TITLE OF PROPOSAL: **THE CAUSALITY BETWEEN CORRUPTION, POVERTY AND GROWTH: A PANEL DATA ANALYSIS**

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INTRODUCTION AND PROBLEM STATEMENT

A key requirement of sustained economic growth is that the governance and equity system be under control. Despite its increased recognition, however, this important prerequisite is often difficult to meet by developing but also by developed countries. Given that most countries have constitutional or statutory limitations restricting their ability to run economic recessions or slowdowns [e.g., see Tanner and Liu (1994), Quintos (1995)], the question of whether the governance and/or equity system is a good predictor for economic growth or vice versa is of high significance for examining whether and how this requirement can be met [e.g., see Bohn and Inman (1996)].

While many studies have examined the relationship between (i) corruption and development, (ii) corruption and growth, (iii) corruption and poverty [e.g., see Bardhan, 1997; Tanzi, 1995, 1997a; UNDP, 1997; Mauro, 1995; Knack and Keefer, 1996; Tanzi and Davoodi, 1997; Abed et al., 1998], the question of whether a causal relationship exists between, corruption, poverty and economic growth based on panel data models, has received less attention, particularly for African countries. In this research we aim at filling this gap by extending the existing literature on this matter.

Indeed, a burgeoning empirical literature suggests that the absence of corruption accelerate economic growth, these studies generally do not simultaneously examine poverty development. More specifically, Tanzi and Davoodi (1997) show that the absence of corruption helps explain economic growth, while Gupta et al. (1998) show that the positive relationship between the absence of corruption and growth is not due to simultaneity bias. They omit measures of poverty developments because measures of poverty developments for a twenty-year period are only available for about 40 countries. Omitting the poverty variables make it difficult to assess whether (i) the negative relationship between corruption and growth when controlling for poverty, is due mainly to corruption (ii) corruption and poverty each have an independent impact on economic growth, or (iii) corruption and poverty matter for growth but it is difficult to identify their separate impact on economic growth.

This research differs from existing studies on causality between the corruption, poverty and economic growth based on panel data in five significant respects: First, it is based on recent causality methods developed for panel data [e.g., see De Melo, 1999; Frankel and Romer, 1999; King and Levine, 1993b; Levine, 1998 and 1999; Levine and Zervos., 1998; Levine, et al., 2000; Mauro, 1997]. Second, in view of recent economic recessions and slowdowns many developing countries and particularly african countries are still experiencing, this paper expects to shed light on whether these economic imbalances (which could eventually prove unsustainable), could be resolved by a clear and comprehensible understanding of the link between governance and/or equity system and economic growth. Third, large and persistent economic recessions and slowdowns were heightened by the Mexican crisis of 1994 and its contagion effects in many developing countries. This calls attention to the risks and temptation to attribute economic recessions and slowdowns to corrupted and/ or poor countries and vice versa. Fourth, the apparent failure of traditional factors explaining economic recessions and slowdowns has spurred renewed interest in the study of 'early-warning' indicators that could help predict the emergence of economic recessions and slowdowns crises [e.g., see Gian et al., 1996]. Fifth, this study provides evidence on the governance and/or equity system and economic growth relationship debate by using international data from a sample of African countries. The use of international data enhances the robustness of our empirical findings by potentially revealing general and specific information on the vastly different economies of the countries studied. For example, in some African countries with relatively high economic growth rates, the judiciary system and the redistribution process are likely to provide a substantial confidence and solidity in institutions. For these countries, therefore, the configuration of institutions may affect the degree of corruption and the redistribution system without transmitting them to the economic growth process. By contrast, other African countries with modest or even negative economic growth rates, the absence of a secured juridical environment, the impact and distributional consequences of corruption [e.g., see Deininger and Squire, 1996; Ravallion and Chen, 1997], the exacerbation of the state of poverty and inequality in these countries, have certainly hindered efficient development programs and therefore could have affected economic growth.

Our analysis of different country episodes follows a non-structural, case study approach. This allows us to take into consideration a broader set of factors than those that can be encompassed in a testable, state-of-the-art model of economic recessions and slowdowns explanation. Finally, we view this approach as complementary to studies previously conducted on developing countries. Thus, the study offers a new avenue to a number of potential explaining indicators of economic recessions and slowdowns insufficiently or never investigated.

From the above perspectives, the approach discussed here is an extension of the ones adopted by Abed et al. (1998), Bardhan (1997), Knack and Keefer (1996), Mauro (1995), Tanzi (1995, 1997a), Tanzi and Davoodi (1997), and UNDP (1997), respectively. The study is based on 'stylized facts' in Africa, because of long traditional economic imbalances in African countries. Since their independence in the 1960s, African countries have experienced many economic disturbances including economic recessions, economic slowdowns and contractions, coupled with high rates of corruption and / or poverty rates. In addition major international development agencies have typically identified the African continent as a place where corruption, poverty and low or even negative economic growth co-exist, perhaps peacefully but actively. The co-existence of these major contributors to economic growth rates, not only creates a vicious circle, but also elect this, *ipso facto*, for a serious empirical investigation.

