# ICT as a Corruption Deterrent: A Theoretical Perspective

*Full papers*

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## Abstract

Investigations of white collar crimes such as corruption are often hindered by the lack of information or physical evidence. However, vast amount of information recorded, stored, analyzed, and shared using information and communication technologies (ICT) by businesses, governments, and citizens may help in investigating and prosecuting these crimes, and in deterring future crimes. This paper investigates the relationship between ICT and corruption at the country level using the theoretical lens of general deterrence theory. Using time-lagged regression and multilevel analysis of country level data from 97 countries for the years 2011-2013, we demonstrate that countries with higher ICT penetration and higher rule of law tend to have lesser corruption after accounting for social, economic, and political controls.

**Keywords:** Corruption, ICT penetration, General Deterrence Theory, Multilevel Analysis

## Introduction

Corruption is rampant in modern society. More than one trillion dollars are paid in bribes every year (UNODC 2005). A survey of 1000 people from 107 countries found that more than 27% of respondents paid bribes in their countries when dealing with public officials (Global Corruption Barometer 2013). Illicit financial flows in the developing countries as the result of bribery, corruption or tax evasion amounted to 1.26 trillion dollars in 2011 alone and are increasing at the rate of 10 percent per annum (Kar and Freitas 2013). Foreign investors interested in investing in a relatively corrupt country can experience a 20% increase in their business costs due to corruption (UNODC 2005). A report by Transparency International notes that more than two-thirds of 177 countries have a corruption score below 50 on a 0-10 scale where 0 represents highest corruption (Transparency International 2011). The report warns of rampant abuse of power, secret dealings, and bribery in the global society.

Corruption is defined as "the abuse of entrusted power for private gain" (Bhargava 2006; Transparency International 2011). This includes bribery, extortion, collusion, fraud, embezzlement, misappropriation, trading influence, illicit enrichment, obstruction of justice, abuse of function, and money laundering. This definition suggests that corruption may take several forms, and is not limited to bribing a judge or public official.

Despite its widespread occurrence, investigation and prosecution of corrupt business people and government officials is difficult due to lack of observable evidence. Unlike traditional crimes such as homicide where there are physical and forensic evidence, such evidence is often lacking in corruption or other white-collar crime investigations (Gottschalk et al. 2011). Corruption investigations often follow unauthorized financial trails, whistleblower accounts, and wiretapped conversations, which may be inadmissible in courts of law. Corrupt officials try to avoid detection by using cash transactions and avoiding electronic communication. Moreover, individuals involved in corrupt acts are often educated, wealthy, respected, and socially influential, with strong political connections, which they leverage to escape prosecution, especially in countries with weak legal frameworks (OECD 2010). When corrupt individuals walk free, the society bears the cost of their corruption in the form of resources siphoned out of public welfare for private wealth creation, harming the citizenry at large.

Since combating corruption requires acquiring and processing information that is hard to obtain, ICT tools that enables the acquisition, storage, and processing of information may play a role in curbing corruption (Blurton 1999). ICT refers to "a diverse set of technological tools and resources used to communicate, create, disseminate, store, and manage information" (Charoensukmongkol and Moqbel 2014). These tools and resources include computer hardware, networks, software, telephony, mobile and satellite systems, surveillance tools, databases, data mining programs, and so forth. Information resources acquired using ICT tools can help in the investigation of the white-collar crimes in multiple ways. First, investigating accounting fraud is now easier due to the internal control procedures embedded in auditing systems. Second, ICT can enable multiagency collaboration that may be necessary for prosecuting white collar crimes. Third, ICT tools provide whistleblowers with the opportunity to expose corruption through anonymous tips, blogs, and websites like WikiLeaks. In light of the above expectations, the research question of interest to this study is: *Can increased ICT penetration reduce or deter corruption at the country level, and if so, why?*

We investigate the above research question using the theoretical lens of general deterrence theory (Gibbs 1975) – a theory from the field of criminal justice that explains why people commit crimes, and what strategies can help deter such crimes. Hypotheses postulated using this theory are then tested using country level data from a sample of 97 countries for the years 2011-2013.

## Literature Review

A meta-analysis of 42 empirical studies on corruption from 1995-2006 (Judge et al. 2011) found that corruption is a social, political, and economic problem and that political, legal, and economic institutions are important for constraining corrupt activities (Collier 2002). The literature suggests several factors that may be related to corruption. Poor citizens are more susceptible to corruption and bribery (Serra 2006). Exposure to international trade exchange has negative effect on corruption (Treisman 2000). Global corruption has negative relationship with judicial efficiency and economic freedom and positively related to foreign aid and government size (Ali and Isse 2002). Political stability and legitimate legal system can act as a deterrent to corruption (Park 2003). The presence of large network of media on Internet can deter corruption (Goel et al. 2012), while maturity of e-government services has a negative effect on corruption (Krishnan et al. 2013).

