

Özşahin, Şerife; Üçler, Gülbahar

## Article

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Article

# The Consequences of Corruption on Inflation in Developing Countries: Evidence from Panel Cointegration and Causality Tests

Şerife Özşahin <sup>1,\*</sup>  and Gülbahar Üçler <sup>2</sup> 

<sup>1</sup> Department of Economics, Necmettin Erbakan University, Konya 42090, Turkey

<sup>2</sup> Department of Economics, Ahi Evran University, Kırşehir 40100, Turkey; gulbahar.ucler@ahievran.edu.tr

\* Correspondence: sozsahin@konya.edu.tr; Tel.: +90-332-325-2024

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**Abstract:** Up until the 1980s, studies on corruption were dominated by disciplines of public administration and sociology. In the following years, however, economists have also provided a good amount of research on this issue. According to Transparency International Agency, corruption, which has a negative impact on most macroeconomic indicators, is “the abuse of entrusted power for private gain”. Even though the disruption of corruption causing weak growth and investment rates has long been examined, there is little evidence regarding its impact on inflation. In this study, the nexus between corruption and inflation was investigated for 20 countries over the period 1995–2015. Estimation results indicated that high corruption increased inflation rates, and that there was a unidirectional causal relationship from corruption to inflation for ten countries in the sample.

**Keywords:** corruption; inflation; heritage foundation; panel data analysis

**JEL Classification:** D73; E31; C33

## 1. Introduction

Corruption is a multidimensional issue with far-reaching effects and is highly related to disciplines of sociology, political science, history, economics, and public administration. Thus, it is quite difficult to make an exact and comprehensive definition of corruption. Corruption has been defined as “the use of public office for private gain” (Gray and Kaufman 1998; Rose-Ackerman 1999; Lambsdorff 2007). In another definition by Shleifer and Vishny (1993), corruption was defined as the “sale by government officials of government property for personal gain”. However, with recent developments, it is inadequate to define corruption only as the abuse of public office. Corruption, which has a more comprehensive scope, is based on the transfer of benefits among the parties and the return offered. The International Transparency Agency defines corruption as “the abuse of entrusted power for private gain”, and evaluates both the public and private sector. As understood from these definitions, to speak about corruption, one needs to exercise their power, and some people need to benefit from the use of this power. Based on this definition, all crimes such as bribery, embezzlement, dishonesty, misconduct, and favoritism can be considered as corruption.

Until recently, studies evaluated corruption as a practice against public morality within the framework of criminal law. Within this scope, studies have mainly focused on the reasons behind it, and the social consequences of corruption. However, with the measurement of corruption, studies started being conducted to reveal the relationship between corruption and macroeconomic variables such as economic growth and investments. The main difficulty faced by the researchers while conducting studies to measure the economic effects of corruption is the way in which corruption is measured and the reliability of this measurement. The measurement of corruption is mainly made through the

examination of perception levels of some segments of the population. The best indexes developed in this respect are the Bribe Payers Index (BPI), the Global Corruption Barometer (GCB), the Control of Corruption Index, the Corruption Perceptions Index (CPI), the Freedom from Corruption, and Business International.

The role of the state in economic and government policies, the structure of the tax system, inequality in income distribution, poverty, inflation, low wages, commercial limitations, low rates of employment, competitive power of the economy, and level of openness and informal economy are among the economic factors that may lead to corruption (Akçay 2001, pp. 44–45). The most destructive effect of corruption on the economy is seen in investments, economic growth, and economic development. High rates of corruption lead to a decrease in investments and slow down economic growth. As a result, companies may postpone their investments in the country, or they may shift their investments to another state. Furthermore, corruption reduces the efficiency of public expenditure and the quality of the existing infrastructure, increases the cost of doing business, and eventually hampers economic growth. Other adverse effects of corruption include damage to income distribution, the prevention of the efficient use of economic resources, and inflation (Al-Marhubi 2000, p. 199).

In addition to these negative effects, some views have proposed that corruption helps save the time lost in bureaucracy and thus leads to efficiency and development. Corruption, which mainly occurs in the form of bribery in countries with a complex bureaucratic system and a weak institutional structure, shortens the time spent on bureaucratic practices and accelerates investments. According to Leff (1964) and Lui (1985), since corruption is a transfer payment from the bribe giver to the bureaucrats, it does not create a social cost.

Although there has been no consensus on the positive and negative effects of corruption on economic indicators, the general view is that its negative effects will outweigh the positive ones in the long run. Corruption emerges as a negative construct that erodes property rights, harms political institutions and complicates the nature of economic development (Hodge et al. 2011). To eliminate the destruction in societies caused by corruption, which was described as a “cancer” by Wolfensohn, the former president of the World Bank, it is of great significance to implement effective policies and methods against corruption (Bhargava 2006, p. 341).

This study aimed to determine the direction of the effects of corruption on inflation by using the data from 20 selected developing countries for the period between 1995 and 2015. Within the scope of this study, following the introduction section, which gives the fundamental definitions about the topic, the theoretical background on the relationship between corruption and inflation is outlined in Section 2. Section 3 presents a review of the literature, and Section 4 describes the dataset and empirical model. Section 5 includes explanations of the econometric method and comments on the empirical findings. The study is concluded with a general evaluation.