1. OBJECTIVES

The main purpose of this paper is to increase the understanding of the relationship between corruption, poverty and growth using cross country data and based on the notion of causality in the context of panel data.

The specific objectives are:

- To determine whether corruption causes growth or vice-versa;
- To determine whether poverty causes growth or vice-versa;
- To determine whether it is the combine effect of corruption and poverty that causes growth.

3. DATA AND RESEARCH METHODS

We analyze the link between corruption, poverty and growth in a panel of 42 African countries for the 1960-2000 time period (depending on availability). The data will be obtained from the SIMA database of the World Bank. Moving to a panel from pure cross-sectional data allows us to exploit the time-series dimension of the data and deal rigorously with simultaneity. The theories we are evaluating focus on the long-run relationships between corruption, poverty and economic growth.

To measure *corruption*, six corruption indicators are used throughout this paper in order to evaluate the sensitivity of the empirical results. The first (*Corruption 1*) is from the *International Country Risk Guide (ICRG)* and the *Business International (BI)* [as used by Tanzi and Davoodi, 1997], averaged between 1980 and 1995. The ICRG index reflects the assessment of foreign investors on the degree of corruption in an economy. Investors are asked whether high government officials are likely to demand special payments and whether illegal payments are generally expected throughout lower levels of government as bribes connected with import and export licenses, exchange controls, tax assessment, police protection, or loans. The ICRG index has been rescaled and spliced with the BI index so that the combined index ranges from 0 (most corrupt) to 10 (least corrupt).

Proxies two through six are the *Transparency International* corruption perception indices for 1995 (*Corruption 2*), 1996 (*Corruption 3*), 1997 (*Corruption 4*), an expanded 1997 index (*Corruption 5*) and a historical corruption index averaged over the 1988 – 92 period (*Corruption 6*). The expanded 1997 corruption index was constructed by Johann Lambsdorff (forthcoming) by applying the same technique as *Transparency International* , but includes countries for which a minimum two survey sources were available.

To measure *poverty*, we use three alternative poverty indicators. These indicators are: the headcount ratio *(poverty 1*), the poverty gap (*poverty 2*) and poverty severity (*poverty 3*). We also use cross-country data that determine overall income growth in the economy [e.g., see Sala-I-Martin 1997; and Sachs and Warner 1997]. We therefore define a measure of change in poverty as the income growth of the bottom 20 percent of the population *(poverty 4).* The rate of change of the income of the bottom 20 percent is chosen as a measure of poverty because it is less prone to measurement errors than levels of poverty. Another advantage of this formulation is that it is unaffected by country-specific factors that influence the level of poverty. These different indicators are used to allow comparison of their different impact on the causality results.

To assess the strength of the independent link between both corruption and growth

and poverty and growth, we control for other potential determinants of economic growth in our regressions. In the *simple conditioning information set* we include the initial real GDP per capita to control for convergence and the average years of schooling to control for human capital accumulation. In the *policy conditioning information set*, we use the simple conditioning information set plus either (i) the share of exports and imports to GDP, (ii) the inflation rate or (iii) the ratio of government expenditures to GDP.

As to the research methods, while Tanzi an Davoodi (1997) show that corruption, poverty are robust predictors of economic growth, their results do not imply a causal link between the corruption, poverty, and economic growth. To control for possible simultaneity, they use initial values of corruption and poverty. Using initial values of the explanatory variables, however, implies not only an efficiency (informational) loss but also a potential consistency loss. If the contemporaneous behavior of the explanatory variables matters for current growth, we run the risk of grossly mis-measuring the 'true' explanatory variables by using initial values, which could bias the coefficient estimates. Using proper instruments for the contemporaneous values of the explanatory variables is therefore preferable to using initial values.

To test the causal relationship between COR_t, POV_t and GDP_t , we consider three econometric approaches: time series, panel data and the SUR models.

(i) A VAR Time Series Model

Granger-causality analysis was first developed by Granger (1969). The definition of (uni-directional) causality is that: 'GDP_t and POV_t are Granger causing COR_t, if we are better able to predict COR_t using all available information than if the information apart from GDP_t and POV_t have been used' [e.g., see Granger, 1969; pp. 428]. Instantaneous causality occurs when 'the current value of COR_t is better predicted if the present value of GDP_t and POV_t are included in the prediction than if they are not' [e.g., see Granger, 1969; pp. 429].

Recent development of Granger-causality analysis is associated with the concept of cointegration, the existence of a long-run equilibrium relation between two non-stationary series [e.g., see Engle and Granger, 1991]. Cointegrated series may move differently in the short run, but economic forces keep them drifting apart [e.g., see Barnerjee at al., 1993; Engle and Granger, 1991].

Engle and Granger (1991) have shown that, if series are cointegrated, standard Granger-causality tests are mis-specified, and error-correction models (ECM) should be used instead. Consequently, Granger-causality between COR_t, POV_t and GDP_t is tested based on four models.

