ECONOMIC GROWTH AND CORRUPTION IN DEVELOPING ECONOMIES: EVIDENCE FROM LINEAR AND NON-LINEAR PANEL CAUSALITY TESTS

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ABSTRACT

This paper aims at determining the causal relationship between economic growth and corruption in 42 developing countries using linear and non linear panel methods over the period 1998 to 2009. The findings show that the outcome of the causal association depends on the method used. Corruption appears to Granger cause economic growth when the linear panel causality tests are applied and economic growth seems to Granger lead corruption with the non- linear panel procedures as the modus operandi. The general value of these results is that adequate institutional facilities must be in place in developing economies to reduce losses from corruption, especially within and after periods of economic growth.

Keywords: Panel linear and non-linear causality, corruption and economic growth.
JEL Classification**:**C33, D73 and D92.

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1.0 Introduction

Corruption, defined as abuse of public power for private benefit, is now globally recognized as a policy variable that affects almost all aspects of social and economic life, especially in small developing countries where it is thought to be more important for the attainment of long-term economic growth and sustainable development. Examples of corruption include embezzlement of public funds, the sale of government property by public officials, bribery, patronage and nepotism. The World Bank (2000) estimated that over one trillionUnited States (US) dollars are lost annually as a result of corruption, which represents about five percent of the world gross domestic product (*GDP).* In fact, this institution identified corruption as the single greatest obstacle to social and economic development since it twists the rule of law and weakens the institutional foundations upon which economic growth is constructed.

An ongoing debate that provides motivation for further research is whether corruption greases or sands the wheels of economic growth (Bardhan, 1997; Pande, 2008; Aidt, 2009). Proponents of the greasing hypothesis (Leff, 1964; Huntington, 1968; Summers, 1977; Lui, 1985; Méon and Weill, 2010) are of the opinion that corruption encourages trade that may not have happened otherwise and promotes efficiency by allowing private sector agents to avoid unmanageable regulations. For instance, Acemoglou and Verdier (1998) contend that some degree of corruption may be part of the optimal allocation of resources in the presence of incomplete contracts or on account of market failure. This point of view is partly acceptable on the ground that illegal payments are required to expedite matters and favourably through the state bureaucracy (Amundsen, 2000). By implication, corruption has the power of producing a more efficient economic agent and in the long run it enhances economic growth.

The opposing school of thought contends that corruption exerts adverse effects on or sands the wheels of long-term economic growth and sustainable development (see Gould and Amaro-Reyes, 1983; Mauro, 1995; United Nations Development Program (UNDP), 1997; Wei, 1997; Kaufmann, 1997; World Bank, 2000; Reinikka and Svensson, 2004; 2005). The transmission mechanisms of these negative impacts include, *inter alia*, reduced domestic and foreign investment, increased cost of production, misallocation of national resources, higher inequality and poverty, uncertainty in decision making. For instance, Mauro (1995) argues that corruption reduces investment across developing countries, thereby negatively affecting growth while Reinikka and Svensson (2004, 2005) find that corruption has detrimental effects on human capital accumulation. Also Gould and Amaro-Reynes (1983), Mauro (1995, 1997), United Nations (2001) and Tanzi and Davoodi (1997) suggest that bureaucratic misconduct seen in the diversion of public funds to where bribes are easiest to collect, imply a bias in the composition of public funds towards low-productivity projects rather than value-enhancing investments.

The preceding research assumes a unidirectional causal relationship that runs from growth to corruption. However, it is quite possible that corruption can lead to economic growth. For instance, Bhattacharyya and Jha (2009) argue that economic growth creates additional resources which allow a country to fight corruption effectively. On the other hand, if more economic growth represents a richer economy this can also increase the probability of individuals getting involved in corruptive activities.

It appears therefore that the causal pattern between corruption and economic growth cannot be determined theoretically and one must undertake an empirical analysis to resolve this issue. It should be noted that the previous empirical investigations undertaken on this association regressed corruption on economic growth or vice versa, which implicitly assumes that corruption or economic growth is exogenous to the model; no analysis allowed for corruption and economic growth to be endogenous and simultaneouslydetermined. By undertaking formal causality tests this paper hopes to rectify this deficiency in the literature.