## 2. Theoretical Background on the Relationship between Corruption and Inflation

The studies that examined the relationship between corruption and inflation found a positive and significant relationship between the change in the rate of inflation and corruption. In this respect, it is possible to cite many reasons that may lead to the relationship between corruption and inflation. Some of these reasons are listed below:

Nordhaus (1975) stated that voters were sensitive to inflation and unemployment rates, and that their choices during the election period were shaped by these two indicators. According to Nordhaus, opportunist political parties used their existing public authority and increased government spending in order to be re-elected in the short term and to remain in power. Politicians financed the budget deficits created by the increase in government overspending taxes, which hurts the voters. Thus, the political authority chooses to finance budget deficits through emission to eliminate this negative impact. Increasing the volume of money through emission leads to inflation. According to Catao and Terrones (2005), in countries with high corruption levels and weak prosecution system, seigniorage becomes the primary source of income for governments.

Moreover, corruption reduces efficiency by preventing the efficient distribution of economic and public resources. The transfer of these resources from productive fields to less-controllable and manipulated projects negatively affects financial performance. This efficiency loss in public space reflects negatively on the private sector after some time and decreases economic performance. To cover the costs (which increase due to corruption), domestic and foreign borrowing is applied, which in turn increases inflation rates and the risk level of the country. This process has a direct deterrent effect on foreign investors and leads to an increase in exchange rates and current account deficit problems. As a result of this vicious circle, the increase in the volume of emission to cover the costs also triggers inflationist pressures.

Therefore, high levels of public deficits and an ineffective tax system in a country render seigniorage necessary to finance these deficits. Governments generate income through the monetization of the fiscal deficit under the name of seigniorage and inflation tax. According to optimal tax theory, tax evasion and tax collection costs may cause governments to turn to inflation tax as a source of income. In particular, it is possible to witness this situation in countries where tax evasion and tax collection costs are at high levels. In their study conducted by using data from 169 countries for the period between 1960 and 1999, [Aisen and Veiga \(2008\)](#) found that the income developing countries earned from seigniorage was five times as high as the income the developed nations received.

On the other hand, an increase in the general level of prices is expected to create more opportunities for illegal and unethical behaviors such as theft and fraud ([Braun and Tella 2004](#), p. 80). High inflation is a problem, which reduces the income of individuals and groups, impairs income distribution, and increases uncertainty in the economy. Due to the rapid and continuous decrease in purchasing power, people may seek ways to illegally generate income ([Al-Marhubi 2000](#), p. 200). Thus, high inflation rates determine how public resources are used, and increasing the activities of rent-seeking, reaping a speculative profit, and lobbying may lead to economic degeneration ([Rahmani and Yousefi 2009](#), p. 3).

Wrong macroeconomic policies pursued to finance high public expenditures cause high budget and current account deficits and trigger inflation. The weak institutional structure of a country creates further pressure, particularly in periods of high inflation. In such an environment, investors cannot protect their property rights, which creates an environment conducive to corruption ([Samimi et al. 2012](#), p. 392).

When a general evaluation is made, it can be said that a two-way relationship exists between inflation and corruption. As corruption increases in a country, capital flows to other countries and taxable resources decrease. A reduction in tax revenue and the increase in public expenditure render emission necessary, which creates an inflationist effect. On the other hand, an acceleration in inflation and continuously changing prices enhance economic uncertainty, reduce purchasing power, and cause people to be involved in corruption to generate extra income.

### 3. Literature Review

[Bliss and Tella \(1997\)](#), [Ades and Tella \(1999\)](#), [Choi and Thum \(1999\)](#), and [Svensson \(2005\)](#) outlined an extensive theoretical background on the economic causes of corruption and its effects. However, empirical tests on the effect of corruption on economic activities were conducted later due to the difficulties experienced in measuring the corruption. With the measurement of corruption and the increase in the number of databases, it became possible to analyze the economic effects of corruption, which led to the construction of literature on this topic. The majority of the studies in this field have focused on the relationship between corruption and macroeconomic indicators such as the rate of economic growth, GDP per capita, the structure of the market, the rate of investment, public expenditures, the volume of foreign direct investment, inflation, and international trade.

[Knack and Keefer \(1995\)](#), [Mo \(2001\)](#), [Leite and Weidmann \(2002\)](#), [Neeman et al. \(2004\)](#), [Pellegrini and Gerlagh \(2008\)](#), [Méon and Sekkat \(2005\)](#) and [Ahmad \(2008\)](#) revealed that corruption negatively affected economic development and GDP per capita. As a result of the analysis conducted

for 68 countries, [Mauro \(1995\)](#) found that corruption had adverse effects not only on economic development, but also on investments and the structure of official institutions. On the other hand, [Aidt et al. \(2008\)](#) argued that corruption negatively affects economic development in countries with high institutional quality, whereas corruption did not have any impact on economic growth in countries with low institutional quality. In their study conducted in Nigeria, [Aliyu and Elijah \(2008\)](#) found that corruption negatively affected economic development, the development of human capital, and total employment. [Dridi \(2013\)](#) investigated the effect of corruption on macroeconomic indicators such as investment, human capital, political instability, inflation, public expenditure, and openness using data from 82 countries for the period between 1980 and 2002. The findings of the study revealed that corruption negatively affected growth through low human capital and political instability.