For one country, if COR_t , POV_t and GDP_t are cointegrated, ECM representations could have the following form:

$$\Delta COR_t = \alpha_1 + \sum_{k=1}^{p} \beta_{1,k} \Delta COR_{t-k} + \sum_{k=1}^{q} \gamma_{1,k} \Delta GDP_{t-k} + \sum_{k=1}^{l} \varphi_{1,k} \Delta POV_{t-k} + \Theta_1 \mu_{t-1} + \zeta_{1,t} \quad (1)$$

H_0: $\gamma_{1,k} = 0$; $\varphi_{1,k} = 0$, $\forall$ $k = 1, \ldots, q$; $\forall$ $k = 1, \ldots, l$ and $\Theta_1 = 0$

$$\Delta COR_t = \alpha_2 + \sum_{k=1}^{p} \beta_{2,k} \Delta COR_{t-k} + \sum_{k=0}^{q} \gamma_{2,k} \Delta GDP_{t-k} + \sum_{k=0}^{l} \varphi_{2,k} \Delta POV_{t-k} + \Theta_2 \mu_{t-1} + \zeta_{2,t} \quad (2)$$

H_0: $\gamma_{2,0} = 0$; $\varphi_{2,0} = 0$ and $\Theta_2 = 0$

$$\Delta POV_t = \alpha_3 + \sum_{k=1}^{p} \beta_{3,k} \Delta COR_{t-k} + \sum_{k=1}^{q} \gamma_{3,k} \Delta GDP_{t-k} + \sum_{k=1}^{l} \varphi_{3,k} \Delta POV_{t-k} + \Theta_3 \mu_{t-1} + \zeta_{3,t} \quad (3)$$

H_0: $\beta_{3,k} = 0$; $\gamma_{3,k} = 0$, $\forall$ $k = 1, \ldots, p$; $\forall$ $k = 1, \ldots, l$ and $\Theta_3 = 0$

$$\Delta POV_t = \alpha_4 + \sum_{k=0}^{p} \beta_{4,k} \Delta COR_{t-k} + \sum_{k=0}^{q} \gamma_{4,k} \Delta GDP_{t-k} + \sum_{k=1}^{l} \varphi_{4,k} \Delta POV_{t-k} + \Theta_4 \mu_{t-1} + \zeta_{4,t} \quad (4)$$

H_0: $\beta_{4,0} = 0$; $\gamma_{4,0} = 0$ and $\Theta_4 = 0$

$$\Delta GDP_t = \alpha_5 + \sum_{k=1}^{p} \beta_{5,k} \Delta COR_{t-k} + \sum_{k=1}^{q} \gamma_{5,k} \Delta GDP_{t-k} + \sum_{k=1}^{l} \varphi_{5,k} \Delta POV_{t-k} + \Theta_5 \mu_{t-1} + \zeta_{5,t} \quad (5)$$

H_0: $\beta_{5,k} = 0$; $\varphi_{5,k} = 0$, $\forall$ $k = 1, \ldots, p$; $\forall$ $k = 1, \ldots, l$ and $\Theta_5 = 0$

$$\Delta GDP_t = \alpha_6 + \sum_{k=0}^{p} \beta_{6,k} \Delta COR_{t-k} + \sum_{k=1}^{q} \gamma_{6,k} \Delta GDP_{t-k} + \sum_{k=0}^{l} \varphi_{6,k} \Delta POV_{t-k} + \Theta_6 \mu_{t-1} + \zeta_{6,t} \quad (6)$$

H_0: $\beta_{6,0} = 0$; $\varphi_{6,0} = 0$ and $\Theta_6 = 0$

where: COR_t , POV_t and GDP_t are defined as corruption, poverty and growth. All variables are stationary time series, Δ is the difference operator. In Equations 1 to 6, the α's, β's, γ's, φ's and Θ's are time invariant coefficients, p, q and l are optimal lags of the series COR_t, POV_t and GDP_t respectively, ζ_{it}'s are serially uncorrelated random error terms, and the μ_{t-1}'s are the lagged values of the error-correction terms derived from the long-run cointegrating equation[1].

Equation 1 tests the hypothesis that GDP_t and POV_t do not Granger cause COR_t [i.e., H_0: $\gamma_{1,k} = 0$; $\varphi_{1,k} = 0$, $\forall$ k = 1, …, q; $\forall$ k = 1, …, l and $\Theta_1 = 0$]. Equation 2 tests the hypothesis that GDP_t and POV_t do not instantaneously Granger cause COR_t [i.e., H_0: $\gamma_{2,0} = 0$; $\varphi_{2,0} = 0$ and $\Theta_2 = 0$][2]. Equation 3 tests that GDP_t and COR_t do not Granger cause POV_t, in Granger's sense, i.e., H_0: $\beta_{3,k} = 0$; $\gamma_{3,k} = 0$, $\forall$ $k = 1, ..., p$; $\forall$ $k = 1, ..., l$ *and* $\Theta_3 = 0$.