Employing a set of 42 countries covering the period 1998 to 2009 this study assesses the relationship between corruption and economic growth using both linear and nonlinear panel causality tests. In applying the causality tests the three issues - stationary series; various lag lengths and controlling for omitted variables – often found to be relevant to the outcome of these tests are discussed.

Linear panel causality methods are increasingly becoming quite popular in economic applications (see Hurlin and Venet, 2001; Hurlin, 2004; Craigwell and Moore, 2008; Greenidge et al., 2010). However, few examples exist in the economic literature that use non-linear panel causality tests. In this regard the application here is a first for corruption and growth studies. Given that theoretical growth models indicate that per capita GDP could follow a non-linear process as economies pass through business cycles of growth and recession (Helaly and El-Shishiny, 2002; Zilibotti, 1995; Peretto, 1999 and Matsuyama, 1999) it therefore seems appropriate to conduct non-linearity causal tests on the corruption and growth variables. Additionally, panel impulse response and variance decompositions functions are used to trace the response of the endogenous variable (corruption or growth) to a change in one of the exogenous innovations (either corruption or growth) and determine the relative importance of each of these innovations in explaining the endogenous variables.

The plan for this paper is as follows: the literature review is discussed in section 2, then the empirical linear and non-linear panel causality methods as well as the data are outlined in section 3, followed by the estimated results in section 4 and the final section concludes.

2.0 Literature Review

The findings from the empirical studies on the impact of corruption on economic growth are mixed and in some instances, conflicting. This can be attributed in part to problems of methodology. For instance, some of this research used time series data, others utilized panel data and the remainder employed cross-national data. In addition, these empirical studies have been done on different countries and over different time periods.

A good starting point for this empirical literature review is with the seminal work of Mauro (1995) who investigated the effect of corruption on growth rates of per capita GDP for 16 countries over the era 1960 to 1985. He found that a standard deviation decline in the corruption index leads to an expansion in economic growth by 0.8 percent. Mo (2001) estimated direct and indirect impacts of corruption on economic growth during the period 1970 to 1985 using three transmission mechanisms namely, investment, human capital and political stability. The result indicated that a unit increase in the corruption index reduces the growth rate by about 0.545 percentage point. However, the direct effect of corruption becomes insignificant after controlling for the influence of other variables. Rahmanet al(1999) looked at the impact of corruption on economic growth and gross domestic investment in Bangladesh and provided support for the hypothesis that corruption adversely affects economic growth by decreasing foreign direct investment (FDI). Likewise, Mauro (1998) presented evidence that shows that corruption decreases domestic investment and, in the process, economic growth. In addition, Wei (1997), utilizing data for 14 countries, provided support for the hypothesis that the prevalence of corruption in a recipient country does not encourage FDI. He obtained the coefficients –0.09 and –9.92 for corruption and host country's marginal tax rate respectively.

Another strand of the empirical literature suggests that corruption greases the wheels of economic growth. Rock and Bonnett (2004) found that corruption significantly facilitates economic growth in the newly industrializing economies of East Asia including China, Indonesia, Thailand and Korea. In a paper on Nigeria, Aliyu et al (2008) showed that corruption exerts a significant direct effect on economic growth and an indirect impact via some critical variables like government capital expenditure, human capital development and total employment. The authors discovered that about 20 per cent of the increase in government capital expenditure ends up in private pockets. Freckleton*et al* (2010) examine42developing countries using Panel Dynamic Ordinary Least Squares and look at the relationship between FDI, corruption and economic growth. The results suggest that corruption has a significant positive influence on per capita GDP in the short run but is not significant in the long run. It was also found that lower levels of corruption enhance the impact of FDI on economic growth.