According to [Abed and Davoodi \(2002\)](#) and [Smarzynska and Wei \(2000\)](#), corruption had a dissuasive effect—similar to tax—on foreign direct investments. The increase in the corruption index created a negative impact on foreign direct investments. [Bandeira et al. \(2001\)](#) maintained that capital efficiency, human capital efficiency, and the total efficiency factor decreased as a result of corruption. [Barreto \(2001\)](#), [Li et al. \(2000\)](#), and [Gyimah-Brempong \(2002\)](#) found a significant positive relationship between corruption and income inequality. Furthermore, [Li et al. \(2000\)](#) tried to reveal the rate at which the increase in corruption increased income inequality.

In addition to the negative impacts, some arguments in favor of corruption are also seen in the literature. Such arguments claim that corruption eliminates the bureaucratic structure that delays the financial decisions and prevents investments, thus accelerating growth. According to [Leff \(1964\)](#), [Nye \(1967\)](#), [Huntington \(1968\)](#), and [Gerni et al. \(2012\)](#), bribery may decrease bureaucratic costs and accelerate efficient public administration. These studies highlight that as bureaucratic procedures are stimulated and bureaucratic costs drop, economic growth is promoted.

Although there are numerous studies that have examined the effect of corruption on economic indicators and growth, few studies have investigated the relationship between corruption and inflation. There are two different approaches regarding the relationship between corruption and inflation. The first approach maintains that corruption leads to inflation. According to the analysis conducted by [Al-Marhubi \(2000\)](#) in 41 countries for the period from 1980–1995, there was a positive relationship between corruption and inflation. [Piplica \(2011\)](#) study, which focused on 10 transition economies in Central and Eastern Europe, revealed that corruption increased inflation. In their research on transition economies, [Abed and Davoodi \(2002\)](#) also found a positive relationship between corruption and inflation. Similarly, [Smith-Hilman \(2007\)](#) and [Samimi et al. \(2012\)](#) indicated the significant positive impact of corruption on inflation. [Piplica and Praksa \(2011\)](#) used the data from 10 EU countries for the period 1995–2008 to reveal that corruption positively affected inflation.

[Mohammadishirkolaei \(2014\)](#) measured the effect of corruption on inflation using the data for MENA (Middle East and North Africa) countries for the 2003–2010 period and the variables of openness degree, per capita income, final consumption expenditures, and equity growth rate. The results of the analysis revealed that openness level, per capita income, and corruption perception index affected inflation rates negatively, whereas equity growth rate and final consumption expenditures had a significant positive effect on inflation.

[Yousefi \(2015\)](#) tested her hypothesis that corruption led to an increase in monetary expansion and thus inflation rate using the data for 164 countries between 1995 and 2010 period. The findings of the study pointed to a significant positive relationship between corruption and inflation for the entire sample. It was further observed that the parameter coefficients for the OECD (Organisation for Economic Co-operation and Development) countries were lower when compared to the non-OECD countries. Thus, the impact of corruption on inflation in developed countries was lower in comparison to the developing countries. Another significant finding of the study was that the impact of corruption on inflation in countries that did not export oil was statistically significant, while this impact was insignificant in oil exporting countries.

From another standpoint regarding the relationship between corruption and inflation, inflation increases corruption. In their study, which examined the relationship between corruption and economic factors, [Getz and Volkema \(2001\)](#) found that economic uncertainties increased the general level of prices, and the increase in inflation triggered corruption. The study by [Paldam \(2002\)](#), which investigated the economic and cultural determinants of corruption, revealed that an increase in inflation rates gave rise to corruption in the short term. [Tosun \(2002\)](#) examined the economic determinants of corruption in 44 countries using data from the 1982 to 1995 period, which pointed to a statistically significant and positive relationship between corruption and inflation.

[Braun and Tella \(2004\)](#) examined the effect of inflation on corruption by using data for 75 countries from the period between 1982 and 1994, and by integrating political rights and import/GDP variables into the model. The results of the study revealed that the increase in the general level of prices aggravated corruption. In their study conducted with data from 97 countries from different income groups for the 2002–2010 period, [Akca et al. \(2012\)](#) investigated the effect of economic variables such as inflation, economic growth, effectiveness of government, political stability, and trade deficit on corruption. As their findings suggested, inflation had a statistically significant positive effect on corruption for all countries in the model. [Ben Ali and Sassi \(2016\)](#) analyzed the data for the period between 2000 and 2012 for 100 countries and found that in particular, countries with a weak institutional structure tended to use seigniorage as a source of income and the expansion of money supply increased inflation rates through other channels.

As a result, the literature on corruption suggested that there was a significant positive relationship between corruption and inflation. While some studies have indicated that corruption leads to inflation, other studies have argued that inflation causes corruption.