Equation 4 tests the hypothesis that GDP_t and COR_t do not instantaneously Granger cause POV_t *iff* H_0: $\beta_{4,0} = 0$; $\gamma_{4,0} = 0$ *and* $\Theta_4 = 0$ is rejected. Equation 5 tests the hypothesis that COR_t and POV_t do not Granger cause GDP_t , i.e., H_0: $\beta_{5,k} = 0$; $\varphi_{5,k} = 0$, $\forall$ $k = 1, ..., p$; $\forall$ $k = 1, ..., l$ *and* $\Theta_5 = 0$ is rejected. The last case considers that COR_t and POV_t do not instantaneously Granger cause GDP_t *iff* H_0: $\beta_{6,0} = 0$; $\varphi_{6,0} = 0$ *and* $\Theta_6 = 0$.

Other causality cases are considered as well. For example, in the first case GDP_t can Granger cause COR_t while POV_t does not. A case which can be tested based on:

H_0: $\gamma_{1,k} = 0$; $\forall$ $k = 1, ..., q$; $\exists$ *at least one* $\varphi_{1,k} \neq 0$ *and* $\Theta_1 = 0$.

The error-correction models allow one to distinguish between short and long-term causality [e.g., see Engle and Granger, 1991]. For example, in Equation 1, GDP_t and POV_t can Granger cause COR_t either through ΔGDP_{t-k} *if* $\gamma_{1,k} \neq 0$ *and* $\varphi_{1,k} \neq 0$, $\forall$ $k = 1, ..., q$; $\forall$ $k = 1, ..., l$ *or through* μ_{t-1} *[if* $\Theta_1 \neq 0$*]*. The former is a short-run dynamic adjustment in response to recent changes in GDP_t and POV_t, whereas the latter is a long-run relation between COR_t and GDP_t and POV_t [e.g., see Engle

[1] Note that this representation is valid only for the case of exactly one cointegrating vector. With a dimension of two, only one vector would also be possible.

[2] Engle and Granger (1991) note that: '… Often, it is desirable to introduce the current value of ΔCOR into the … equation making it a 'structural form' equation than a 'reduced form' relation. This can always be done but will, of course, change the interpretation of all the coefficients but the cointegration coefficient' (pp. 10).

and Granger, 1991]. The short-run effect is tested with χ^2 or F [assuming that the errors are independent and identically normally distributed], and the long-run effect with t-statistics.

If the null hypothesis tested with Equation 1 is rejected, it suggests that GDP_t and POV_t do Granger-cause COR_t, or exogenous GDP_t and POV_t.

If the null hypothesis tested with Equation 2 is rejected, then there is an instantaneous feedback relationship between COR_t, POV_t and GDP_t .

If the null hypothesis tested with Equation 3 is rejected, it suggests that GDP_t and COR_t do Granger-cause POV_t, or endogenous POV_t.

If no null hypothesis is rejected, for example in equation 1, then COR_t, POV_t and GDP_t , are causally independent, in Granger's sense.

The long-run multipliers measure the cumulative effect on a variable of a permanent change in other variables, holding everything else constant [e.g., see Greene, 2003]. Long-run multiplier estimation relies on Equations 2, 4 and 6 with past and current effects. The long-run multiplier of COR_t on POV_t and GDP_t [denoted $LRM_{COR\rightarrow POV,\ GDP}$], the long-run multiplier of POV_t on COR_t and GDP_t [denoted $LRM_{POV\rightarrow COR,\ GDP}$] and the long-run multiplier of GDP_t on COR_t and POV_t [denoted $LRM_{GDP\rightarrow COR,\ POV}$] are based on Equation 5:

$$\left.\begin{array}{l}
LRM_{COR\rightarrow POV,GDP}=\dfrac{\sum_{k=0}^{q}\gamma_{2,k}+\sum_{k=0}^{l}\varphi_{2,k}}{1-\sum_{k=1}^{p}\beta_{2,k}} \\
LRM_{POV\rightarrow COR,GDP}=\dfrac{\sum_{k=0}^{p}\beta_{4,k}+\sum_{k=0}^{q}\gamma_{4,k}}{1-\sum_{k=1}^{l}\varphi_{4,k}} \\
LRM_{GDP\rightarrow COR,POV}=\dfrac{\sum_{k=0}^{p}\beta_{6,k}+\sum_{k=0}^{l}\varphi_{6,k}}{1-\sum_{k=1}^{q}\gamma_{6,k}}
\end{array}\right\} \qquad (7)$$

The standard error of the long-run multiplier is obtained from the variance-covariance matrix of the estimated coefficients as in Chao and Buongiorno (2001):

$$V(LRM) = \left[\frac{\partial\, LRM}{\partial c_1}\right]' \sum\nolimits_1 \left[\frac{\partial\, LRM}{\partial\, c_1}\right] \qquad (8)$$

where c_1 is the vector of parameters in Equation 2: $c_1 = \{\gamma_{2,0},...,\gamma_{2,q};\varphi_{2,0},...,\varphi_{2,l};\beta_{2,1},...,\beta_{2,p}\}$; $\sum_1$ is the variance-covariance matrix of c_1; the partial derivatives are with respect to each element of c_1. The LRM's give information on the magnitude of adjustment, and its speed [e.g., see Greene, 2003]. Likewise, we define the variance-covariance matrix of the estimated coefficients in Equations 4 and 6.