The above studies on corruption have concentrated on its effect on economic growth. Such analyses are usually undertaken with the Ordinary Least Squares method and implicitly assume that economic growth is exogenous. If this assumption does not hold then estimates from these exercises could be biased and inconsistent. Indeed it is quite possible that economic growth can cause corruption as discussed in the introduction where it was proposed that economic growth creates additional resources which could allow a country to fight corruption effectively, or on the other hand, can encourage involvement in corruptive activities. To support this hypothesis, Abed and Davoodi (2002) examined the impact of corruption in transition economies using a panel and cross-sectional data for 25 countries over the period 1994 to 1998. The results show that higher economic growth is significantly associated with lower corruption in both panel and cross-sectional regressions. Bhattacharyya and Jha (2009) assert that economic growth creates additional resources which permit a country to fight corruption effectively. They found that economic growth reduces overall corruption as well as corruption in banking, land administration, education, electricity, and hospitals. Growth however has little impact on corruption perception. In contrast the Right to Information (RTI) Act reduces both corruption experience and corruption perception. The basic result holds after controlling for state fixed effects and various additional covariates. It is also robust to alternative instruments and outlier sensitivity tests.

3.0 Data and Methodology

3.1 Data

Besides corruption (CO) and per capita GDP (GR), the data set consists of several control variables which are augmented to the test equations to check the robustness of the relationship between CO and GR. The control variables utilized are foreign and domestic investment as a percentage of GDP (FDI_GDP) and (Invt_GDP) respectively. These variables are self-explanatory as they are often employed as standard macroeconomic variables in explaining the impact of corruption on per capita growth (see Freckleton et al, 2010).The data utilised in this paper cover the period 1998 to 2009 for 42 markets and were obtained from the International Monetary Fund's International Financial Statistics, the World Bank's Statistics Database and the Transparency International for the corruption index. This latter measure of corruption is preferred because it is commonly used and most readily available. Other proxies of corruption like the World Bank's Control of Corruption index or the corruption index of the International Country Risk Guide lack sufficient degrees of freedom for reliable estimation.

3.2 Methodology

The concept of statistical causation was developed by Granger (1969), where he states that a variable X Granger causes Y, as values of Y are better predicted from the past values of X, than from its own values. Variables could therefore show unidirectional causality as X_t causes Y_t ($X_t \rightarrow Y_t$) or Y_t causes X_t ($Y_t \rightarrow X_t$) or bidirectional causality where $Y_t \rightarrow X_t$ and $X_t \rightarrow Y_t$.

3.2.1 Panel Causality Linear Tests

The causality approach used here is based on panel data which is chosen over the time series version because it increases the number of observations, improves degrees of freedom, reduces collinearity among explanatory variables, exploits both cross-sectional and time-series information and generally leads to greater efficiency in the analysis (Holtz-Eakin et al., 1988; Hurlin and Venet, 2001; Greenidge et al., 2010). The most popular approaches to testing causality using panel data are those developed by Holtz-Eakin et al. (1988), Weinhold (1996) and Nair-Reichert and Weinhold (2001) which allows for variation in the autoregressive coefficients. However this process decreases the degrees of freedom and increases the inefficiency of the estimates unless a 'large time dimension' is included. This deficiency is rectified by Hurlin and Venet (2001) and Hurlin (2004) where the coefficients are treated as constants which improve the number of observations and degrees of freedom leading to greater efficiency of the estimates.

The Hurlin (2004) procedure is adopted in this paper and is based on the following Equation (1):

$$CO_{it} = \eta_i + \sum_{k=1}^{p} \delta_k CO_{it-k} + \sum_{k=0}^{p} \beta_{ik} x_{it-k} + \varepsilon_{it} \tag{1}$$

where CO represents corruption, the individual country specific coefficients are given by η, the autoregressive and regression coefficients on lagged values of corruption and the explanatory variables (x) are denoted by δ and β, respectively, while ε is the error term with classical properties (Moore, 2006; Craigwell, 2006; Craigwell and Moore, 2008; Greenidge et al., 2010). The individual effects η are presumed fixed along with δ and β and the lag order, k, is identical (balanced) for all cross-section units of the panel (Hurlin, 2004). These fixed effects models generally perform well in panel data sets, and provide efficient estimates with or without time varying parameters. Estimates are only less robust if the number of cross sections and time dimensions is small (N=20) and (t=5) respectively which is not the case in the sample used here (see Hurlin, 2004). This paper employs a cross section of approximately (420) and time dimensional of t =11.