#### 4. Data Set and the Empirical Model

This study examined the relationship between corruption and inflation using data from 20 developing countries for the 1995–2015 period. These countries were selected based on the availability of data in the IMF (International Monetary Fund) emerging and developing economies list. Although there were no precise and objective measures of corruption described in the literature, some international institutions have developed some indicators. The Corruption Perception Index developed by Transparency International, Freedom from Corruption presented by the Heritage Foundation, Business International used by [Mauro \(1995\)](#), and the World Bank Control of Corruption Index are the most widely used corruption measurement tools. All of these indices measure perception and based on surveys conducted by private firms and international organizations. However, these are not the perfect criteria for corruption, and should only be perceived as substitute tools that could be used in measuring corruption ([Rohwer 2009](#)).

[Serra \(2006\)](#) pointed out that aggregate corruption indicators such as the Corruption Perception Index (CPI) and Freedom from Corruption would be more reliable than the indices obtained from individual sources such as the ICRG (International Country Risk Guide) and the World Bank ([Serra 2006](#), p. 229). This study used the Freedom from Corruption data set developed by the Heritage Foundation to measure corruption. In this index, which uses a scale between 0 and 100, large numbers indicate an improvement in the level of corruption. The Freedom from Corruption Index, which was developed based on the Corruption Perception Index (CPI) prepared by Transparency International, is one of the ten indicators of the Economic Freedom Index. The Corruption Perception Index obtains a value between 0 and 10, where high values indicate low levels of corruption, while low values point to high levels of corruption. The Freedom from Corruption Index by the Heritage Foundation, on the other hand, is a revised version of the Corruption Perception Index, where values between 0 and 100 are assigned. High values in the Freedom from Corruption Index point to low levels of corruption in a country, so each value in this index is deducted from 100 and reversed for ease of interpretation. Thus, the freedom from corruption variable, which was reconstructed for econometric analysis, is expected

to have a positive sign (Al-Marhubi 2000; Abed and Davoodi 2002; Braun and Tella 2004; Piplica 2011; Smith-Hilman 2007; Piplica and Praksa 2011; Samimi et al. 2012; Ben Ali and Sassi 2016).

Annual percentage changes in consumer prices were used for the inflation rate, which was the dependent variable of the estimated long-term equation in the study. Additionally, some control variables (which are determinants of inflation) were included in the long-run equation to prevent the problem of omitted-variable bias. To this end, based on Romer (1993), Lane (1997), Terra (1998), Gokal and Hanif (2004), Wynne and Kersting (2007), Badinger (2009), Blackburn and Powell (2011), Evans (2012), Ben Ali and Sassi (2016), GDPGAP to measure the difference between actual output and potential output, OPEN for the economic integration level of a country into the world, and M2 for price stability and the decisions of the monetary authority were added to the regression. Econometric analyses were conducted using EViews 9 and Gauss10 software. The regression model to be estimated to determine the relationship between corruption and inflation is given in Equation (1):

$$INF_{it} = \beta_0 + \beta_1 GDPGAP_{it} + \beta_2 OPEN_{it} + \beta_3 M2_{it} + \beta_4 COR_{it} + e_{it}, \text{ for } i = 1, 2, \dots, N, t = 1, 2, \dots, T \quad (1)$$

In this equation,  $i$  represents the cross-sectional units, while  $t$  is time and  $e_{it}$  is the error term that is independently identically distributed with zero mean and constant variance. Furthermore,  $INF$ ,  $GDPGAP$ ,  $OPEN$ ,  $M2$ , and  $COR$  represent the inflation rate, the output gap, the share of total imports and exports of goods and services in GDP, annual broad money growth rate, and the freedom from corruption index, respectively. The  $GDPGAP$ ,  $OPEN$ ,  $M2$  and  $INF$  variables were compiled from the World Bank WDI 2015 data set, while  $COR$  was obtained from the Heritage Foundation data.  $\beta_1$ ,  $\beta_2$ ,  $\beta_3$ ,  $\beta_4$  represent the long-term coefficients for each variable. Detailed information on the variables in the long-term equation is given in Table 1.

**Table 1.** Definition of variables and data sources.

Variables	Explanations of Variables	Data Source
$INF$	Consumer prices (annual %)	World Bank, WDI
$COR$	Freedom from corruption index	Heritage Foundation
$GDPGAP$	Real GDP minus detrended GDP with Hodrick-Prescott Filter	World Bank, WDI
$OPEN$	Exports plus imports of goods and services (% of GDP)	World Bank, WDI
$M2$	Broad money growth (annual %)	World Bank, WDI

There have been different theories regarding the long-run coefficient of the output gap on inflation rates. According to the New Keynesian Phillips curve, which is based on the rational expectations hypothesis, a positive output gap leads to a boosting effect on inflation rates (Gali and Gertler 1999; Dewan et al. 1999; Paul 2009; Tivari Aviral K. and Albuлесcu 2014; Abbas et al. 2016). In this case,  $\beta_1$  will have a positive sign.

