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Innovation and Corruption

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Abstract

This study investigates the relationship between innovation and perceived corruption using data from 131 countries. We employ a cross-sectional analysis and find that innovation is positively significant in reducing corruption. Innovation causes the industries and private sectors to become less dependent on the favoritism from the public officials and authorities as they are more encouraged to innovate to gain the competitive advantage.

Keywords: Innovation, corruption, cross sectional analysis.

1. INTRODUCTION

Corruption is a serious problem faced by almost every country in the world, especially in the developing and emerging economies. Countries facing this problem often suffer inefficiencies in their economic, social and political development. According to Transparency International (TI), 69 per cent of the countries today are facing "a serious corruption problem". The rest, though some are categorized as 'clean', cannot claim that they are completely free from corruption. Corruption reflects the institutional weakness in the country that slows the economic growth and may distort the allocation of public resources. This problem occurs in all levels of society, local municipalities and federal governments, small and large businesses, and even non-profit organizations.

Fighting corruption is difficult to due to many factors. The persistency of corruption among government officials may be attributed to the reputation effect (Tirole, 1996). In a country where corruption is pervasive, there are no incentives for individuals to fight corruption (Mauro, 1995). Due to its secretive and illegal nature, corruption is also hard to measure. We often rely on the perceived corruption data which are based on the perception of professional bodies, organizations, businesses and the public. An example of corruption activity is 'greasing the palm' of government officials to secure government contracts (Cheung, Rau and Stouraitis, 2012) and to bypass complex regulations (Huntington, 1968). The act of corruption is rationalized as a mean to gain advantage against other competitors.

Besides the conventional way of fighting corruption through the enforcement of laws and regulations, we can identify the factors that could indirectly help to control and inhibit corruption. The problem persists when there is a demand for bribes from the authorities or government officials, and there are firms or individuals who are willing to participate in giving bribes. Numerous studies focused on the determinants of corruption, such as income, economic freedom, education, taxation, regulations, military spending, national competitiveness, the size of the public sector, institutional quality and efficiency, and public sector wages (Gupta et. al, 1998; Mauro, 1995; Pieroni and Agostino, 2013; Tanzi, 1998; Ulman, 2014).

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Some studies examined the role of innovation in influencing the level of corruption. The Principal-Agent-Client Approach by Kliitgaard (1988) illustrates the relationship between innovation and corruption. Principals are the politicians, who are elected into office, and many have inadequate information on the operational activities. These principals employ the officials as their agents and these agents usually hold too much information that they are incapable of monitoring the whole economic activities. These agents may have access to a monopoly or they are able to administer or create higher market power. Some agents possess a lack of accountability and may demand bribes from competing businesses. In order to reduce corruption, it is important that we modify the principal-agent-client relationship by controlling the access to monopoly, limiting discretion and ensuring accountability among the agents. This can be done by increasing the level of innovation. When the level of innovation is high, individuals and businesses have little or no incentive to offer bribes and they can focus on innovation to gain monopoly or increase profit by gaining competitive advantage.

Most studies on innovation used technological progress as its proxy. Osborne (2006) suggested that technology increases the relative return on production and causes an endogenous decrease in rent-seeking activities. This is also supported by Bosco (2016), which explains that high technological progress makes the industrial sector and the service sector less dependent on the protection and favoritism from public authorities. High-tech sectors become less exposed to corruption requests from public officials, and are less inclined to plead for advantage in obtaining government contracts or avoiding complex bureaucracy. Despite its widely used, technological progress does not have high accuracy to represent the whole framework of innovation. Thus, in this study, we examine the corruption impact of innovation by using the Global innovation index published by Cornell University, INSEAD and the World Intellectual Property Organization. This index is said to have higher accuracy as it is developed by including the whole element of innovation such as institutional, human capital research and development (R&D) and the industrial and market sophistication.

This paper is organized as follows. Section 2 reviews and discusses literature of this issue. Section 3 discusses the methodology, theoretical and empirical models. Section 4 presents the empirical findings and discussion of the analysis. Section 5 concludes.

2. LITERATURE REVIEW

The publication of various indices of corruption (such as the CPI, WGI) has prompted researchers to empirically investigate the determinants of corruption, namely by examining the social, political, regional, cultural and economic factors. Armantier and Boly (2008) identified several universal determinants of bribery. They found that age, ability, and religiosity significantly affect the probability of accepting bribes in both developed and developing countries. Their result supports these factors as common influences on corrupt behavior.

Bosco (2016) found that social distress and public expenditure have an adverse impact on corruption. However, the effectiveness and efficiency of public policies can counterbalance the negative effect of public expenditure and the undesirable influence of poverty on corruption. The author also suggested that technology raises the relative return on production. In addition, there was evidence of an endogenous decrease in rent-seeking activities. Ulman (2014) found that national competitiveness significantly influence the perception of corruption in a country. The study also concluded that the standard of living, the rate of employment, productivity, commercial equilibrium, national attractiveness, the ability of objective implementation, the flexibility and ability of sustaining growth are determinants of the perceived corruption.