Implementing the Hurlin (2004) panel causality methodology starts with checking for homogenous and instantaneous non-causality (*HINC*) which is based on the following Wald coefficient test that all the β s are equal to zero for all individuals *i*and all lags *k:*

$$F_{HINC} = \frac{(SSR_r - SSR_u)/Np}{SSR_u / \left[NT - N(1+p) - p\right]} \tag{2}$$

where SSR_uisthe sum of squared residuals from Equation (1) and $SSR_r$is the restricted sum of squared residuals under null hypothesis that β_k is zero for all *i* and *k.* If the regression coefficients are not significantly different from zero, then the hypothesis is accepted which implies that the variable *x* is not Granger causing *CO* in the sample. Once the result indicates non-causality then there is no need for further testing (Hurlin and Venet, 2001; Hurlin, 2004; Greenidge et al., 2010).

If the null hypothesis is rejected there exists the possibility that a causal relationship for the variables is identical across all countries in the series (Greenidge et al., 2010). This is referred to as the homogeneous causality (*HC*) test which indicates that the regression coefficients are not statistically different across the countries for all lags. The usual Wald statistic is undertaken to check the significance of the coefficients. *HC* is rejected if the Wald statistic given by $F_{HC} = \frac{(SSR_r^{'} - SSR_u)/[(N-1)p]}{SSR_u / \left[NT - N(1+p) - p\right]}$ is significant, where $SSR^{'}_r$ is the residual sum of squares obtained from Equation (1) under H_0.

The rejection of the HC test requires that the regression coefficients must be examined for any statistically significant causal relationships across differing countries. This heterogeneous non-causality (*HENC*) test is one in which the coefficients of the lagged variables are checked to see if all of these terms are equal to zero or statistically different. The Wald statistic for this calculation is given as $F_{HC} = \frac{(SSR_r^{''} - SSR_u)/p]}{SSR_u / \left[NT - N(1+2p) - p\right]}$ where $SSR^{''}_r$ is the residual sum of squaresfrom Equation (1) under the hypothesis that the *k* coefficients are equal to zero only for country *i* (Hurlin and Venet, 2001; Hurlin, 2004; Greenidge et al., 2010).

3.3.2 Panel Causality Non Linear Tests

Growth models will through business cycle changes of highs and lows result in per capita GDP following a non-linear process especially among developing economies (Peretto, 1999). It is appropriate therefore that non-linearity causality tests be performed to check this nature of the relationship between corruption and growth. Non linearity causality tests were first introduced by Baek and Brock (1992a) using nonparametric methods of spatial probabilities. However, their tests failed to provide an appropriate statistic that has similar critical values even if the data being considered is a linear I (0) or non-linear I(1) process and is likewise consistent against non-linearity of either form (Harvey and Leybourne, 2007). The deficiencies in this approach led to Harvey and Leybourne (2007) methodology being adapted in this paper.

Assuming that the hypothesis being tested is $GR \rightarrow CO$, the regression model is written as follows:

$$CO = \beta_0 + \beta_1 GR_{it-1} + \beta_2 GR_{it-2}^2 + \beta_3 GR_{it-3}^3 + \beta_4 \Delta GR_{it-1} + \beta_5 (\Delta GR_{it-1})^2 + \beta_6 (\Delta GR_{it-1})^3 \quad (3)$$

For $CO \rightarrow GR$ the model is expressed as

$$GR = \beta_0 + \beta_1 CO_{it-1} + \beta_2 CO_{it-2}^2 + \beta_3 CO_{it-3}^3 + \beta_4 \Delta CO_{it-1} + \beta_5 (\Delta CO_{it-1})^2 + \beta_6 (\Delta CO_{it-1})^3 \quad (4)$$

As with the linear panel causality approach, the HC tests are performed first to determine if the β_{ik} coefficients are statistically different from zero across all the countries. If the results show significant difference then the null hypothesis is rejected. Next, the HINC statistics are employed to check whether the β_{ik} coefficients are statistically different from zero. If the null hypothesis is rejected the HINC tests on the β_{ik} coefficients for each country is used to determine whether these coefficients are nonlinear and statistically significant.