A few studies have explored the relationship between ICT and corruption. Usually, such studies focus on a specific ICT application like e-government, rather than ICT in general (e.g., Krishnan et al. 2013; Andersen 2000). Castells (2000) suggests that ICT can reduce corruption by decentralizing power but does not provide any empirical evidence for the proposed relationship. Lio et al. (2011) show that the level of Internet adoption in a country is negatively related to its level of corruption. Charoensukmongkol and Moqbel (2014) observe that ICT investment reduces corruption up to a certain extent but excess ICT investments may create new avenues for corruption (Charoensukmongkol and Moqbel 2014). Bertot et al. (2012) note that ICT can create an atmosphere of openness that can help identify and deter corrupt behavior, but the extent to which ICT can lead to a culture of transparency and openness is unclear. Goel et al. (2012) suggest that Internet creates corruption awareness, which in turn, deters corruption.

A field study found that corporate ICT applications such as ERP systems can (a) use embedded procedures to compel employees to follow a disciplined approach, and (b) the integrated nature of data stored in such systems leads to greater data visibility that assists proper monitoring (Elmes et al. 2005). Deploying such systems can help businesses detect inconsistencies in employee work and/or flow of funds that may be linked to corrupt activities. ICT usage by businesses and government organizations also increases the accountability of employees as their actions, movements, and transactions are recorded, and available to supervisors, news media, and independent audit agencies upon request (Elmes et al. 2005). If employees perceive that their actions are visible to others, their tendency to follow rules and standard procedures will increase (Foucault 1977).

However, most of the above studies are correlational (rather than explanatory), non-cumulative (i.e., don't build on prior studies) and atheoretical. In addition, corruption research is beset with conflicting conceptualizations and varying measurements of the corruption construct, making it difficult to compare findings across studies (Goel et al. 2012). We address these gaps in the literature by employing a theoretical approach to building hypotheses linking ICT and corruption in the next section.

## Theory and Hypothesis

In order to examine if ICT is indeed an effective deterrent for corruption, we employ general deterrence theory (GDT) from the criminal justice literature. This theory examines why people commit crimes and what can be done to prevent crimes. GDT assumes that criminals are not pathological or disturbed individual who need help or psychological counselling, but rather perfectly rational people whose criminal acts can be explained by a cost-benefit analysis. If the expected cost of committing a crime is lower than its expected benefits, criminals are more likely to commit the crime. Conversely, if the expected cost is higher, they are less likely to engage in criminal activity (Gibbs 1975).

A central assumption of GDT is the rationality of human behavior. While such rationality may be lacking in violent crimes like homicide where criminals may act in a fit of rage or under the influence of drugs, this assumption is reasonable for white collar crimes such as bribery and corruption that often involve careful and deliberate planning. According to this theory, criminal acts can be deterred by increasing the expected costs of committing a crime, such as by increasing its perceived certainty, swiftness, and severity of punishment (Gibbs 1975). Hence, techniques that increase the certainty of punishment (e.g., increased police patrol in high crime areas, using drug-sniffing dogs), its swiftness (e.g., using fast track or special courts), and severity (e.g., capital punishment, mandatory minimum sentencing, "three strikes law") can deter criminal activities.

GDT's historic origins date back to the works of classical philosophers Thomas Hobbes (1588-1678), Cesare Beccaria (1738-1794), and Jeremy Bentham (1738-1842) (Bosworth 2005). While previous philosophers like Thomas Aquinas insisted that people naturally do good rather than evil, in *Levinthan,* first published in 1651, Hobbes argued that people are neither good nor evil, but rather creatures of their own volition. In the Hobbesian view, people pursue their self-interests, such as material gain, personal safety, and social reputation (Bosworth 2005). During this pursuit, they may encroach upon the rights and safety of others, creating conflict and war, without a fitting government to protect the rights and safety for all. To avoid war, conflict, and crime, people enter into a "social contract" with the government, granting the sovereign the use of force to uphold the social contract in return for protection from human predicaments. But crimes may still occur even after governments perform their duties, and to deter such crime, Hobbes argued that the punishment for crimes must be greater than the benefits derived from criminal acts.

In *Dei Delitti e delle Pene* (*On Crimes and Punishment*), published in 1764, Beccaria argued that punishments are unjust and repressive when their severity exceeds what is necessary to achieve deterrence, punishment should be proportion to the crime committed, and torture and secret detentions should be eliminated (Bosworth 2005). However, be maintained that people are rationally self-interested and will avoid crimes if the cost of committing crimes exceed their benefits. In this view, it is not the excessive severity of punishment, but rather swift and certain punishment are the best means of controlling crime. Beccaria argued that laws should be published so that people are aware of their purpose and intent, and the process by which justice will be served.