Romer (1993), Lane (1997), Wynne and Kersting (2007), and Evans (2012) argued that economic integration has a direct and indirect price effect on inflation rates. Trade openness means easier access to cheap final goods and imported inputs. As a result of the decrease in production costs, domestic prices and inflation rates will also decrease. Furthermore, the intense competition in trade with the external world pushes the domestic firms to manufacture in areas where they have comparative advantages, which results in an increase in productivity and a decrease in price levels (Wynne and Kersting 2007, pp. 8–9). Grossman and Helpman (1991) pointed out four possible ways where increasing trade openness led to an increase in domestic productivity. In this respect, openness leads to an increase in productivity as technical knowledge transfer among the countries increases; creates pressure on the firms to develop new products in order to not lose their competitive advantage; provides a wider market opportunity through which successful innovative activities may be utilized; and causes an increase in productivity by encouraging countries to specialize in certain sectors. Given the direct and indirect price effects, trade openness will decrease domestic prices and a country's long-run inflation rates, and  $OPEN$  is expected to take a negative sign in the long run ( $\beta_1 < 0$ ). Romer (1993) maintained

that unanticipated monetary expansion was an important variable that led to an increase in inflation rates. In this respect, it is predicted that  $\beta_3$  will have a negative sign.

## 5. Methodology and the Empirical Findings

To determine the relationship between corruption and inflation, the stationarity of variables was first tested through the unit root methods, and then the presence of a long-term relationship was investigated with co-integration tests. However, as global integration has reached significant dimensions both commercially and financially, particularly after the 1980s, a shock in one country eventually spreads to other countries. Thus, before conducting an econometric analysis in empirical studies, the effect of countries with cross-sectional units on each other must be tested with cross-sectional dependence methods. The findings of the cross-sectional dependence test helped us determine the unit root, co-integration, and causality methods most appropriate to the structure of the dataset.

The [Breusch and Pagan \(1980\)](#) *LM* (Lagrange Multiplier), [Pesaran \(2004\)](#), *CD*, *CD<sub>LM</sub>*, and [Pesaran et al. \(2008\)](#) *LM<sub>adj</sub>* (bias-adjusted *CD*) tests are the most commonly used methods to test the cross-sectional dependence. In each of these methods, the null hypothesis states that there is no cross-sectional dependence. Among these methods, *LM* yields valid results in panels where the cross-sectional dimension is small and the time dimension is very large. Under the null hypothesis, the *LM* statistic has asymptotic chi-square distribution with  $N(N - 1)/2$  degrees of freedom. Under the condition that time dimension is greater than cross-sectional dimension, another method, the *CD<sub>LM</sub>* test developed by [Pesaran \(2004\)](#) is used with samples where both time and cross-sectional dimensions take large values ( $T \rightarrow \infty$  and then  $N \rightarrow \infty$ ). This test statistic has a standard normal distribution. [Pesaran \(2004\)](#) also developed the *CD* test to be used in large panels without any conditions ([Menyah et al. 2014](#), p. 390). Calculations in [Pesaran \(2004\)](#) *CD<sub>LM</sub>* and *CD* statistics are made with the formulas in Equations (2) and (3):

$$CD_{LM} = \sqrt{\frac{1}{N(N-1)} \sum_{i=1}^{N-1} \sum_{j=i+1}^N (T\hat{\rho}_{ij}^2 - 1)} \quad (2)$$

$$CD = \sqrt{\frac{2T}{N(N-1)} \left( \sum_{i=1}^{N-1} \sum_{j=i+1}^N \hat{\rho}_{ij} \right)} \quad (3)$$

In addition to these methods, the *LM<sub>adj</sub>* (bias-adjusted *CD*) test was developed by [Pesaran et al. \(2008\)](#) as a different version of the *LM* test. This method yields meaningful results for large panels including first  $T \rightarrow \infty$  and then  $N \rightarrow \infty$ . The *LM<sub>adj</sub>* statistic, which has asymptotic normal standard distribution, is calculated with the formula given in Equation (4):

$$LM_{adj} = \sqrt{\frac{2}{N(N-1)} \sum_{i=1}^{N-1} \sum_{j=i+1}^N \frac{(T-k)\hat{\rho}_{ij}^2 - \mu_{Tij}}{\vartheta_{Tij}}} \quad (4)$$

Table 2 shows the results of the cross-sectional dependency test for 20 developing countries. The findings in the table indicated that the null hypothesis of no cross-sectional dependence could not be rejected at a 99% significance level for all methods. This result meant that a shock in one of the countries in the sample was not expected to have the same effect on the other countries.



**Table 2.** Cross-sectional dependence test results.

Test	Statistics	<i>p</i> -Value
<i>LM</i> (Breusch and Pagan 1980)	183.2	0.62
<i>CD<sub>LM</sub></i> (Pesaran 2004)	−0.345	0.36
<i>CD</i> (Pesaran 2004)	−1.224	0.11
<i>LM<sub>adj</sub></i> (Pesaran et al. 2008)	−0.117	0.54

The fact that the cross-sectional dependence test pointed to cross-sectional independence among the countries in the panel meant that some first-generation methods could be used in the unit root, co-integration, and causality analyses. Thus, three different unit root tests were used to determine the integration levels of the series. Among these methods, Levin et al. (2002, hereinafter LLC) proposed a test that made a homogeneity hypothesis, while Im et al. (2003, after this IPS) was based on heterogeneity hypothesis. These two tests can be used to check the null hypothesis of stationary and the presence of the unit root in the alternative hypothesis. On the other hand, in contrast from the first two methods, the Hadri (2000) test, which was used as the third unit root method, examines the presence of unit root in the null hypothesis and the stationary of the series in the alternative hypothesis.

