). The Allocation of Talent: Implications for Growth. The Quarterly Journal of Economics, 503-530.

Murphy, K. M., Schleifer, A., & Vishny, R. W. (1993). Why Is Rent-Seeking So Costly to Growth? American Economic Review, 409-414.

OECD. (2005). Oslo Manual Guidlines for Collecting and Interpreting Innovation Data. OECD and Eurrostat.

OECD. (2012). Innovation for Development. OECD.

Olney, W. W. (2014). Impact of corruption on firm level export decisions. Williams College mimeo.

Romer, P. M. (1990). Endogenous Technological Change. Journal of Political Economy, S71-S102.

Saljanin, S., & Thorwarth, S. (2013). Does Competitive Pressure Spur or Hinder Corporate Basic Research.

Scherer, F. M. (1965). Firm Size, Market Structure, Opportunity, and the Output of Patented Inventions. The American Economic Review, 1097-1125.

Schleifer, A., & Vishny, R. W. (1993). Corruption. Quarterly Journal of Economics, 599-617.

Schumpeter, J. A. (1943). Capitalism, Socialism and Democracy. USA: George Allen & Unwin.

Straub, S. (2005). Corruption and Product Market Competition.

Teece, D. T. (1981). The Market for Know-How and the Efficient International Transfer of Technology. Annals of the American Academy of Political and Social Science, 81-96.

Vives, X. (2008). Innovation and Competitive Pressure. The Journal of Industrial Economics, 419-469.

Williams, Richard. 2006. "Generalized Ordered Logit/ Partial Proportional Odds Models for Ordinal Dependent Variables." The Stata Journal 6(1):58-82.

World Bank. (2011). World Bank's Enterprise Survey: Understanding the Questionnaire. World Bank.

# Appendix

Table 1: Description of the variables

| **Variable** | **Variable name in original dataset** | **Type** | **Question or Description** |
|---|---|---|---|
| Corruption Obstacle | j30f | Ordinal | Is corruption No Obstacle, a Minor Obstacle, a Moderate Obstacle, a Major Obstacle, or a Very Severe Obstacle to the current operations of this establishment? |
| Innovation | e7 | Binary | During the last three years, did this establishment introduce onto the market any new or significantly improved products (goods or services)? |
| Education | l9 | Ordinal | What is the average educational attainment of a typical production worker employed in this establishment? |
| Size | size_cat | Ordinal | Small, Medium, and Large firm categories based on no. of employees |
| Finance | k8 | Binary | At this time, does this establishment have a line of credit or a loan from a financial institution? |
| Exports | d3a<br>(100-d3a) | Continuous | In fiscal year 2005/6, what percent of this establishment's sales were national sales? |
| Competition | e2 | Ordinal | In fiscal year 2005, for the main market in which this establishment sold its main product, how many competitors did this establishment's main product face? |

Data source: World Bank Enterprise Survey

Table 2: Correlations between explanatory variables

| | Corruption Obstacle | Innovation | Education | Education$^2$ | Size | Finance | Exports | Competition |
|---|---|---|---|---|---|---|---|---|
| **Corruption Obstacle** | 1.0000 | | | | | | | |
| **Innovation** | 0.0633 | 1.0000 | | | | | | |
| **Education** | 0.0476 | 0.1663 | 1.0000 | | | | | |
| **Education$^2$** | 0.0478 | 0.1621 | 0.9838 | 1.0000 | | | | |
| **Size** | 0.0299 | 0.1886 | 0.0855 | 0.0755 | 1.0000 | | | |
| **Finance** | 0.0709 | 0.1969 | 0.2120 | 0.2026 | 0.2585 | 1.0000 | | |
| **Exports** | 0.0323 | 0.0962 | 0.0519 | 0.0488 | 0.2204 | 0.1107 | 1.0000 | |
| **Competition** | 0.0770 | 0.0012 | 0.0092 | 0.0059 | -0.0458 | 0.0263 | -0.0434 | 1.0000 |