Economic freedom is also believed to have an effect on corruption. Countries with high economic freedom are more open to trade, have fewer restrictions and allow better press freedom. According to Saha et. al (2009), democracy and economic freedom significantly reduce corruption. Pieroni & D'Agostino (2013) found that economic freedom can explain why the lack of competition policies and government regulations tend to yield more corruption. They argued that market competition increases corruption when institutions are weak, as is often the case in developing countries.

Studies on the impact of innovation on corruption are scarce in the existing literature. Therefore, we also refer to the studies on technological progress and other measures that serve as proxies to represent the innovation framework. For example, Galindo and Mendez-Picazo (2013) analyzed the relationship between innovation and economic growth by examining the entrepreneurial activity. The results showed that innovation plays a central role in the economic growth process, where the entrepreneurs act as vehicles in introducing new technologies that can improve the firm's activities. Adak (2015) investigated the influence of technological progress and innovation on the Turkish economy using the OLS method and found that there is a significant effect of technological progress and innovation on economic growth. Bosco (2016) studied several old and new factors of corruption in

the European countries and found that technological progress reduces corruption. The author suggested that technology raises the relative return on production and can cause an endogenous decrease in rent-seeking activities.

At the firm level, Paunov (2016) investigated the impact of corruption on firm innovation using firm-level data for 48 developing countries. This study found that corruption reduces the likelihood of firms in these industries receiving quality certificates. The author then concluded that corruption affects smaller firms, but has no impact on exporters or foreign and publicly owned firms. Lio et. al (2011) estimated the effect of internet adoption on reducing corruption and found that the effect is statistically significant but not too substantial. They suggested that the internet adoption is capable in reducing corruption.

Xu and Yano (2016) investigated the effect of anticorruption on financing and investing in innovation in China. The authors found that stronger anticorruption efforts make firms more likely to commit to long-term debt and firms located in the provinces with stronger anticorruption efforts tend to invest significantly in R&D and generate more patents.

3. METHODOLOGY AND DATA

We examine the impact of innovation on corruption using the following specification:

$$RCPI_i = \beta_0 + \beta_1 * INNO_i + \beta_2 * LNGDPPc_i + \beta_3 * EF_i + \varepsilon_i$$

where *RCPI* is the reversed corruption perceived index; *INNO* is the level of innovation in the respective countries; *LNGDPPC* is the natural log of income per capita, *EF* is economic freedom, and ε refers to the disturbances assumed to be distributed across countries with zero mean.

RCPI is based on the Transparency International's (*TI*) Corruption Perception Index (*CPI*) scores data. *CPI* is published since 1995 and annually ranks countries by their perceived levels of corruption, derived from expert assessments and opinion surveys. The *TI's CPI* score is higher for countries with lower corruption. In order to avoid confusion, we use the reversed *CPI* score which is the maximum *CPI* Score (10 or 100, depends on the year of data publication) minus the score for each respective country. *CPI* is widely used in many studies to examine the effect of corruption (D'Agostino, 2012; Ulman, 2014).

INNO represents the level of innovation in the country, including the whole framework of innovation, such as institutional, human capital, R&D and the industrial and market sophistication. We employ the Global Innovation Index published by Cornell University, INSEAD and the World Intellectual Property Organization (WIPO, an agency of the United Nations).

Income is represented by log GDP per capita (*LGDPPC*), following the emphasis by Serra (2006), which stated per capita GDP as an acceptable proxy of economic development. It has also been used in many previous studies, such as Bosco (2016) and Lio, M. et. al (2011). The data are taken from the World Bank's World Development Indicators (WDI).

Economic freedom is included as one of the control variables. Saha et. al (2009) found economic freedom as one of the determinants that reduce corruption. Economic freedom reflects the freedom in the business sector, which can be measured by the degree of government intervention in the market, trade openness and foreign direct investment. The Heritage Foundation's Index of Economic Freedom is an annual index and ranking produced by the Heritage foundation and the Wall Street Journal since 1995, with the objective to measure the degree of economic freedom in the world. The Index's 2008 definition of economic freedom states that "the highest form of economic freedom provides an absolute right of property ownership, fully realized freedoms of movement for labour, capital and goods, and an absolute absence of coercion or constraint of economic liberty beyond the extent necessary to protect and main liberty itself".

All data are 3 years average from 2013 to 2015 and taken from 131 sample countries. The 3 years average samples are chosen due to the availability of innovation index which only exist in these 3 years. Table 1 shows the sources of data used in this study.