3.3.3 Panel Impulse Response and Variance Decomposition

Impulse response functions track the effect of a one- time shock to one of the innovations on the current and future values of the endogenous variables. Shocks directly affect the endogenous variable and are transmitted to all other variables through the VAR lag structure (Pesaran, 1988). If the innovations ε_t are uncorrelated, interpretation of the impulse response is more straightforward and easy where the i-th innovation $\varepsilon_{i,t}$ is simply a shock to the i-th endogenous variable $y_{i,t}$. However, most innovations are usually correlated which makes association with a specific variable difficult (Swanson and White, 1997). In order to improve the interpretation of the impulse response, most researchers apply a transformation P to the innovations so they become uncorrelated, i.e. $y_t = P\varepsilon_t \sim (0, D)$, where D is a diagonal covariance matrix.

Unlike impulse responses that trace the effect of a shock in the VAR, variance decomposition separates the variation in an endogenous variable into the component shocks (Campbell, 1991), and hence examines the importance of each random innovation in affecting the variables in the VAR.

4.0 Estimated Results

The validity of the causality tests relies on having stationary series, appropriate lag lengths and incorporating control variables that rule out the possibility of an omitted variable being the driving force of the causal relationship of interest (Feige and Pearce, 1977). So this section starts by exploring the temporal properties of the series. The results indicate that corruption (CO), per capita income (GR), and the controls of foreign and domestic investment as a percentage of GDP ((FDI_GDP) and (Invt_GDP)) are all stationary in levels. The series are also checked for cross sectional dependence, and nonlinearity using the method developed by Pesaran (2007) which combines the cross averages of lagged levels and first differences of the series, known as the cross sectional augmented DF regression (CADF). Note all of the above mentioned results were not reported due to space considerations but are available on request. Once the variables are stationary and independent, the panel Granger causality tests can be conducted on the statistical significance of the regression coefficients using the above mentioned Wald statistics.

4.1 Linear Panel Causality Results

Since the variables are stationary in levels the panel regression equations can be estimated in levels. In this regard two types of panel regression methods are considered; the pooled ordinary least square (OLS) model and the fixed effects model. The pooled OLS model assumes no variation of the coefficients and intercept terms while the fixed effects model allows for variation within each country intercept (Hsiao, 2003; Craigwell and Moore, 2008). The test statistics, based on the two panel regression methods, are given for lags 1 to 3 and statistically significant coefficients suggest that the null hypothesis cannot be accepted and there is causality between the variables. The appropriateness of the lag lengths depends on the values of the regression coefficients; an F test was used to test restrictions on the coefficients at the chosen lag lengths which were determined by the Schwartz Bayesian Criterion (SBC), given the relatively small sample utilized here.

The HC test results seen in Table 1 reveal a strong causal relationship from corruption to economic growth, and a weaker link from economic growth to corruption. These findings suggest that corruption facilitates economic growth in developing countries. To ensure that the model in Table 1 is well specified, foreign and domestic investments as a percentage of GDP are added as control variables. These results are displayed in Table 2. They are similar to those in Table 1 and one can therefore conclude that corruption causes and facilitates economic growth, with a weaker association running from economic growth to corruption.

Table 1: Homogenous and Instantaneous

Non-Causality Tests (No Controls)

	Lags	OLS – Levels	Fixed effects – Levels
$CO \rightarrow GR$	1	17.87***	1.13
	2	16.96***	1.86*
	3	15.93***	2.13**
$GR \rightarrow CO$	1	17.38***	0.99
	2	16.44***	0.17
	3	15.37***	-0.38

Note: ***, ** and * indicates significance at the 1, 5 and 10 percent level, respectively.