The results of the unit root test are displayed in Table 3. According to the test results, although the inflation rate (*CPI*) and money supply (*M2*) had a unit root at the level according to the LLC and Hadri tests, they were stationary at the level according to the IPS. The variables of corruption (*COR*) and output gap (*GDPGAP*) were not stationary at the level according to the IPS and LLC, while the openness (*OPEN*) had a unit root at the level according to all the unit root tests. The results of the differenced series showed that each series became stationary at the first difference. This indicated that the series were integrated to the order of one,  $I(1)$ , according to at least one of the unit root tests (IPS, LLC, and Hadri). Following these findings, the presence of a long-term relationship among the series had to be investigated through co-integration methods. To this end, co-integration analysis was conducted with the Pedroni (1999) and Kao (1999) techniques, which are among the first-generation co-integration methods.

**Table 3.** Unit root tests results.

Variable	LLC		IPS		Hadri	
	Level	First Diff.	Level	First Diff.	Level	First Diff.
<i>CPI</i>	6.10 ***	−13.1	−5.18	−16.2	6.32 ***	23.2
<i>GDPGAP</i>	−6.53	−10.69	−5.80	−11.18	1.44	10.43
<i>OPEN</i>	−2.07 *	−6.53	−1.17 ***	−6.22	7.66 ***	4.70
<i>M2</i>	−1.62 ***	−9.43	−2.94	−14.1	5.54 ***	16.2
<i>COR</i>	−15.6	−14.5	−14.1	−14.6	6.70 ***	6.14

Note. \*\*\* and \* indicate that the variable has unit root at 1 and 10% levels of significance, respectively. Newey-West bandwidth selection with Bartlett Kernel is used for unit root analysis. The SIC is used to determine the optimal lag lengths. Estimations are made with the inclusion of constant and trend.

Pedroni (1999), who used the Engle and Granger (1987) co-integration method as the basis, made seven statistical calculations for the heterogeneous panel, four of which were within-dimension and three of which were between-dimension. The within-dimension statistics proposed by Pedroni were panel  $\nu$ , panel  $\rho$ , panel PP, and panel ADF-statistics, while the between-dimension statistics were Group  $\rho$ , Group PP, and Group ADF. This method tests the absence of a long-term relationship in the null hypothesis and the existence of a long-term relationship in the alternative hypothesis.

Another co-integration test that used the Engle and Granger (1987) approach as the basis was developed by Kao (1999). Unlike Pedroni (1999), this approach tested the null hypothesis of no long-term relationship among the variables by assuming that the slope coefficients of all the cross-sectional units were homogeneous. The Pedroni (1999) and Kao (1999) panel co-integration test results are reported in Table 4.

**Table 4.** Pedroni and Kao co-integration tests results.

Country	Constant	Probability	Constant and Trend	Probability
<i>Pedroni (1999)</i>				
Panel v	1.072	0.14	−0.601	0.72
Panel rho	−2.538	0.00	−1.282	0.09
Panel pp	−17.05	0.00	−18.22	0.00
Panel adf	−16.92	0.00	−18.98	0.00
Group rho	0.952	0.82	1.814	0.96
Group pp	−10.95	0.00	−13.20	0.00
Group adf	−9.383	0.00	−11.36	0.00
<i>Kao (1999)</i>				
<i>t</i> statistics	−5.845	0.00		

Note: Lag selection is based on the SIC with the maximum of 3 lags.

The results of the Pedroni cointegration test, which are presented in Table 4, showed that the null hypothesis of no cointegration could be rejected according to five of the seven statistics. This result indicated that there was a long-term relationship among the variables in Equation (1). The findings of Kao (1999) test also verified this result. The *t* statistics in the constant model of the Kao (1999) residual co-integration test showed that the null hypothesis was rejected at the 99% significance level. Eventually, it can be concluded that there exists a long-run relationship between inflation and the independent variables in Equation (1).

As a result of the finding that the variables in Equation (1) moved together in the long term, the parameter coefficients were obtained with the Pesaran and Smith (1995) Mean Group estimator (MG) in the next stage. The Pesaran and Smith (1995) MG estimator gives heterogeneous coefficients for each country in the panel under cross-sectional independence. The results of the panel MG estimator are presented in Table 5.

**Table 5.** Panel mean group estimation results for 20 developing countries.

Country	GDPGAP	M2	COR	OPEN
Argentina	0.60 ***	0.24 ***	0.06	0.48 ***
Azerbaijan	3.64	0.82	6.72 **	−1.87
Brazil	−0.58	0.25	2.09 ***	−1.89 ***
Bulgaria	5.15	2.96 ***	2.61	0.16
China	1.57 *	0.29 *	0.12	−0.10
Egypt	−0.40	0.02	−0.14	0.19 **
Hungary	0.84 *	0.26	−0.41	−0.15 **
India	−0.01	0.10	−0.17	0.12 *
Indonesia	2.46 ***	0.14	0.46 **	0.13
Kazakhstan	3.12	0.70 ***	−1.06	−0.40
Malaysia	0.13	0.06	0.03	−0.001
Mexico	−0.39	0.14	0.97 ***	−0.35
Pakistan	0.76	0.05	0.10	1.03 ***
Poland	0.01	0.37 ***	0.10	−0.19 ***
Romania	2.35 **	1.16 ***	0.59	0.47
Russia	1.59	1.74 ***	−1.62	−1.18
South Africa	0.19	0.07	0.32 **	0.18 **
Thailand	0.29 **	0.22 **	0.10 **	0.02
Tunisia	−0.11	0.06	−0.06	0.04 *
Turkey	−0.95	0.81 ***	0.38	−0.73
PANEL	0.85 **	0.51 ***	−0.015	−0.20

Note: \*, \*\*, and \*\*\* denote statistical significance at the 10%, 5%, and 1% levels, respectively.