Bentham extended the pleasure-pain calculus of his predecessors and the role of the state in *An Introduction to the Principles of Morals and Legislation*, published in 1780. Bentham (1948) argued that "nature has placed mankind under the governance of two sovereign masters, pain and pleasure" (p. 125), and that the duty of the state is "to promote the happiness of society, by punishing and rewarding" (p. 189). He suggested that punishment is evil unless it is used to avert a greater evil or to control the act of offenders.

Drawing from the works of Hobbes, Beccaria, and Bentham, GDT emphasizes three components of punishment: severity, certainty, and swiftness (Bosworth 2005). Certainty implies making potential criminals aware that crimes will be punished. This includes enacting laws that allow uniform prosecution of all crimes, and informing the public of these laws, such as by posting signs such as "Trespassers will be prosecuted." Swiftness implies building a system for handling large volumes of criminal offenses in an efficient manner, such as by establishing special courts and statues of limitations for crimes. Severity implies ensuring a punishment that is proportional to the nature of the crime and is consistent with the norms of fairness and justice. This includes categorizing crimes under different classes of misdemeanors and felonies and establishing sentencing guidelines for each class so as to reduce ambiguity and arbitrariness in the judicial process.

Punishment and deterrence has been practiced as a social practice for at least the last 2,000 years of human civilization. In the absence of formal laws during the medieval ages, public executions were used to convey the severity of punishment to the public and the offender's family members. Although outlawed in Western countries, public caning is still practiced in many countries for minor crimes such as public intoxication and lewd behavior. In Saddam Hussain's Iraq, people who committed acts against the state were punished by amputation of arms, legs, and ears. With advancements in jurisprudence, laws became formalized and documented, at least for most traditional crimes. However, this continues to be a limitation for many white-collar crimes, where prosecution is difficult, let alone establishing severity, certainty, and swiftness of punishment.

Can ICT deter white collar crimes such as corruption by affecting the severity, certainty, or swiftness of punishment for such crimes? The severity of punishment for corruption is established by social and legal norms of a country and is beyond the scope of ICT. Likewise, swiftness depends on the amount of caseload to be investigated and processed. However, ICT can ensure the certainty of punishment for corruption in three ways:

- Surveillance: ICT tools such as wiretapping, global positioning systems, spy camera, and sensors have made it possible to capture data unobtrusively, without human intervention and often without the offender's knowledge, and monitor the flow of information and funds between different parties on the Internet (Hartle et al. 2011; Levine 2011). For example, magnetic access cards record employees' times of entry and exit from workplace premises, as well as their access to secure corporate assets such as server rooms. Database logs are used to monitor employees' access to and modification of organizational databases and applications. Surveillance may extend beyond corporate premises. Investigative journals use spycams to record government officials accepting bribes, and even ordinary citizens have used smartphones to record instances of police brutality. In 2010, WikiLeaks, an international non-profit organization, released 400,000 classified military documents of the Iraq war, along with video footage of airstrikes in Baghdad that they obtained by hacking into secure US government websites. Surveillance tools provide the means for capturing data that is needed to build a compelling case against white-collar criminals.
- Data storage, retrieval and analysis: Advancements in ICT help store, process, and share vast amounts of data needed to prosecute white collar crimes. Today, databases are capable of storing hundreds of terabytes of data, in structured or unstructured form (e.g., files, images, video evidence), and provide means for searching and mining that data, and distributing it upon request among multiple parties involved in corruption investigations. Governments are already utilizing social network data for criminal investigation and prosecutions (Levine 2011).Crime mapping and analysis facilitated by data are changing the way police department operate (Manning 2008; Elizabeth 2014). Data based policing complements police knowledge and experience and helps the law enforcement agencies do their work better (Greengard 2012).
- Building public awareness: Lastly, widespread media coverage of corruption cases by virtue of the Internet and social media networks creates public awareness of often hidden white-collar crimes. This awareness helps mobilize public support for prosecuting high-profile corruption cases, further increasing the certainly that those crimes will be punished. As examples, evidence obtained through ICT did help with prosecuting several white collar crimes such as Bernie Madoff's Ponzi scheme (for which he received a 150-year prison term), former Worldcom CEO Bernard Ebbers' illegal corporate accounting (25 year term), and hedge fund owner Raj Rajaratman's insider trading activities (11-year term).

There is some empirical support on the negative relationship between ICT and corruption (e.g., Castells 2000; Bertot et al. 2012), while others (e.g., Charoensukmongkol and Moqbel 2014) have shown that ICT may simultaneously reduce corruption and also create new avenues for corruption. Some studies note that specific types of ICT such as e-government (Krishnan et al. 2013; Andersen 2000) and Internet (Lio et al. 2011; Goel et al.(2012) reduce country-level corruption, while corporate ICT applications such as ERP (Elmes et al. 2005) discourage employee corruption within firms. In light of the above expectations, we hypothesize:

H1: ICT penetration in a country is negatively related to its overall level of corruption.