Table 2: Homogenous and Instantaneous Non-Causality Tests (With Controls for the Effects of Foreign and Domestic Investment)

	Lags	OLS – Levels	Fixed effects – Levels
$CO \rightarrow GR$	1	12.67***	1.43
	2	13.89***	2.06**
	3	13.03***	3.20***
$GR \rightarrow CO$	1	21.77***	1.67*
	2	18.44***	0.89
	3	19.75***	0.21

Note: ***,** and * indicates significance at the 1,5 and 10percent level, respectively.

With evidence that corruption causes economic growth, country specific causal tests of the HINC form can be conducted (Hood *et al.,* 2008; Craigwell and Moore, 2008). Utilizing the HINC tests, the regression coefficients across countries are statistically different from zero and the null hypothesis is rejected (Table 3). The $HENC$ test is also used to determine if the β_{ik} coefficients are different across countries. Table 4 shows that there is no bi-directional relationship between corruption and economic growth, however there is a unidirectional causal link to economic growth from corruption for 11 markets (Belgium, Brazil, Bulgaria, Chile, Estonia, Hungary, Mexico, Poland, Romania, Turkey and Venezuela). While for Belarus and Uruguay economic growth Granger caused corruption. The other 29 markets were not statistically significant and hence did not indicate any causality between corruption and economic growth.

Table 3: Homogenous Causality Tests

	Lags	OLS – Levels	Fixed effects – Levels
$CO \rightarrow GR$	1	10.89***	0.96
	2	11.54***	2.40***
	3	12.78***	2.03**
$GR \rightarrow CO$	1	13.67***	0.32
	2	14.59***	1.49
	3	14.99***	1.70*

Note: ***, ** and *indicates significance at the 1,5 and 10 percent level of testing, respectively.

Table 4: Heterogeneous Granger Causality Tests

Country	$CO \rightarrow GR$	$GR \rightarrow CO$
Argentina	-0.68	0.46
Belarus	0.91	-2.39**
Belgium	8.08***	0.92
Bolivia	0.33	0.63
Botswana	1.36	-0.93
Brazil	11.78***	-0.86
Bulgaria	2.07**	-0.45
Cameroon	0.27	0.67
Chile	1.92*	-0.15
China	0.63	0.22
Colombia	1.38	0.88
Costa Rica	0.65	-0.005
Ecuador	1.04	-0.50
Egypt	0.24	-0.61
Estonia	5.01***	0.86
Ghana	0.08	0.49
Guatemala	0.25	-0.07
Hungary	3.69***	0.38
Indonesia	0.68	0.98
India	0.27	0.67
Jamaica	0.53	-0.57
Jordan	0.57	-0.22
Kenya	0.12	0.078
Malaysia	1.43	-0.06
Mexico	2.11**	0.10
Namibia	0.76	-0.75
Nicaragua	0.05	-0.35
Pakistan	0.19	0.35
Paraguay	0.61	0.44
Peru	0.30	-0.81
Philippines	0.34	-0.69
Poland	2.67***	0.23
Romania	2.57**	1.46
South Africa	1.01	0.36
El Salvador	0.56	0.35
Senegal	0.18	0.55
Tunisia	0.51	-0.99
Turkey	1.88*	1.19
Uganda	0.10	0.36
Ukraine	1.42	-0.07
Uruguay	0.34	2.65***
Venezuela	2.53**	-0.80

4.2 Non Linear Panel Causality Results

Using Equations (3) and (4) non-linear Granger causality can be determined for corruption and economic growth (Tables 5 and 6). The results show that the hypothesis of corruption Granger causing economic growth is rejected contrasting with the acceptance findings from the hypothesis that economic growth Granger causes corruption.

Table 5: Non-Linear Causality Results: Dependent Variable (CO)

Causal Variable	Lags	Coefficient	t-statistic
GR	1	0.001	24.81***
GR^2	2	-0.0008	-16.76***
GR^3	3	-0.000017	0.016
ln(GR)	1	-0.0010	-4.54***
$\ln(GR)^2$	1	-0.00224	-3.79***
$\ln(GR)^3$	1	0.0016	1.74*

Note: ***,** and * indicates significance at the 1,5 and 10 percent level of testing, respectively.