The Mean Group estimator showed that in 14 of the 20 developing countries, corruption positively affected inflation rates, while in six countries, the results were statistically significant. The positive relationship between inflation rates and freedom from corruption also indicated that corruption increased the inflation rates in a country, which was in accordance with [Al-Marhubi \(2000\)](#), [Braun and Tella \(2004\)](#), and [Ben Ali and Sassi \(2016\)](#). The *GDPGAP*, which accounts for the effect of output gap on inflation rates, had a positive and significant sign in six of the countries in the panel. According to the New Keynesian Phillips curve, the positive effect of output gap on inflation rates meant that the current GDP level was below the potential GDP and thus, the increase in output had a boosting effect on inflation ([Gali and Gertler 1999](#); [Abbas et al. 2016](#); [Ben Ali and Sassi 2016](#)). This finding coincided with the findings of [Paul \(2009\)](#), [Tivari Aviral K. and Albuлесcu \(2014\)](#), and [Valadkhani \(2014\)](#), who maintained that the output gap was positively related to the inflation rate. The effect of the *M2* variable, which shows monetary expansion, on inflation rates was, as expected, positive in all countries, and these results were statistically significant in nine countries. It was seen that the *OPEN* variable, which represents trade openness, had a positive coefficient in six countries, while it had a negative and significant coefficient in three countries. Thus, it was found that openness had a lowering effect on inflation rates in only Brazil, Hungary, and Poland through the availability of cheap imported input, or productivity increase.

[Engle and Granger \(1987\)](#) showed that if two variables were integrated to order one and cointegrated, there might be a causal relationship at least in one direction. In this study, the presence of a causality relationship between corruption and inflation rate was investigated through the [Canning and Pedroni \(2008\)](#) causality analysis. In this method, which used the dynamic error correction model as the basis, the long-term equation expressed in Equation (1) was estimated and based on this equation, and  $\hat{\epsilon}_{it}$  was calculated in Equation (5).

$$\hat{\epsilon}_{it} = INF_{it} - \hat{\beta}_0 - \hat{\beta}_1 GDPGAP_{it} - \hat{\beta}_2 OPEN_{it} - \hat{\beta}_3 M2_{it} - \hat{\beta}_4 COR_{it} \quad (5)$$

Following Equation (5), the error correction models seen in Equations (6) and (7) were constructed.

$$\Delta INF_{it} = \beta_{1i} + \lambda_{1i} \hat{\epsilon}_{it-1} + \sum_{j=1}^K \varphi_{11ij} \Delta INF_{i,t-j} + \sum_{j=1}^K \varphi_{12ij} \Delta COR_{i,t-j} + \varepsilon_{1it} \quad (6)$$

$$\Delta COR_{it} = \beta_{2i} + \lambda_{2i} \hat{\epsilon}_{it-1} + \sum_{j=1}^K \varphi_{21ij} \Delta INF_{i,t-j} + \sum_{j=1}^K \varphi_{22ij} \Delta COR_{i,t-j} + \varepsilon_{2it} \quad (7)$$

In the error correction models,  $\varepsilon_{it}$  shows how distant the variables are from the equilibrium. For a long-term relationship between the variables, at least one of the  $\lambda_{1i}$  and  $\lambda_{2i}$  adjustment coefficients must be different from zero ([Canning and Pedroni 2008](#), p. 512). The significance test of  $\lambda_{1i}$  may be interpreted as an investigation of whether corruption has a long-term effect on inflation. Similarly, the significance test of  $\lambda_{2i}$  is also a test to identify the effect of inflation on corruption in the long run. On the other hand,  $-\lambda_{1i}/\lambda_{2i}$ , gives information about the direction of the long-term effect of inflation on corruption ([Canning and Pedroni 2008](#), p. 513).

Group mean based and Lambda-Pearson based tests were developed to choose between the null hypothesis of no causality, and the alternative hypothesis, which proposed the causal relationship. Group mean panel test and Lambda-Pearson statistics were calculated with the formulas in Equations (8) and (9) ([Canning and Pedroni 2008](#), pp. 518–19).

$$\bar{t}\lambda 1 = N^{-1} \sum_{i=1}^N t\lambda 1i \quad (8)$$

$$P\lambda 1 = -2 \sum_{i=1}^N \ln P\lambda 1i \quad (9)$$

The  $t_{\lambda 1}$  in Equation (8) is the t statistics about the  $\lambda_{1i} = 0$  null hypothesis of no causality in country  $i$ . In Equation (9),  $\ln P_{\lambda 1i}$  is the logarithmic value pertaining to the p probability value of  $t$  statistics in

country  $i$  (Canning and Pedroni 2008, pp. 518–19). The causality relationship between corruption and inflation rates, which were the two main variables of our study, was two-directional: from inflation rate to corruption, and from corruption to inflation rate. Rejection of the null hypothesis at the observed significance levels implied a causal relationship between variables.