GDT also argues that if the level of punishment for a certain crime is high, it will increase the cost of criminal behavior and deter potential offenders from engaging in criminal acts. This expectation leads us to hypothesize:

H2: Penalties against corrupt individuals is negatively related to the level of corruption in a country.

Figure 1 illustrates our two hypotheses. From prior research, we know that corruption is correlated with social, economic, and political factors (Judge et al. 2011). In particular, poverty, literacy, and political stability have been found to be negatively related to the level of corruption (Triesman 2000; Blurton 1999; Gupta 1998). For instance, corruption tends to be more predominant in poor countries (an economic problem) and in countries with higher illiteracy rates (a social problem), where the citizens have either more pressing economic issues to attend or lack technical skills needed to utilize anti-corruption ICT tools. Likewise, political instability (e.g., armed conflict, social unrest, lawlessness) in some countries may divert public attention away from corruption to more exigent political problems. Since these factors vary across countries, to control for their potential effects on the dependent variable, we include gross domestic product (GDP) per capita, literacy rate, and political stability as control variables in our research model.

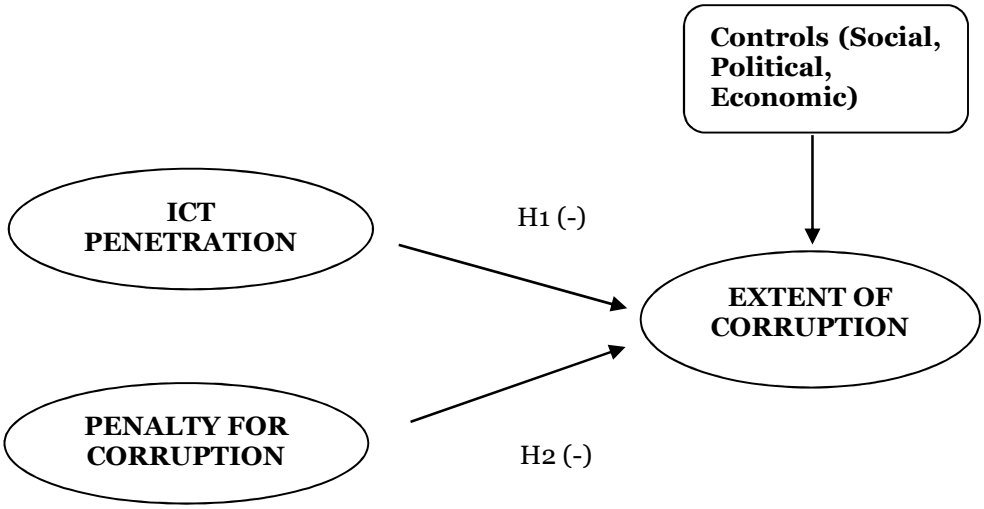


**Figure 1. Research Model**

## Research Methods

We tested the proposed hypotheses using archival data aggregated from multiple sources. The choice of secondary data was motivated by: (a) the difficult and infeasibility of collecting primary data on corruption across various countries of the world, and (b) availability of data from reputable third-party sources such as Transparency International, Global IT Report, and the World Bank. Table A1 in the appendix describes our construct measures, sources, and sample component dimensions of each construct.

Corruption was assessed using two measures: control of corruption (COC) as measured by Worldwide Governance Indicator (Worldwide Governance Indicator 2012), and Corruption Perception Index (CPI) as measured by Transparency International (2011). We chose two different measures because there is a wide diversity in corruption measures used in prior research and consequently findings reported in many studies are inconsistent with each other. Although CPI is a more popular measure of corruption, we wanted to see if our analysis was robust to the choice of our corruption measure, hence our selection of COC as a second measure. CPI is an index from 0 (high corruption) to 10 (low corruption) that takes into account factors such as accountability of public funds, executives, and public employees, information access to society, government control over corruption, bribery, anti-corruption initiatives, and so forth. COC is an index ranging from -2.5 (high corruption) to +2.5 (low corruption), which takes into account

corruption among public officials, diversion of public funds, level of corruption, and so forth. Note that both COC and CPI are reverse-scaled, meaning that high values indicate low levels of corruption and vice versa.

ICT penetration was measured using the total ICT usage sub-index (ICT) from the Global IT Report (Dutta and Osorio 2012). This index aggregates ICT penetration among individuals, businesses, and government on a scale of 0 (low penetration) to 10 (high penetration).Individual penetration examines factors such as number of mobile phone subscriptions, number of people using the Internet, households with Internet access, and so forth. Business penetration considers factors such as firm-level technology absorption, business Internet use, extent of staff training, and so forth. Government penetration includes government prioritization of ICT, government online service index, and so forth.