Table 1: Variable and Data Explanation

Variable	Explanation	Source
RCPI	Reversed Corruption Perceived Index (Average 2013-2015)	Transparency's International Corruption Perception Index
INNO	Global Innovation Index (Average 2013-2015)	INSEAD's & WIPO Global Innovation Index
LNGDPPC	Log Gross Domestic Product (GDP) Per Capita (Average 2013-2015)	World Bank's World Development Indicator
EF	Index of Economic Freedom (Average 2013-2015)	Heritage International's Economic Freedom index

The regression analysis is carried out using the ordinary least square (*OLS*) regression. The classical assumptions are tested through a set of diagnostic tests.

4. RESULTS AND ANALYSIS

Table 2 shows the descriptive statistics of the samples. The table shows that innovation level among the 131 countries are varies. The highest innovation level is 66.567 and the lowest is 19.667 while the mean is 37.738. The similar situation is observed in the Reversed Corruption Perceived Index, the log GDP per Capita and Economic Freedom.

Table 2: Descriptive Statistics

	Reversed CPI	Innovation	Log GDP Per Capita	Economic Freedom
Mean	5.346	37.738	8.779	62.655
Median	5.900	35.833	8.749	61.817
Maximum	8.200	66.567	11.553	89.665
Minimum	0.866	19.667	5.944	33.927
Std. Dev.	1.951	11.2617	1.465	9.880
Skewness	-0.709	0.676	-0.135	-0.012
Jarque-Bera	13.011	11.545	5.407	0.318
Probability	0.00149	0.00311	0.06693	0.85266
Sum	700.45	4943.73	1150.12	8207.88
Sum Sq. Dev.	495.22	16488.73	279.36	12690.85
Observations	131	131	131	131

The OLS regression results is presented in Table 3. The study finds that the model is unbiased, although having a near multicollinearity problem. We decide to ignore this problem due to the fact that the variable in question, which is income, is proven to be a very important variable in previous studies (Mauro, 1995). In addition, having a near multicollinearity problem does not affect the BLUE properties of the OLS estimators. The estimators are still consistent, unbiased and efficient, since the presence of near multicollinearity does not violate any of the CLRM assumptions (Blanchard, 1987). The model is tested against other proxies and we find that the model is robust for all variables.

The result shows a strong relationship between innovation and corruption, which is in accordance with our initial expectation. The negative coefficient for the level of innovation supports that innovation has a negative relationship with corruption, where high innovation can reduce corruption. According to our hypothesis, high level of innovation creates opportunities for businesses and allows them to be less dependent on public officials, thus resulting in lower corruption (Bosco, 2016). Firms and businesses stand to gain the legal monopoly over intellectual property rights, and able to reduce their dependency on the public sector for government contracts or concessions. Businesses that invest more in research and technology can gain real profits and have a higher

competitive advantage. This advantage helps firms to gain legal monopoly power; therefore, they are less dependent on public officials and more unlikely to offer bribes. This is in line with our hypothesis and the findings from previous studies (Bosco, 2016; Xu and Yano, 2016). In our efforts to fight corruption, we urge the policymakers to consider increasing the level of innovation. This can be done by promoting relevant policies that encourage innovation among the public sector, private sectors, non-profit organizations and learning institutions.

A higher level of innovation enables the firms to compete better and gain more market power by using the latest technology to improve their products and services. They are less dependent on government contracts, have less needs to deal with corrupt officials and are able avoid potential situations that may involve giving a bribe. Although they still have to go through the normal standard bureaucratic process to register patents or copyrights, they minimize their exposure to bureaucracy that may lead to a higher level of corruption.

We also find evidence to support that income and economic freedom are important determinants of corruption. An increase in all these determinants would ultimately reduce corruption.

Table 3: OLS Regression Result

Dependent Variable: Reversed CPI				
Independent Variables	2013	2014	2015	AVERAGE 2013-2015
Intercept	14.21***	14.63***	15.11***	14.53***
Innovation	-0.090***	-0.077***	-0.014***	-0.082***
Log GDP Per Capita	-0.151	-0.221**	-0.262**	-0.196*
Economic Freedom	-0.065***	-0.071***	-0.076***	-0.070***
R-Squared	0.798	0.804	0.816	0.811
F-Stat	166.85***	175.98***	183.78***	181.75***
Obs	131	131	131	131

Note: Asterisks *,** and *** indicate the 10%, 5% and 1% significant levels, respectively.

We compare the results for each subsequent year (2013-2015) with the mean for the whole period, and all the results are statistically significant. We also observe that income is significant, except for the year 2013, while economic freedom is significant for each year. Our results show that the level of innovation reduces the level of corruption. Our finding also suggests that income and economic freedom have a significant effect in reducing the level of corruption.

