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The relationships between corruption and pollution on corruption regimes

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Abstract

Previous studies have focused mainly on the effect of corruption on pollution. The results of these studies show an inverted U-shaped relationship between economic growth and pollution. In addition, some researchers have suggested that corruption plays an important role in determining pollution. This study proposes the hypothesis of a nonlinear long-run relationship between pollution and corruption. The goal of the study is to investigate the threshold cointegration effect of pollution on corruption using panel data for 62 countries over the period from 1997 to 2004. The results show that the effect of the Corruption Perceptions Index (CPI) on pollution is insignificant in low-corruption regimes. This implies that corruption does not slow down environmental pollution in countries with low corruption. The impact of the CPI on environmental pollution is also insignificant in high-corruption regimes. This result implies that corruption has no adverse impact on environmental pollution in countries with high corruption.

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1. Introduction

The positive effect of economic growth on pollution and the relationship between economic growth and pollution has been widely discussed in previous studies. Previous literature (Cole, Elliott, and Fredriksson, 2006; Cole and Fredriksson, 2009; López and Mitra, 2000) has argued that the quality of a political institution plays an important role in environmental pollution. In addition, some studies (Cole, 2006; Farzin and Bond, 2006; Leitão, 2006; López and Mitra, 2000; Zugravu, Millock and Duchene, 2008) have discussed the relationship between corruption and environmental quality, and found that the impact of corruption on environmental policies has a negative effect, while the impact of democracy has a positive effect. Hence, a reduced corruption level induces higher growth rates and stricter environmental policies (Pellegrini and Gerlagh, 2006).

As in previous studies (Cole, 2006), Pellegrinia and Gerlagh (2006) have shown that corruption has a positive and direct effect on sulphur dioxide (SO_2) and carbon dioxide (CO_2) emissions, and an indirect effect on both pollutants via per capita income. Leitão (2006) also supports the result that the relationship between environment and income is influenced by corruption level, and shows that countries with high corruption have high income per capita before reaching the turning point of the EKC (environmental Kuznets curve) inverted-U shape. Farzin and Bond's (2006) study supports the result that the interacting term of qualities of political institutions and various indicators of societal preference create an inverted-U shaped relationship between pollution and income. Previous studies (Fredriksson and Svensson, 2003; Zugravu et al., 2008) indicate that corruption significantly reduces the stringency of environmental policy policy, but that this effect is reduced as political instability increases. Therefore, political instability reduces the stringency of environmental policy with low corruption levels. In other words, political instability has a negative effect on the stringency of environmental regulation when corruption levels are low, but a positive effect when corruption is high. Zugravu et al. (2008) find that political instability reduces corruption in transition and emerging economies, but that this effect is weak in industrialized economies. Thus, corruption may influence environmental quality.

The above-mentioned studies investigate the relationship between corruption and pollution quality using a linear approach, while ignoring the nonlinear relationship between two variables using a threshold autoregressive model. The goal of this study is to test whether the long-run relationship between corruption and pollution is nonlinear.

2. Empirical Approach

If a linear model is used as the empirical model for the effect of corruption on pollution, it can be expressed as follows:

$$PO_t = \alpha + \beta CPI_t + \varepsilon_t \tag{1}$$

where PO denotes the pollutant emissions; CPI_t denotes the level of corruption and is scaled from 0 (defined as most corrupt) to 10 (defined as least corrupt).

If pollution and CPI variables are integrated of order one, that is, *I*(1), it is possible to find a stationary linear combination among integrated variables in levels. When these variables are cointegrated, it implies that a long-term equilibrium exists in Equation (1). Given the existence of a single cointegrating vector in Equation (1), the linear error-correction model can be written as follows

$$\Delta X_t = \Lambda + \alpha w_{t-1} + \sum_{i=1}^{p} \Gamma_i \Delta X_{t-i} + \varepsilon_t \tag{2}$$

where, $\Delta X_t = \begin{bmatrix} \Delta PO_t \\ \Delta CPI_t \end{bmatrix}$, $\Lambda = \begin{bmatrix} \mu_1 \\ \mu_2 \end{bmatrix}$, $\Gamma_i = \begin{bmatrix} \theta_{11i}\theta_{12i} \\ \theta_{21i}\theta_{22i} \end{bmatrix}$ and $\varepsilon_t = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}$.