Penalty for corruption was measured using the rule of law (ROL) measure from Transformation Index (Transformation Index BTI 2012). This 0 (low penalty) to 10 (high penalty) measure includes dimensions such as prosecution of office abuse, separation of power, independence of judiciary, and so forth.

Three control variables were also included in our analysis. Literacy rate (LIT), a social control, was measured using (Worldbank 2014) as the percentage of population aged 15 and higher who can read, write, and understand a short, simple statement of their everyday life. GDP per capita, an economic control, was also measured using World Bank data as the gross value added by all resident producers of the economy minus taxes and subsidies, divided by the country's population (Worldbank 2014). Political stability (PS), a political control, was derived from Worldwide Governance Indicator (2012), which included metrics such as the extent of armed conflict, violent demonstrations, social unrest, and so forth.

After pooling together measures of our constructs of interest, we obtained matched data on 97 nations for the years 2010-2012 for predictor variables (lagged predictors) and 2011-2013 for the dependent variable (CPI/COC). CPI for 2012 and 2013 was measured on 0-100 point scale, hence we rescaled it to a 0-10 point scale for the analysis. Since, literacy rate (LIT) data is not updated each year we used latest value of LIT for each country. The rule of law (ROL) measure is available only for 2010 and 2012, and hence we interpolated it for 2011. Our analysis did not extend beyond the year 2012 because this was the last year for which all of the above data was available.

We tested our hypotheses using two different statistical approaches. The first approach estimated three lagged regression model for country level cross sectional data of each year independently. We lagged our independent variables by one year behind the dependent variable, consistent with other country-level analysis (Krishnan 2013), to account for the temporal nature of the effects of ICT penetration on corruption as well as reverse causality. We also conducted a two-year lagged analysis with almost identical results, which are not reported here to conserve space. Our lagged regression model was as follows:

**Model 1:** $(\mathrm{CPI}_t \;/\; \mathrm{COC}_t) = \beta_0 + \beta_1 \mathrm{ROL}_{(t-n)} + \beta_2 \mathrm{ICT}_{(t-n)} + \beta_3 \mathrm{GDP}_{(t-n)} + \beta_4 \mathrm{PS}_{(t-n)} + \beta_5 \mathrm{LIT}_{(t-n)} + \varepsilon \quad (1)$

where, n was the lag between the dependent and independent variables in years (n=1 for years 2011-2013).

In the second approach, we tested our hypothesis using a multilevel random effects model (see equation 4 below) (Hox 2002). This model was estimated on combined observations for all three years at two levels where level 1 unit consisted of the repeated measures for each country and level 2 units were countries themselves (Hoffman and Rovine 2007). We obtained a longitudinal as well as cross-sectional panel data structure with a total of 291 observations (3x97) with repeated measures nested within countries. Multilevel modeling is gaining popularity due to improving computational resources (Ma et al. 2014; Hohlfeld et al. 2008; Linnakyla 2001).Multilevel modeling allowed to control for variability in the existing level of corruption across countries (equation 3) and gave us generalizable estimates of the explanatory variables by incorporating the variability across countries as random effects. A preliminary analysis of CPI scores in the new data structure yielded an interclass correlation coefficient (ICC) of 98% indicating very high variability between groups (country-level) than within groups (year-level) (Heck and Thomas, 1999). Modeling country-level and year-level variables separately gave us more reliable estimates of the parameters. We introduced literacy (LIT) as a level 2 (country level) predictor in our model because (a) it could explain variability in existing level of corruption; and (b) measurement constraints made it a country-specific variable (single observations for all three years).

$$(\mathrm{CPI}_{it}\ /\mathrm{COC}_{it}) = \beta_{i0} + \beta_1 \mathrm{ROL}_{i(t-n)} + \beta_2 \mathrm{ICT}_{i(t-n)} + \beta_3 \mathrm{GDP}_{i(t-n)} + \beta_4 \mathrm{PS}_{i(t-n)} + \beta_5 \mathrm{LIT}_{i(t-n)} + \varepsilon \quad (2)$$

$$\beta_{i0} = \gamma_{00} + \gamma_{01} \mathrm{LIT}_{i(t-n)} + \mathrm{u}_0 \quad (3)$$

**Model 2 (mixed model):** $(\mathrm{CPI}_{it}\ /\mathrm{COC}_{it}) = \gamma_{00} + \gamma_{01} \mathrm{LIT}_{i(t-n)} + \beta_1 \mathrm{ROL}_{i(t-n)} + \beta_2 \mathrm{ICT}_{i(t-n)} + \beta_3 \mathrm{GDP}_{i(t-n)} + \beta_4 \mathrm{PS}_{i(t-n)} + \mathrm{u}_0 + \varepsilon \quad (4)$

In the complete/mixed model (Model 2), the level 2 error term $\mathrm{u}_0$ was distributed normally with variance $\tau_{00}$. $\mathrm{CPI}_{it}$ represented corruption in a country 'i' at time t (year). Model 2 was estimated using restricted maximum likelihood estimation (RMLE) for reliable estimates with small group size (3 years). Similar to model (1) we factored in a lag time of one year (n=1) to account for reverse causality and delay in effect of explanatory variables on country-level corruption (Krishnan et al. 2013).