Table 6: Non-Linear Causality Results: Dependent Variable (GR)

Causal Variable	Lags	Coefficient	t-statistic
CO	1	50.59	0.15
CO^2	2	308.3	2.86***
CO^3	3	-7.37	-0.70
ln(CO)	1	5.85	0.44
$\ln(CO)^2$	1	-5.14	-0.38
$\ln(CO)^3$	3	7.52	0.61

Note: ***,** and * indicates significance at the 1,5 and 10 percent level of testing, respectively.

As in the linear panel causality investigations, the appropriateness of the lag lengths is determined using an F test along with the SBC statistic. Likewise as there is evidence of causality, country specific non-linear panel causal checks are made utilizing the HC and HINC tests (Table 7) which determine if the coefficients are statistically different from zero across the countries. The results show that eight markets (Argentina, Belgium, Brazil, Hungary, Mexico, Poland, Turkey and Venezuela) have a significant non-linear causal relationship from corruption to economic growth while there were bi-directional links for Argentina, Brazil, Mexico, Poland and Venezuela, and 21 markets revealed that economic growth Granger lead corruption. The other markets were not statistically significant and hence no causal pattern can be discerned between corruption and economic growth.

Table 7: Heterogeneous Granger Non-Linear Causality Tests

Country	$CO \rightarrow GR$	$GR \rightarrow CO$
Argentina	2.33**	2.19**
Belarus	0.054	1.08
Belgium	7.69***	1.39
Bolivia	0.25	1.75*
Botswana	-0.06	2.18**
Brazil	10.92***	-4.42***
Bulgaria	0.78	1.55
Cameroon	0.24	1.78*
Chile	-0.33	2.83***
China	-0.04	2.80***
Colombia	0.97	0.93
Costa Rica	0.42	0.42
Ecuador	1.20	-0.03
Egypt	-0.08	1.03
Estonia	1.49	0.56
Ghana	-0.60	2.12**
Guatemala	0.49	0.76
Hungary	2.16**	-1.20
Indonesia	0.59	1.48
India	-0.18	2.98***
Jamaica	0.98	-0.12
Jordan	-0.31	4.12***
Kenya	-0.05	2.10**
Malaysia	0.54	1.06
Mexico	2.91***	-3.06***
Namibia	-0.27	2.20**
Nicaragua	-0.14	2.25**
Pakistan	-0.02	2.12**
Paraguay	0.63	1.05
Peru	-0.04	1.43
Philippines	-0.02	1.34
Poland	2.22**	-1.99**
Romania	1.52	0.35
South Africa	0.38	1.44
El Salvador	0.36	2.25**
Senegal	-0.36	2.82***
Tunisia	-0.31	2.40**
Turkey	1.98**	-0.70
Uganda	-0.25	2.54**
Ukraine	0.81	1.51
Uruguay	0.78	2.35**
Venezuela	2.92***	-2.08**

Note: ***,** and * indicates significance at the 1,5 and 10 percent level respectively.

4.3 Panel Impulse Response Function

The tabular results of a shock equal to one standard deviation (S.D) of GR and CO variables are displayed in Tables 8 and 9 respectively. The findings reveal that a GR innovation has a positive impact on economic growth and corruption throughout the eight periods. However, in Table 9 a CO shock has a smaller effect on the two variables immediately from the first period. The results in Table 8 show that the GR innovation causes GR in the first period to expand by 3484.76 and CO by 617 and by round 2 (one period ahead), GR has now fallen by 2895.37, while CO has declined to 537. For the CO innovation, the findings reveal that economic growth changes marginally to 0.026 by the third round when “shocked” by corruption innovation, while corruption contracts marginally to 0.33 for the same period after starting at values of 0.37 and 0.34 in the earlier rounds. The error terms are included in brackets.