Note that p is the lag length, Δ is the difference operator, w_{t-1} is error-correction term, Λ and $\Gamma_i (i = 1,...p)$ are vector autoregression parameters to be estimated, and ε_t is the stochastic disturbance term. According to Hansen and Seo (2002), all coefficients, excluding the cointegrating vector α, are allowed to vary with the regimes if the presence of a threshold effect is shown in Equation (1). Thus, if the empirical model is nonlinear, linear modeling may cause problems of misspecification and misleading conclusions regarding cointegration. To check this, we applied Hansen and Seo's (2002) Lagrange multiplier (LM) test to determine the presence of a threshold effect. If the error-correction model has a threshold effect, a two-regime threshold cointegration model can be rewritten as follows:

$$\Delta X_t = \begin{cases} A_1' X_{t-1}(\beta) + \mu_t & \text{if } w_{t-1}(\beta) \le \gamma \\ A_2' X_{t-1}(\beta) + \mu_t & \text{if } w_{t-1}(\beta) > \gamma \end{cases} \tag{3}$$

with

$$X_{t-1}(\beta) = \begin{bmatrix} 1 \\ w_{t-1}(\beta) \\ \Delta X_{t-1} \\ \vdots \\ \Delta X_{t-p} \end{bmatrix} \tag{4}$$

Where A_1 and A_2 are coefficient matrices in each of the regimes, μ_t is an error term, and γ is a threshold value that needs to be estimated.

The threshold model (3) has two regimes, defined by the value of the error-correction term. Hansen and Seo (2002) propose heteroskedastic-consistent LM test statistics, that is, *sup*LM, to test threshold cointegration. In addition, they used the bootstrap method to calculate asymptotic critical values and *p*-values for the *sup*LM test.

3. Empirical Results

The sample data comprise eight years of panel data from 1997 to 2004 covering 62 countries. We use Transparency International's (TI) corruption-perceptions-index (CPI) to measure corruption, which is often applied in empirical studies to capture bureaucratic corruption in a broad empirical scope[1]. Corruption is defined by TI as the misuse of entrusted power for private gain. The corruption index is a composite index based on a variety of assessments created on the basis of elite business surveys or expert panels. The score[2] for each country is standardized via a matching percentiles technique before being averaged into the CPI. The corruption index in this study is rescaled from 0 (defined as least corrupt) to 10 (defined as most corrupt). In addition, data on CO_2 emissions per capita and the growth rates of these emissions are taken from the World Bank Global Development Network Growth Database.

Regarding the stationarity of a set of series, the conventional unit root test suffers from the problem of low power because it ignores the cross-section trend. Levin, Lin, and Chu (2002) proposed a panel unit-root test (LLC test) to solve the problem of the conventional unit root test. The test assumes a common unit root process for all series. In this study, we applied Levin et al.'s (2002) panel unit-root test to determine whether the data are stationary. Table 1 shows that the null hypothesis for stationarity, in level and first difference, can be rejected at the 1 percent significance level. This implies stationarity of these variables.

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[1] Although the World Bank's control of corruption index and the international country risk guide are the popular measures of corruption, the former are only available for the periods of 1996, 1998, 2000, and from 2002 to 2008. Additionally, the latter are computed monthly by the assessments of the staff and have very few changes in the covered countries in most months. Although the methodology of calculating TI's corruption index changes over time, the TI's data are historical annually and available for the period from 1995 to 2009, therefore, can capture most bureaucratic corruptions in a broader empirical scope.

[2] Its value ranges between 10 (highly clean) and 0 (highly corrupt).

Table 1 Unit root test for variables

Variables	Level	First difference
CO_2R	–11.998 (0.000)***	–5.7E+12 (0.0000)***
CO_2P	–16.111 (0.000)***	–50.057 (0.0000)***
CPI	–10.189(0.0000)***	–25.349 (0.0000)***

Notes: The values in parentheses are *p*-values, and *** denotes significant at the 1 percent level. Exogenous variables in the LLC test include individual effects and individual linear trends.

The goal of this study is to investigate the effects of CPI on CO_2 growth rates and CO_2 per capita. Regarding the long-run effect of CPI on CO_2 growth rate, the estimated cointegrating relationship is $w_t = CO_2R_t - 0.494 \times CPI_t$. For the *sup*LM test statistics proposed by Hansen and Seo (2002), the asymptotic *p*-value with a fixed regressor is 0.000, implying that the null of linear cointegration can be strongly rejected at the 5 percent significance level. The estimated threshold value γ is estimated at -0.95, where the error-correction term is used as the threshold variable. Countries falling into $w_{t-1} \le -0.95$ and $w_{t-1} > -0.95$ regimes account for 0.51 percent and 0.49 percent of the observations, respectively. The first regime occurs as $CO_2R_{t-1} \le 0.494 \times CPI_{t-1} - 0.95$, implying that CO_2 growth rate is more than 0.95 percentage points below the CPI. In addition, the second regime occurs as $CO_2R_{t-1} > 0.494 \times CPI_{t-1} - 0.95$. Thus, the first and second regimes are denoted as high-corruption and low-corruption regimes, respectively.

Regarding the effect of CPI on the CO_2 per capita, the estimated cointegrating relationship is $w_t = CO_2P_t - 0.723 \times CPI_t$. For the *sup*LM test statistic, the *p*-value with the fixed regressor is 0.000, implying that the null of linear cointegration can be strongly rejected at the 5 percent significance level. The estimated threshold value γ is estimated at 1.92, where the error-correction term is used as the threshold variable. Countries falling into $w_{t-1} \le 1.92$ and $w_{t-1} > 1.92$ regimes account for 0.51 percent and 0.49 percent of the observations, respectively. Thus, the first regime occurs as $CO_2P_t \le 0.723 \times CPI_t + 1.92$, implying that the CO_2 per capita is more than 1.92 percentage points above the CPI. Moreover, the second regime occurs when $CO_2P_t > 0.723 \times CPI_t + 1.92$. Thus, the first and second regimes are denoted as high-corruption and low-corruption regimes, respectively.