(ii) Common Effects Panel Model

A major limitation of annual data is that there are few of them for each country. Panel data models can be used to increase the degrees of freedom, widen the range of variables, and generalize results across cross-sectional units.

With the common effects panel model, Equations 1 to 6 become:

$$\Delta COR_{it} = \alpha_1 + \sum_{k=1}^{p}\beta_{1,k}\Delta COR_{it-k} + \sum_{k=1}^{q}\gamma_{1,k}\Delta GDP_{it-k} + \sum_{k=1}^{l}\varphi_{1,k}\Delta POV_{it-k} + \Theta_1\mu_{it-1} + \zeta_{1,it} \qquad (9)$$

$$\Delta COR_{it} = \alpha_2 + \sum_{k=1}^{p}\beta_{2,k}\Delta COR_{it-k} + \sum_{k=0}^{q}\gamma_{2,k}\Delta GDP_{it-k} + \sum_{k=0}^{l}\varphi_{2,k}\Delta POV_{it-k} + \Theta_2\mu_{it-1} + \zeta_{2,it} \qquad (10)$$

$$\Delta POV_{it} = \alpha_3 + \sum_{k=1}^{p}\beta_{3,k}\Delta COR_{it-k} + \sum_{k=1}^{q}\gamma_{3,k}\Delta GDP_{it-k} + \sum_{k=1}^{l}\varphi_{3,k}\Delta POV_{it-k} + \Theta_3\mu_{it-1} + \zeta_{3,it} \qquad (11)$$

$$\Delta POV_{it} = \alpha_4 + \sum_{k=0}^{p}\beta_{4,k}\Delta COR_{it-k} + \sum_{k=0}^{q}\gamma_{4,k}\Delta GDP_{it-k} + \sum_{k=1}^{l}\varphi_{4,k}\Delta POV_{it-k} + \Theta_4\mu_{it-1} + \zeta_{4,it} \qquad (12)$$

$$\Delta GDP_{it} = \alpha_5 + \sum_{k=1}^{p} \beta_{5,k} \Delta COR_{it-k} + \sum_{k=1}^{q} \gamma_{5,k} \Delta GDP_{it-k} + \sum_{k=1}^{l} \varphi_{5,k} \Delta POV_{it-k} + \Theta_5 \mu_{it-1} + \zeta_{5,it} \tag{13}$$

$$\Delta GDP_{it} = \alpha_6 + \sum_{k=0}^{p} \beta_{6,k} \Delta COR_{it-k} + \sum_{k=1}^{q} \gamma_{6,k} \Delta GDP_{it-k} + \sum_{k=0}^{l} \varphi_{6,k} \Delta POV_{it-k} + \Theta_6 \mu_{it-1} + \zeta_{6,it} \tag{14}$$

$$i = 1, \ldots, N; \;\; t = 1, \ldots, T$$

where: N is the number of countries, and T is the number of years.

Causality testing procedures between COR_t, POV_t and GDP_t based on common effects panel models follow the same lines as in Equations 1 to 6.

(iii) Fixed Effects Panel Model

A common formulation of fixed effects panel models assumes that differences across countries can be captured in differences in the constant term. This model is also known as the least squares with dummy variables (LSDV) or analysis of covariance model. With the fixed effect panel model, Equations 1 to 6 become:

$$\Delta COR_{it} = \sum_{i=1}^{N} D_i \alpha_{1,i} + \sum_{k=1}^{p} \beta_{1,k} \Delta COR_{it-k} + \sum_{k=1}^{q} \gamma_{1,k} \Delta GDP_{it-k} + \sum_{k=1}^{l} \varphi_{1,k} \Delta POV_{it-k} + \Theta_1 \mu_{it-1} + \zeta_{1,it} \tag{15}$$

$$\Delta COR_{it} = \sum_{i=1}^{N} D_i \alpha_{2,i} + \sum_{k=1}^{p} \beta_{2,k} \Delta COR_{it-k} + \sum_{k=0}^{q} \gamma_{2,k} \Delta GDP_{it-k} + \sum_{k=0}^{l} \varphi_{2,k} \Delta POV_{it-k} + \Theta_2 \mu_{it-1} + \zeta_{2,it} \tag{16}$$

$$\Delta POV_{it} = \sum_{i=1}^{N} D_i \alpha_{3,i} + \sum_{k=1}^{p} \beta_{3,k} \Delta COR_{it-k} + \sum_{k=1}^{q} \gamma_{3,k} \Delta GDP_{it-k} + \sum_{k=1}^{l} \varphi_{3,k} \Delta POV_{it-k} + \Theta_3 \mu_{it-1} + \zeta_{3,it} \tag{17}$$