# Results

Table 1 depicts bivariate correlations between our variables of interest. The two corruption measures, CPI and COC, were highly correlated (r=0.99) providing confidence in our measure of the dependent variable. Each of these constructs are also correlated with IT penetration (ICT) (r-0.74) and rule of law (RUL) (r=0.58, 0.56). As a test for multicollinearity, we compared VIF values for model 1 across all the three years, which ranged from 1.45 to 2.64; less than the maximum limit of 4.0.

**Table 1. Correlation between variables**

| | CPI | COC | ROL | ICT | GDP | LIT | PS |
|---|---|---|---|---|---|---|---|
| CPI | 1.00 | | | | | | |
| COC | 0.99 | 1.00 | | | | | |
| ROL | 0.58 | 0.56 | 1.00 | | | | |
| ICT | 0.74 | 0.74 | 0.30 | 1.00 | | | |
| GDP | 0.58 | 0.58 | 0.06 | 0.66 | 1.00 | | |
| LIT | 0.38 | 0.39 | 0.34 | 0.56 | 0.38 | 1.00 | |
| PS | 0.69 | 0.69 | 0.57 | 0.52 | 0.42 | 0.42 | 1.00 |

Coefficient estimates and their significance are shown in Table 2(a) and 2(b) for COC and CPI as measures of corruption. As seen in these tables, total ICT penetration (ICT) had significant positive associations ($p<0.05$) with both measures of corruption (COC and CPI) for each of the three years of analysis (2011-2013). Since COC and CPI were reverse-coded measures, these results confirmed that increasing ICT penetration leads to lower corruption, consistent with Hypothesis H1. Rule of law (ROL) was negatively related to corruption (reverse of COC and CPI) for each of the three years, supporting Hypothesis H2. A rerun of our analysis with a two-year lag between corruption (2013) and ICT penetration and rule of law (2011) found similar results, confirming the robustness of our findings across two different measures of corruption (from two sources), three different years of analysis (2011-2013), and two different time lags (n=1, 2). Partial F-test comparing the total variance explained in a baseline model with only control variables versus the hypothesized model with independent and control variables found that the R-square increase from the baseline model to the hypothesized model was significant for all lags and all years under consideration. This analysis confirmed that ICT penetration and rule of law added significant explanatory power in our model over and above the control variables.

In order to determine the relative strength of the effect of the predictor variables (ICT, ROL, GDP, LIT and PS) on explanatory variable (CPI/COC) in model 1 we obtained the standardized regression coefficients by estimating the model using z-scores of all variables (mean of 0; variance of 1). For the years 2012 and 2013, ICT penetration had the highest influence on CPI or COC compared to other independent variables (table 2(a)). A one standard deviation change in ICT penetration produced more change in the CPI/COC than any other predictor variables for these years. As an example, for year 2013 Std. β of ICT against COC is 0.41 (table 2(a)) implying that an increase in ICT penetration a year before (2012) by 0.7 (Std. deviation of ICT for 2012) increases the COC measure by 0.41*0.69 where 0.69 is Std. deviation of COC for 2013. ROL also had an effect that was comparable to other control variables on corruption measures.

Among the three control variables, GDP per capita (GDP) had a significant negative effect on corruption (Std. β≈0.23 to 0.4) and political stability (PS) had a high negative effect (Std. β≈0.20 to 3.50) as

expected. However, literacy rate (LIT) had a significant *positive* effect on corruption, opposite of what was expected, although the strength of this relationship was the weakest amongst all variables (Std. β ≈ -0.16 to -0.13). Similar findings were observed in some recent corruption studies (Saha and Su 2012; Saha et al. 2009), which were attributed to the limited variability in the literacy rate across the countries (Belasen and Peyton 2011).