The Canning and Pedroni (2008) causality test results in Table 6 showed that there was no causal relationship between *INF* and *COR* according to the Lambda-Pearson statistics for the whole panel. However, when the results were evaluated by country, it was seen that the null hypothesis, which indicated that inflation rates did not cause corruption, was rejected in only five of the 20 countries in the panel. In this respect, the inflation rate was found to be a statistically significant variable leading to corruption in Brazil, Bulgaria, Indonesia, Kazakhstan, and Mexico. When the second analysis was done with the null hypothesis, it was seen that there was a causality relationship for more countries. It was found that there was causality from the level of corruption to inflation rates in 10 of the 20 countries in the panel. Another significant finding obtained from the Canning and Pedroni (2008) test was that there was a bilateral causality relationship between the inflation rates and corruption at the 99% significance level in Indonesia.

Table 6. Canning and Pedroni (2008) causality test results.

Country	COR→INF $\lambda_1$	$p$ -Value	INF→COR $\lambda_2$	$p$ -Value	Ratio — $\lambda_{1i}/\lambda_{2i}$
Argentina	−1.528 ***	0.01	−0.152	0.52	−0.09
Azerbaijan	−0.770 **	0.04	−0.032	0.89	−0.04
Brazil	0.149	0.65	0.737 ***	0.00	−4.95
Bulgaria	0.004	0.81	−0.028 **	0.03	6.33
China	−0.818 *	0.10	−0.526	0.31	−0.64
Egypt	−0.246	0.43	−0.160	0.45	−0.64
Hungary	−0.240	0.40	−0.516	0.13	−2.14
India	−0.211	0.33	−0.096	0.70	−0.45
Indonesia	−0.793 ***	0.00	−0.269 ***	0.01	−0.33
Kazakhstan	−0.133	0.35	−0.265 *	0.05	−2.00
Malaysia	−1.195 **	0.04	0.596	0.54	0.49
Mexico	−0.190	0.13	0.818 ***	0.00	4.31
Pakistan	−0.344	0.15	−0.161	0.63	−0.46
Poland	−0.141	0.62	0.012	0.97	0.08
Romania	−0.147 **	0.02	−0.048	0.51	−0.32
Russia	−0.305 **	0.02	−0.055	0.19	−0.17
South Africa	−2.074 ***	0.01	0.261	0.78	0.12
Thailand	−1.584 **	0.04	−0.269	0.70	−0.16
Tunisia	−0.481	0.34	−2.182	0.11	−4.53
Turkey	−0.141 *	0.10	−0.004	0.93	−0.02
PANEL	−0.559	0.34	−0.116	0.39	−0.20

Note: \*\*\*, \*\* and \* indicate the rejection of the null hypothesis of no causality at 1, 5, and 10 percent levels of significance, respectively.

## 6. Conclusions

Corruption, as an economic malady, is seen as one of the reasons behind weak economic performance. The negative effect of corruption on economic development has been the topic of many theoretical and empirical studies. There is fairly extensive literature stating that corruption negatively affects economic growth and development, reduces investments, and leads to a waste of resources. Corruption also impairs the competition between people and institutions and leads to unfair social, political, and economic structures. On the other hand, some researchers have argued that corruption may positively contribute to economic growth in countries with weak institutional structure. Studies that support this view argue that in countries with a complex and stagnant bureaucratic structure, corruption in the form of bribery accelerates investments and increases economic growth.

Although many studies have so far examined the effect of corruption on economic development, few studies have investigated the effect of corruption on the inflation rate. According to theoretical explanations, corruption increases inflation, particularly as governments in countries without an efficient tax system choose to compensate for the loss of income through seigniorage. The increase in money supply with emission leads to inflation. Moreover, bribery payments increase the general level of prices as an additional cost. Similarly, corruption harms the effective distribution of the financial and public resources, and negatively affects productivity and economic performance.

This study examined the relationship between corruption and inflation using data from 1995–2015 for 20 developing countries. The Corruption Perception Index, Freedom from Corruption, World Bank Control of Corruption, and Business International indices are cited as the most reliable corruption tools in the literature to measure the degree of corruption. This study used the Freedom from Corruption data set developed by the Heritage Foundation as the corruption measurement tool, and long-term coefficients were obtained using the first-generation panel data methods. The findings obtained through the Mean Group estimator showed that there was a positive and statistically significant relationship between inflation and corruption in 6 of the 20 developing countries. Accordingly, an increase in corruption caused a high level of the inflation rate. This result verifies the general view in the literature. Moreover, the [Canning and Pedroni \(2008\)](#) causality test revealed that there was causality from the corruption levels to inflation rates in 10 out of 20 developing countries. Accordingly, it can be argued that controlling corruption with effective policies can also help in reducing the inflation rate and achieving price stability.

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