Table 8: Effect of One S.D Economic Growth Innovation

Period (Annual)	CO	GR
1	617 (163)	3484 (114)
2	537 (214)	2895 (191)
3	550 (177)	2352 (186)
4	552 (162)	1916 (205)
5	550 (158)	1563 (222)
6	545 (160)	1278 (230)
7	537 (164)	1047 (229)
8	527 (168)	859 (222)

Table 9: Effect of One S.D Corruption Innovation

Period (Annual)	CO	GR
1	0.37 (0.01)	0.000 (0.000)
2	0.34 (0.02)	0.02 (0.01)
3	0.33 (0.01)	0.026 (0.019)
4	0.32 (0.02)	0.029 (0.02)
5	0.30 (0.021)	0.031 (0.028)
6	0.29 (0.02)	0.03 (0.03)
7	0.28 (0.02)	0.033 (0.034)
8	0.27 (0.02)	0.033 (0.036)

4.4 Panel Variance Decomposition

The results outlined in Table 10 below show the variance decomposition of economic growth (GR) following a shock to the GR innovations of 3484. Given the ordering corruption – economic growth, the entire change in growth in the first round (100%) resulting from the shock to the GR innovations is due to this initial shock. This shock to the GR innovations also causes an immediate change in the corruption variable, but the resulting adjustment in corruption has an immediate effect itself on economic growth at this point (3.04%). The corruption variable continues to have an impact on economic growth in round two, when it accounts for 3.16% of the change in economic growth, with GR still accounting for the main portion of 96.83%. For the 10 period, however corruption influences on economic growth increases to 7.5% on economic growth at the end of the variance period. On examination of the lower half of the table which traces the variation of economic growth and corruption due to an initial shock of 0.37 to the corruption variable. This shock has full effect on corruption and none on economic growth. In the second period the corruption shock accounts for 99.80% of the variation in the corruption variable, while economic growth accounts for the rest of the variation and ends at 0.89% in the last period with corruption accounting for 99.10%.

Table 10: Panel Variance Decomposition

Variance Decomposition of Economic Growth (GR)			
Variance Period (Yr)	Standard Error (S.E)	Corruption (CO)	Economic Growth (GR)
1	3484	3.04	96.95
2	4604	3.16	96.83
3	5199	3.60	96.39
4	5569	4.12	95.87
5	5810	4.68	95.31
6	5974	5.26	94.73
7	6089	5.85	94.14
8	6172	6.42	93.57
Variance Decomposition of Corruption (CO)			
1	Standard Error (S.E) 0.37	CO 100	GR 0.00
2	0.51	99.80	0.19
3	0.61	99.67	0.32
4	0.69	99.57	0.42
5	0.75	99.47	0.52
6	0.81	99.38	0.61
7	0.86	99.30	0.69
8	0.90	99.23	0.76

5.0 Conclusion

This paper aims at determining the causal relationship between economic growth and corruption in 42 developing countries using linear and non-linear panel methods over the period 1998 to 2009. The findings show that the outcome of the causal association depends on the method used. With the linear panel methods the evidence shows that there is a strong causal association from corruption to economic growth and a weaker link from economic growth to corruption. The unidirectional causal link to economic growth from corruption occurs in 11 markets (Belgium, Brazil, Bulgaria, Chile, Estonia, Hungary, Mexico, Poland, Romania, Turkey and Venezuela), while the reverse pattern is seen for Belarus and Uruguay. The other 29 markets were not statistically significant and hence did not indicate any causality between corruption and economic growth. These findings suggest that corruption facilitates economic growth in *some* developing countries but certainly should not be treated as a universal fact as adopted by many researchers.

The causal results from the non-linear procedures are quite different from those of the linear methods in that corruption Granger caused economic growth for eight markets (Argentina, Belgium, Brazil, Hungary, Mexico, Poland, Turkey and Venezuela), there were bi-directional links for Argentina, Brazil, Mexico, Poland and Venezuela and 21 markets revealed that economic growth Granger lead corruption. The other markets imply no causality between corruption and economic growth.

The general value of the above results is that adequate institutional facilities must be in place in developing economies to reduce losses from corruption especially within and after periods of economic growth.

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