Data source: World Bank Enterprise Survey

Table 3: Summary statistics of variables used in the model

| Variable | No. of Obs. | Mean | Std. Dev. | Min. | Max |
|---|---|---|---|---|---|
| **Dependent** | | | | | |
| -Corruption Obstacle | 7,776 | 2.114712 | 1.522888 | 0 | 4 |
| **Independent** | | | | | |
| -Innovation | 7,776 | 0.6156121 | 0.4864815 | 0 | 1 |
| -Education | 7,746 | 2.798477 | 0.8555007 | 1 | 5 |
| -Education$^2$ | 7,746 | 8.563258 | 8.563258 | 1 | 25 |
| -Size | 7,776 | 1.6770830 | 0.7379607 | 1 | 3 |
| -Finance | 7,774 | 0.4354258 | 0.4958445 | 0 | 1 |
| -Exports | 7,776 | 1.969264 | 2.316602 | 1 | 10 |
| -Competition | 7,185 | 0.5645094 | 0.4958556 | 0 | 1 |

Data source: World Bank Enterprise Survey

Table 4: Regression results of the ordered logit model

| **Dependent Variable:** Corruption Obstacle | | | | |
|---|---|---|---|---|
| **Independent Variables** | **Model** | | | |
| | **(1)** | **(2)** | **(3)** | **(4)** |
| **Core** | | | | |
| -Innovation | 1.271329***<br>(0.0504299) | 1.184126***<br>(0.0647676) | 1.189849***<br>(0.0633222) | 1.171702***<br>(0.0667415) |
| **Control** | | | | |
| -Country dummies | … | Included | Included | Included |
| -Education | … | … | 1.515714**<br>(0.2490764) | 1.564606***<br>(0. 2532699) |
| -Education$^2$ | … | … | 0.9249508***<br>(0.0256044) | 0.9200989***<br>(0.0255174) |
| -Size | … | … | … | 1.003097<br>(0.0270075) |
| -Finance | … | … | … | 1.145994<br>(0.097631) |
| -Exports | … | … | … | 1.030235***<br>(0.011914) |
| -Competition | … | … | … | 1.358993***<br>(0.0303917) |
| **Constant Terms** | | | | |
| -Cutpoint 1 | -1.006522<br>(0.1095293) | -0.3474432<br>(0.3657483) | 0.1436921<br>(0.3780829) | 0. 3061592<br>(0.3723372) |
| -Cutpoint 2 | -.3661978<br>(0.0929109) | 0.3474432<br>(0.369587) | 0.868545<br>(0.3977612) | 1.039874<br>(0.3768712) |
| -Cutpoint 3 | 0.2431467<br>(0.097351) | 1.065587<br>(0.3932738) | 1.558983<br>(0.3977612) | 1.726934<br>(0. 3942826) |
| -Cutpoint 4 | 1.232105<br>(0.0712373) | 2.150879<br>(0.3811502) | 2.644215<br>(0.3852819) | 2.825744<br>(0. 3805742) |
| **Observations** | 7776 | 7776 | 7746 | 7153 |
| **Pseudo R-Squared** | 0.0014 | 0.0492 | 0.0497 | 0.0533 |

*Notes*: Table reports odds ratios. Robust standard errors are in parentheses. Data source: World Bank Enterprise Survey
***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table 5: Countries and number of firms used in the study

| **Country** | **No. of firms** | **Percentage (%)** |
|---|---|---|
| -Angola | 215 | 2.76 |
| -Argentina | 620 | 7.97 |
| -Bolivia | 345 | 4.44 |
| -Botswana | 114 | 1.47 |
| -Burundi | 102 | 1.31 |
| -Chile | 602 | 7.74 |
| -Colombia | 606 | 7.79 |
| -Democratic Republic of Congo | 149 | 1.92 |
| -Ecuador | 353 | 4.54 |
| -El Salvador | 414 | 5.32 |
| -Gambia | 33 | 0.42 |
| -Guatemala | 303 | 3.90 |
| -Guinea | 134 | 1.72 |
| -Guinea-Bissau | 48 | 0.62 |
| -Honduras | 248 | 3.19 |
| -Mauritania | 79 | 1.02 |
| -Mexico | 1,030 | 13.25 |
| -Namibia | 103 | 1.32 |
| -Nicaragua | 333 | 4.28 |
| -Panama | 220 | 2.83 |
| -Paraguay | 359 | 4.62 |
| -Peru | 345 | 4.44 |
| -Rwanda | 59 | 0.76 |
| -Swaziland | 68 | 0.87 |
| -Tanzania | 273 | 3.51 |
| -Uganda | 305 | 3.92 |
| -Uruguay | 316 | 4.06 |
| **Total** | **7,776** | **100.00** |