**Table 2a Estimates of Model 1 (lag=1) for COC**

| | **COC** | | | | | |
|---|---|---|---|---|---|---|
| **Year** | **2011** | | **2012** | | **2013** | |
| | β | Std. β | β | Std. β | β | Std. β |
| (Intercept) | -1.50* | NA | -1.60* | NA | -1.83* | NA |
| Rule of Law (ROL) | 0.14* | 0.41* | 0.09* | 0.20* | 0.10* | 0.28* |
| ICT penetration (ICT) | 0.25* | 0.27* | 0.33* | 0.32* | 0.42* | 0.41* |
| GDP/Capita (GDP) | 0.00* | 0.28* | 0.00* | 0.27* | 0.00* | 0.21* |
| Literacy (LIT) | -0.01* | -0.13* | 0.00 | -0.2 | -0.01* | -0.14* |
| Political Stability (PS) | 0.21* | 0.25* | 0.25* | 0.27* | 0.21* | 0.26* |
| Adj. R. Squared | 0.74 | | 0.73 | | 0.71 | |
| F-statistic | 54.67 | | 52.13 | | 49.57 | |
| *p<0.05 | | | | | | |

**Table 2b Estimates of Model 1 (lag=1) for CPI**

| | **CPI** | | | | | |
|---|---|---|---|---|---|---|
| **Year** | **2011** | | **2012** | | **2013** | |
| | β | Std. β | β | Std. β | β | Std. β |
| (Intercept) | 1.74* | NA | 14.73* | NA | 10.63* | NA |
| Rule of Law (ROL) | 0.18* | 0.26* | 2.04* | 0.32* | 2.32* | 0.34* |
| ICT penetration (ICT) | 0.35* | 0.18* | 6.33* | 0.33* | 7.44* | 0.38* |
| GDP/Capita (GDP) | 0.00* | 0.4* | 0.00* | 0.27* | 0.00* | 0.23* |
| Literacy (LIT) | -0.01 | -0.09 | -0.10* | -0.13* | -0.13* | -0.16* |
| Political Stability (PS) | 0.43* | 0.25* | 4.64* | 0.28* | 4.36* | 0.27* |
| Adj. R. Squared | 0.61 | | 0.75 | | 0.75 | |
| F-statistic | 30.79 | | 59.41 | | 61.10 | |
| *p<0.05 | | | | | | |

**Table 3. Estimates for Model 2 (lag=1)**

| **Fixed Effects** | | |
|---|---|---|
| **Response** | **COC** | **CPI** |
| Intercept ($\gamma_{00}$) | -0.31* | 4.62* |
| Rule of Law ($\beta_1$) | 0.134* | 0.20* |
| ICT penetration ($\beta_2$) | 0.083* | 0.64* |
| GDP/Capita ($\beta_3$) | 0.001* | 0.001* |
| Literacy ($\gamma_{01}$) | 0.001 | -0.001* |
| Political Stability ($\beta_4$) | 0.082* | 0.35* |
| Deviance | -118.35 | 531 |
| *p<0.05 | | |
| **Random Effects** | | |
| Level 2 Variance ($u_0$) | 0.38* | 0.43* |
| Level 1 Variance ($\varepsilon$) | 0.09* | 0.15* |

Parameter estimates of the multilevel mixed model (Model 2) are shown in Table 3 above. After controlling for variability in corruption scores across countries using a random intercept, we find significant evidence of negative relationship of CPI with ICT and ROL. The estimates of GDP and PS are

also consistent with the past literature. However, the relationship between LIT and COC is non-significant and is positive for CPI, implying higher literacy leads to higher corruption. As discussed earlier this opposite and insignificant relationship can be attributed to lesser variability in the literacy rate across countries over time and less frequent updates of the literacy measure (Saha and Gounder 2013; Belasen and Peyton 2011). Another possible reason for this finding may be that the perceived corruption measured through surveys is higher for a literate society because of the people's understanding of corruption and concern for it. Research has shown that it is impossible to measure corruption based on any hard empirical data such as number of bribes reported or prosecutions, but that it is best measured through citizens and business perception about corruption (Transparency International 2011). We leave further investigation on the corruption and literacy relationship for the future research. In summary, higher relative influence of ICT penetration (ICT) and rule of law (ROL) in determining corruption across countries supports the proposed theoretical perspective outlined in the study.

## Conclusion and Discussion

The study empirically investigated the relationship between ICT penetration among businesses, government, and citizens in a country and its level of corruption. While prior studies have demonstrated that ICT may help reduce corruption, they did not present a theoretical rationale as to why it could be so. Furthermore, there were inconsistencies between measures of corruption between these studies and sometimes-conflicting effects were reported, making it hard to reconcile differences between studies.

We addressed these gaps in the literature by using a theoretical approach to studying corruption, and testing our hypotheses using multiple measures of corruption, multiple years of analysis, and multiple analytic models. Using the theoretical lens of general deterrence theory, we argued that the higher the certainty and severity of punishment related to corruption, the greater would be the deterrence against corruption. ICT penetration among nation's citizens, businesses, and government creates vast amount of information resources, provides tools to store, search, and analyze that data, and mechanisms to share the data among multiple parties involved in a corruption investigation. This increased level of monitoring as well as unobtrusive collection and analysis of corruption-related data can be utilized by investigators to prosecute white-collar crimes like corruption. By increasing the certainty of criminals being caught during or after the act of corruption, ICT can help reduce corruption. As per GDT, countries with higher rule of law should have less corruption by increasing the severity of punishment for corrupt acts. These effects were confirmed in our empirical analysis, while accounting for political, social, and economic controls. Our analysis was robust across multiple measures of corruption (COC and CPI), three different years of analysis (2011-2013), and with single level (regression) and multilevel (mixed effect model) statistical analyses.