After estimating the model, we proceed to diagnostic results. The first test is heteroscedasticity test using three types of tests: White's test, Harvey's test and Breusch-Pagan-Godfrey's test. All three tests reject the null hypothesis of heteroscedasticity, therefore, we can conclude that our model is homoscedastic. The results are as summarized in Table 4.

Table 4: Heteroscedasticity Tests Result

Heteroscedasticity Tests	P-Value	Verdict
White	0.42	Reject null hypothesis, no heteroscedasticity
Harvey	0.87	Reject null hypothesis, no heteroscedasticity
Breusch-Pagan-Godfrey	0.40	Reject null hypothesis, no heteroscedasticity

The second test is the normality test to determine the Jacque-Bera p-value. We find that the JB p-value is at least significant at 10%, therefore, we conclude that the error terms are normally distributed.

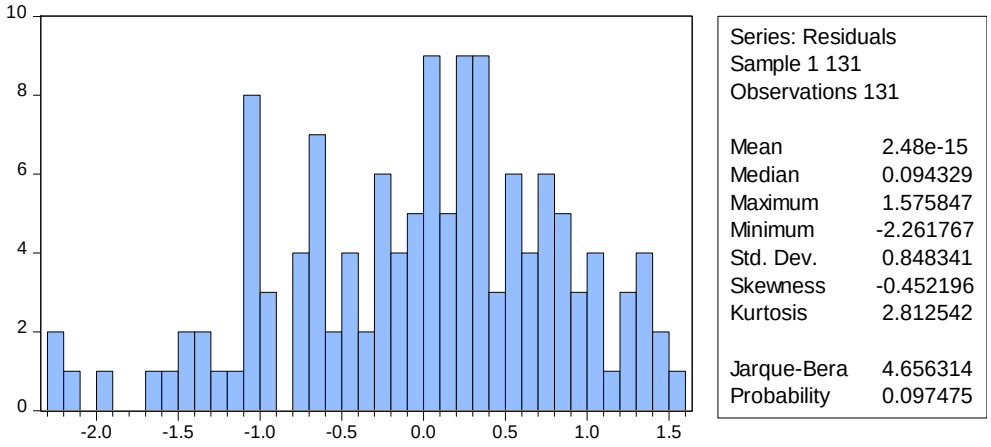

Figure 2: Normality Test Result

The third is the multicollinearity test. From the result in Table 6, we find evidence of a near multicollinearity between LGDPPC and INNO (0.86). However, we choose to ignore this problem as near multicollinearity does not affect the BLUE properties (Blanchard, 1987). The model remains unbiased and efficient. In addition, existing literatures supported that income (LGDPPC) is an important determinant of corruption.

Table 6: Correlation Result For Multicollinearity Detection

	Reversed CPI	Log GDP Per Capita	Economic Freedom	Innovation
Reversed CPI	1			
Log GDP Per Capita	-0.7891	1		
Economic Freedom	-0.8071	0.6668	1	
Innovation	-0.8656	0.8580	0.7520	1

4.3 Robustness Test

We measure the robustness of this model by using World Bank's Worldwide Governance Indicator: Control of Corruption data to replace TI's reversed CPI and Bloomberg's Innovation Index to replace INSEAD's Global Innovation Index. The result is as the following:

Table 7: Robustness Test Result

	DV: Reversed CPI	DV:World Governance Index (Control of Corruption)	DV:World Governance Index (Control of Corruption)
Intercept	20.68***	-4.420***	-7.64***
Innovation (Global Innovation Index)		0.051***	
Innovation (Bloomberg's Innovation Index)	-0.025**		0.015**
Log GDP Per Capita	-0.916***	0.072	0.479***
Economic Freedom	-0.087***	0.031***	0.040***
R-squared	0.849	0.824	0.868
F-Stat	84.46***	147.83***	72.04***
Obs	49	131	49

Note: Asterisks *,** and *** indicate the 10%, 5% and 1% significant levels, respectively.

The results indicate that the model is robust, even when tested against other proxies to represent corruption and innovation. However, the coefficients are positive since the WGI's corruption data are not reversed.

5. CONCLUSION

Many studies had shown that innovation is beneficial to growth, and corruption has a distortionary effect on growth. This study focuses on a different perspective, by examining the role of innovation in increasing firm competitiveness and reducing corruption. Countries striving to combat corruption often fail to tackle the problem directly because of the secretive and illegal nature of the problem. Therefore, in order to gain better outcomes, the fight against corruption can be indirectly supported by influencing other determinants to reduce the demand for corruption. We employ the OLS regression to the model, and the result shows there is a relationship between innovation and corruption. A country with a higher level of innovation is more likely to have a lower level of corruption. Future research may seek further empirical evidence by applying the dynamic model, to gain more insight into this relationship. As the data gathered for this study are limited, further studies may benefit from more data that could be obtained in the future.

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