The two-regime threshold VAR for the effects of CPI on CO_2 growth rate are expressed as follows:

$$\Delta CO_2R_t = \begin{cases} 0.010 + 0.001w_{t-1} - 0.210\Delta CO_2R_{t-1} - 0.018\Delta CPI_{t-1} + u_{1_t}, w_{t-1} \le -0.95 \\ (0.019)\ (0.006)\quad (0.119)\qquad\qquad (0.016) \\ 0.027 + 0.063w_{t-1} - 0.260\Delta CO_2R_{t-1} - 3.614\Delta CPI_{t-1} + u_{2_t}, w_{t-1} > -0.95 \\ (0.247)\ (0.118)\quad (0.350)\qquad\qquad (3.034) \end{cases} \tag{5}$$

$$\Delta CPI_t = \begin{cases} 0.012 + 0.007w_{t-1} - 0.190\Delta CO_2R_{t-1} - 0.079\Delta CPI_{t-1} + u_{3_t}, w_{t-1} \le -0.95 \\ (0.077)\ (0.025)\quad (0.381)\qquad\qquad (0.072) \\ -0.017 - 0.001w_{t-1} - 0.004\Delta CO_2R_{t-1} - 0.071\Delta CPI_{t-1} + u_{4_t}, w_{t-1} > -0.95 \\ (0.022)\ (0.000)^{*}\quad (0.004)\qquad\qquad (0.096) \end{cases} \tag{6}$$

where the figures in parentheses in Equations (5) and (6) are Eicker-White standard errors. '*' denotes significance at 5% level.

The two-regime threshold VAR for the effects of CPI on the CO_2 per capita are expressed as follows:

$$\Delta CO_2P_t = \begin{cases} 0.013 - 0.004w_{t-1} - 0.060\Delta CO_2P_{t-1} - 0.004\Delta CPI_{t-1} + u_{5_t}, w_{t-1} \le 1.92 \\ (0.047)\ (0.013)\quad (0.117)\qquad\qquad (0.057) \\ 0.030 + 0.006w_{t-1} + 0.340\Delta CO_2P_{t-1} - 0.108\Delta CPI_{t-1} + u_{6_t}, w_{t-1} > 1.92 \\ (0.064)\ (0.009)\quad (0.103)\qquad\qquad (0.181) \end{cases} \tag{7}$$

$$\Delta CPI_t = \begin{cases} -0.031 - 0.007w_{t-1} - 0.183\Delta CO_2P_{t-1} - 0.072\Delta CPI_{t-1} + u_{7_t}, w_{t-1} \le 1.92 \\ (0.033)\ (0.009)\qquad (0.083)^{*}\qquad\qquad (0.070) \\ -0.013 + 0.001w_{t-1} - 0.018\Delta CO_2P_{t-1} - 0.060\Delta CPI_{t-1} + u_{8_t}, w_{t-1} > 1.92 \\ (0.044)\ (0.004)\qquad (0.025)\qquad\qquad (0.097) \end{cases} \tag{8}$$

where the figures in parentheses in Equations (7) and (8) are Eicker-White standard errors. '*' denotes significance at 5% level.

The estimation of the error-correction term in threshold VAR, w_{t-1}, allows for a straightforward investigation into the behavior of the gap between environmental pollution and corruption. The relationships between ΔCO_2P and ΔCPI as well as ΔCO_2R and ΔCPI both have minimal error-correction effects and minimal dynamics. The sign and magnitude of these coefficients are used to analyze the adjustment process by which long-run equilibrium between environmental pollution and corruption is restored. Error-correction terms in Equations (5) and (6) are insignificant at the 5 percent significance level, but significant at the same level in the second regime in corruption equation. In addition, based on Equations (7) and (8), error-correction terms in CO_2 per capita and corruption equation are insignificant at the 5 percent significance level. This finding shows an error-correction effect in corruption.

4. Conclusions

This study models the long-run relationship between pollution and corruption for 62 countries over the period from 1997 to 2004. This study also provides a better empirical description of the long-run relationship between pollution and corruption. Our empirical methodology used Hansen and Seo's (2002) threshold cointegration approach to consider the possibility of a nonlinear relationship between pollution and corruption.

The results showed that the null hypothesis of linear cointegration would be rejected in favor of a two-regime threshold cointegration model. In the short-run, corruption has an insignificant negative impact on environmental pollution. The result implies that corruption does not create an obvious impact on environmental quality in countries with high corruption. According to the results, in the short run, environmental pollution is not influenced by corruption in any regime. Thus, corruption does not slow down environmental pollution.

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