$$\Delta POV_{it} = \sum_{i=1}^{N} D_i \alpha_{4,i} + \sum_{k=0}^{p} \beta_{4,k} \Delta COR_{it-k} + \sum_{k=0}^{q} \gamma_{4,k} \Delta GDP_{it-k} + \sum_{k=1}^{l} \varphi_{4,k} \Delta POV_{it-k} + \Theta_4 \mu_{it-1} + \zeta_{4,it} \tag{18}$$

$$\Delta GDP_{it} = \sum_{i=1}^{N} D_i \alpha_{5,i} + \sum_{k=1}^{p} \beta_{5,k} \Delta COR_{it-k} + \sum_{k=1}^{q} \gamma_{5,k} \Delta GDP_{it-k} + \sum_{k=1}^{l} \varphi_{5,k} \Delta POV_{it-k} + \Theta_5 \mu_{it-1} + \zeta_{5,it} \tag{19}$$

$$\Delta GDP_{it} = \sum_{i=1}^{N} D_i \alpha_{6,i} + \sum_{k=0}^{p} \beta_{6,k} \Delta COR_{it-k} + \sum_{k=1}^{q} \gamma_{6,k} \Delta GDP_{it-k} + \sum_{k=0}^{l} \varphi_{6,k} POV_{it-k} + \Theta_6 \mu_{it-1} + \zeta_{6,it} \tag{20}$$

$$i = 1, \ldots, N; \;\; t = 1, \ldots, T$$

where: D_i are dummy variables [equal to 1 for country i, 0 otherwise]; N is the number of countries, and T is the number of years.

If we are interested in differences across countries, then we can test the hypothesis that the constant terms are all equal with an F test. The F ratio used for the test is:

$$F_{[n-1,\, nT-n-K]} = \frac{\left(R^2_{LSDV} - R^2_{Pooled}\right) / (n-1)}{\left(1 - R^2_{LSDV}\right) / (nT - n - K)} \tag{21}$$

where LSDV indicates the dummy variable model and Pooled indicates the pooled or restricted model with only a single overall constant term. Alternatively, the model may have been estimated with an overall constant and (n – 1) dummy variables instead.

Note also that since our panels are unbalanced, some minor modifications are required in computing the different parameters [e.g., see Greene, 2003, pp. 293].

Causality testing procedures between COR_t, POV_t and GDP_t based on fixed effects panel models follow the same schemes as in Equations 1 to 6.

(iv) Random Effects Panel Model

The fixed effects model is a reasonable approach when we can be confident that the differences between countries can be viewed as parametric shifts of the regression function. This model might be viewed as applying only to the cross-countries in the study, not to additional ones outside the sample. For example, an inter-country comparison may well include the full set of countries for which it is reasonable to assume that the model is constant. In other settings, it might be more appropriate to view individual specific constant terms as randomly distributed across-countries. This view would be appropriate if we believed that sampled cross-countries were drawn from a large population.

Consider, then, a reformulation of the previous model

$$\Delta COR_{it} = \alpha_1 + \sum_{k=1}^{p} \beta_{1,k} \Delta COR_{it-k} + \sum_{k=1}^{q} \gamma_{1,k} \Delta GDP_{it-k} + \sum_{k=1}^{l} \varphi_{1,k} \Delta POV_{it-k} + \Theta_1 \mu_{it-1} + \sum_{i=1}^{N} D_i \varsigma_{1,i} + \zeta_{1,it} \quad (22)$$

$$\Delta COR_{it} = \alpha_2 + \sum_{k=1}^{p} \beta_{2,k} \Delta COR_{it-k} + \sum_{k=0}^{q} \gamma_{2,k} \Delta GDP_{it-k} + \sum_{k=0}^{l} \varphi_{2,k} \Delta POV_{it-k} + \Theta_2 \mu_{it-1} + \sum_{i=1}^{N} D_i \varsigma_{2,i} + \zeta_{2,it} \quad (23)$$

$$\Delta POV_{it} = \alpha_3 + \sum_{k=1}^{p} \beta_{3,k} \Delta COR_{it-k} + \sum_{k=1}^{q} \gamma_{3,k} \Delta GDP_{it-k} + \sum_{k=1}^{l} \varphi_{3,k} \Delta POV_{it-k} + \Theta_3 \mu_{it-1} + \sum_{i=1}^{N} D_i \varsigma_{3,i} + \zeta_{3,it} \quad (24)$$

$$\Delta POV_{it} = \alpha_4 + \sum_{k=0}^{p} \beta_{4,k} \Delta COR_{it-k} + \sum_{k=0}^{q} \gamma_{4,k} \Delta GDP_{it-k} + \sum_{k=1}^{l} \varphi_{4,k} \Delta POV_{it-k} + \Theta_4 \mu_{it-1} + \sum_{i=1}^{N} D_i \varsigma_{4,i} + \zeta_{4,it} \quad (25)$$