To the best of our knowledge, this study is possibly the first to investigate the relationship between ICT and corruption using a theoretical perspective, and investigate the robustness of the relationship using a variety of methods. Based on our findings, we recommend that countries with high level of corruption consider investing in ICT tools to reduce corruption within its borders. However, we caution that ICT is not a cure-all solution for global corruption. Countries must also invest in building rule of law, through legal and judicial institutions, in order to realize the most benefit from their ICT investments. We also hope that our study will stimulate future studies to further explore the ICT-corruption link, the contingent factors under which this effect is strong versus weak, and additional factors that may enable or constrain the impact of ICT on corruption.

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**APPENDIX**

**Table A1 (Constructs and their measures)**

| Construct | Measure | Source | Components |
|---|---|---|---|
| ICT Penetration | Total ICT usage Sub Index (Scale : 0 (low usage) | The Global IT Report (2010-12) | Individual Usage: mobile phones subscription, individuals using internet, households with PC, households with internet access, use of social networks. |

| | | | |
|---|---|---|---|
| | to 10 (high usage) | | Business Usage: Firm level technology absorption, capacity for innovation, business internet use, extent of staff training<br>Government Usage: Government prioritization of ICT, importance of ICT to government vision, Government Online Service Index. |
| Penalty for Corrupt | Rule of Law (ROL)<br>Scale: -2.5 (low) to 2.5 (high) | Tranforma-tion Index BTI (2010-12) | Separations of power, Independent Judiciary, Prosecution of office abuse, Civil Rights |
| Corruption | Control of Corruption (COC)<br>Scale: -2.5 (low) – 2.5 (high) | Worldwide Governance indicator (2011-13) | Corruption among public officials, Diversion of Public Funds, Irregular Payments, Level of corruption between (Administration and citizens, local businesses, foreign companies) , spread of corruption |
| | Corruption Perception Index (CPI) Scale : 0 (high corruption) to 10 (low corrupt-tion) | Transparency International (2011-13) | Accountability of (Executives and public employees, Public Funds),Government Control over Corruption, Bribery for contracts and Favor, Anti-corruption Initiatives, Perception of corruption by Business People, Social Tolerance towards corruption |
| Political Control | Political Stability (PS) Scale: -2.5 (low) – 2.5 (high) | Worldwide Governance Indicator (2010-12) | Orderly transfers, Armed conflict, Violent demonstrations, Social Unrest, International tensions, Frequency of political killings , Frequency of disappearances, Political terror scale , Security Risk Rating, Intensity of Internal conflicts |
| Social Control | Literacy Rate (LIT) (percentage) | World Bank (2010-12) | Total is the percentage of the population age 15 and above who can, with understanding, read and write a short, simple statement on their everyday life. |
| Economic Control | GDP/ Capita (GDP) (Dollars) | World Bank (2010-12) | GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. |

**Table A2 (List of countries)**

| | | | |
|---|---|---|---|
| Albania | Ecuador | Malaysia | South Korea |
| Algeria | Egypt | Mali | Serbia |
| Argentina | El Salvador | Mauritania | Singapore |
| Armenia | Estonia | Mauritius | Slovakia |
| Azerbaijan | Ethiopia | Mexico | Slovenia |
| Bahrain | Georgia | Mongolia | South Africa |
| Bangladesh | Ghana | Montenegro | Sri Lanka |
| Benin | Guatemala | Morocco | Syria |
| Bolivia | Honduras | Mozambique | Taiwan |
| Bosnia | Hungary | Namibia | Tajikistan |

| | | | |
|---|---|---|---|
| Botswana | India | Nepal | Tanzania |
| Brazil | Indonesia | Nicaragua | Thailand |
| Bulgaria | Jamaica | Nigeria | Tunisia |
| Burkina | Jordan | Oman | Turkey |
| Burundi | Kazakhstan | Pakistan | United Arab Emirates |
| Côte d'Ivoire | Kenya | Panama | Uganda |
| Cambodia | Kuwait | Paraguay | Ukraine |
| Cameroon | Kyrgyz | Peru | Uruguay |
| Chad | Latvia | Philippines | Venezuela |
| Chile | Lesotho | Poland | Vietnam |
| China | Libya | Qatar | Zambia |
| Colombia | Lithuania | Romania | Zimbabwe |
| Costa | Macedonia | Russia | |
| Croatia | Madagascar | Saudi Arabia | |
| Czech | Malawi | Senegal | |