$$\Delta GDP_{it} = \alpha_5 + \sum_{k=1}^{p} \beta_{5,k} \Delta COR_{it-k} + \sum_{k=1}^{q} \gamma_{5,k} \Delta GDP_{it-k} + \sum_{k=1}^{l} \varphi_{5,k} \Delta POV_{it-k} + \Theta_5 \mu_{it-1} + \sum_{i=1}^{N} D_i \varsigma_{5,i} + \zeta_{5,it} \quad (26)$$

$$\Delta GDP_{it} = \alpha_6 + \sum_{k=0}^{p} \beta_{6,k} \Delta COR_{it-k} + \sum_{k=1}^{q} \gamma_{6,k} \Delta GDP_{it-k} + \sum_{k=0}^{l} \varphi_{6,k} \Delta POV_{it-k} + \Theta_6 \mu_{it-1} + \sum_{i=1}^{N} D_i \varsigma_{6,i} + \zeta_{6,it} \quad (27)$$

$$i = 1, \ldots, N; \quad t = 1, \ldots, T$$

where: D_i are dummy variables (equal to 1 for country i, 0 otherwise); N is the number of countries, and T is the number of years.

To examine the appropriateness of the random effect panel model, we test the statistical significance of the random effects. Breusch and Pagan (1980) have devised a Lagrange multiplier test for the random effects model based on the OLS residuals, that is:

$$H_0: \sigma_\zeta^2 = 0 \ \ vs. \ H_a: \sigma_\zeta^2 \neq 0 \quad (28)$$

The test statistic is:

$$LM = \frac{nT}{2(T-1)} \left[\frac{\sum_{i=1}^{n} \left[\sum_{t=1}^{T} \varsigma_{i,t} \right]^2}{\sum_{i=1}^{n} \sum_{t=1}^{T} \varsigma_{i,t}^2} - 1 \right]^2 \text{ or } LM = \frac{nT}{2(T-1)} \left[\frac{\sum_{i=1}^{n} \left[T \bar{\varsigma}_{i.} \right]^2}{\sum_{i=1}^{n} \sum_{t=1}^{T} \varsigma_{i,t}^2} - 1 \right]^2 \quad (29)$$

Under the null hypothesis, LM is distributed as χ^2 with one degree of freedom.

In addition, an inevitable question is, which model (fixed or random models) should be used? It is possible to test for orthogonality of the random effects and the regressors. The specification test has been devised by Hausman (1978). It is based on the idea that under the hypothesis of no correlation, both OLS in the LSDV model (fixed effect panel model) and GLS (random effect panel model) are consistent, but OLS is inefficient, whereas under the alternative, OLS is consistent, but GLS is not. Therefore, under the null hypothesis, the two estimates should not differ systematically, and a test can be based on the differences. Thus, we test for:

H_0: Absence of systematic differences between the coefficients of the two panel models,

vs.

H_a: Presence of random effects, i.e., presence of systematic differences between the coefficients of the two panel models,

The Wald test statistic is:

$$W = \left(\beta_{Fixed} - \beta_{Random}\right)' \left(\sum_{Fixed} - \sum_{Random}\right)^{-1} \left(\beta_{Fixed} - \beta_{Random}\right) \qquad (30)$$

where: β_{Fixed} and β_{Random} are the two estimates of the β matrix based on the fixed and random panel models, respectively; $\sum_{Fixed}$ and $\sum_{Random}$ their associated covariance matrix. Under the null hypothesis, W is distributed as χ^2 with (K-1) degrees of freedom, K representing the number of estimated parameters excluding the constant term.

However, unbalanced panels add a new layer of difficulty in the random effects model than they had in the LSDV model and major modifications are required in computing the different parameters [e.g., see Greene, 2003, pp. 316]. In particular, in order to estimate the random effects models, we need some additional parameter estimates. The GLS transformation for the specific group i is:

$$\theta_i = 1 - \frac{\sigma_{\varsigma_i}}{\sqrt{\sigma^2_{\varsigma_i} + T_i \sigma^2_{\varsigma}}}$$

(31)

Therefore, for computing the appropriate feasible generalized least squares estimator, we need only devise consistent estimators for the variance components and then apply the GLS transformation. One possible way to proceed is as follows: Since the pooled OLS is still consistent, OLS provides a usable set of residuals. Using the OLS residuals for the specific groups, we would have, for each group,

$$\sigma^2_{\varsigma_i} + \varsigma^2_i = \frac{e_i' e_i}{T} \qquad (32)$$

The residuals from the dummy variable model are purged of the individual specific effect, ς_i, so $\sigma^2_{\varsigma_i}$ may be consistently (in T) estimated with

$$\hat{\sigma}^2_{\varsigma_i} = \frac{\left(e_i^{LSDV}\right)' \left(e_i^{LSDV}\right)}{T}$$

(33)

Combining terms, then

$$\hat{\sigma}^2_{\varsigma} = \frac{1}{n}\sum_{i=1}^{n}\left[\left(\frac{\left(e_i^{OLS}\right)' \left(e_i^{OLS}\right)}{T}\right) - \left(\frac{\left(e_i^{LSDV}\right)' \left(e_i^{LSDV}\right)}{T}\right)\right] = \frac{1}{n}\sum_{i=1}^{n}\left(\hat{\varsigma}^2_i\right) \qquad (34)$$

We can now compute the FGLS estimator.

Causality testing procedures between COR_t, POV_t and GDP_t based on random effects panel models proceed as in Equations 1 to 6.

(v) SUR Methods

The drawback of the panel models described above is that they assume that the β's, γ's and Θ's parameters are the same in all countries. A more flexible approach is the seemingly unrelated regression (SUR) method or Zellner's method, which allows parameters to vary across countries, while accounting for heteroskedasticity, and contemporaneous correlation in the errors across equations [e.g., see Greene, 2003]. Here, correlated disturbance across countries is plausible because, in principle, all countries compete in the same international financial markets. In addition, exogenous shocks such as economic depression might affect all countries' COR_t and GDP_t simultaneously. The SUR models are the same as Equations 1 to 4; however the parameters are estimated simultaneously by maximum likelihood.

To test for uni-directional or bi-directional or instantaneous causality between COR_t, POV_t and GDP_t , we proceed as in Equations 1 to 6.

4. APPLICATIONS OF THE RESEARCH RESULTS

Knowing the causal directions between corruption, poverty and economic growth is essential to make any informed decision on growth and thereby on the growth process. How does corruption affect growth? How does poverty interfere on growth? Could growth be sustained with an unsound governance system? Could the growth be sustained with an unsound social equity system? Do corruption and poverty have independent impacts on growth? These are few questions that the proposed research would like to address. It is clear from the literature that growth can be enhanced through the governance system not to mention the re-distribution process. Indeed, governance system can boost productive investment. In doing so they contribute to growth. Moreover, governance system and the re-distribution system can affect productivity through specialization of resources (greater division of labor) and hence, contribute to growth. Hence, results from the study will motivate decision makers actions towards reforming the governance and re-distribution system and greater attention to it.

Poverty also affects growth. For example, if the re-distribution system is weak and does not perform well, it will impact negatively on growth. Investigating the causal relationship between poverty and growth will give a strong indication to decision makers to pay greater attention to the re-distribution system and equity. If the re-distribution system is such that low and medium social classes have a limited consumption power, growth will suffer.

Analysing simultaneously corruption, poverty and growth could shed light on how these variables can develop synergy and boost growth. Results from such an investigation will help policy makers in making informed policy decisions. Results will also be helpful to scientists and academics by providing them with empirical evidence on the relationship between simultaneously corruption, poverty and growth. Results will also open-up new area and avenue of empirical research investigation. Another issue that the paper will address is that, cross-section and time series data taken alone cannot tackle the question of causality in a satisfactory way. Panel data are more suited for such a task.

5. EXPECTED RESULTS

It is clear from past research that there is a causal link between simultaneously corruption, poverty and growth. We expect such results. We also expect that using governance variables and poverty indicators will reinforce their impact on growth. With respect to the causal relationship between these variables, we expect the following causal link:

- Corruption does not cause economic growth;
- Growth does not cause corruption;
- Poverty does not cause economic growth;
- Growth does not cause poverty;
- Both corruption and poverty do not cause economic growth;
- Growth does not cause both corruption and poverty;

The paper will also analyze heterogeneity, autocorrelation as well as sample size issues and see how they affect the causality results. In addition, guidance will be given as to actions / strategies necessary to substantially reduce corruption and poverty so as to improve economic growth.

Results of the present study will:

- be published as policy briefs;
- be published as working papers;
- be disseminated as interim reports in University libraries as well as in national and regional seminaries;
- be published in international refereed journals;

6. PROJECT TIMELINE

Activities	**M. 1**	**M. 2**	**M. 3**	**M. 4**	**M. 5**	**M. 6**	**M. 7**	**M. 8**	**M. 9**	**M. 10**	**M. 11**	**M. 12**
Data acquisition												
Data processing												
Submission of first draft for peer review and revision												
Submission of revised draft to SAGA												
Revision of second draft												
Submission of final draft												

Submission of article for publication in a refereed scientific journal												
Seminar presentations and working papers preparations												

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APPENDIX: LIST OF COUNTRIES INCLUDED IN THE PANEL

1. Angola	15. Guinea	29. People Rep. of Congo
2. Benin	16. Ivory Coast	30. Reunion
3. Botswana	17. Kenya	31. Rwanda
4. Burkina Faso	18. Lesotho	32. Senegal
5. Burundi	19. Liberia	33. Seychelles
6. Cameroon	20. Madagascar	34. Sierra Leone
7. Chad	21. Malawi	35. Somalia
8. Comores	22. Mali	36. South Africa
9. Democratic Rep. of Congo	23. Mauritania	37. Sudan
10. Djibouti	24. Mauritius	38. Swaziland
11. Ethiopia	25. Mozambique	39. Tanzania
	26. Namibia	

12. Gabon	27. Niger	40. Togo
13. Gambia	28. Nigeria	41. Zambia
14. Ghana		42. Zimbabwe