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The Destructive Effect of Corruption on Economic Growth in Mali : a Nonlinear Model Analysis

Oyibo Paul Vivien[1], Brou Djandji Emmanuel[1], Anzian Kouamé Marcel[1], & Djeban Koffi Mouroufié Emmanuel[1]

[1] Department of Economics, Alassane Ouattara University, Bouaké, Côte d'Ivoire

Correspondence: Oyibo Paul Vivien, Department of Economics, Alassane Ouattara University, Bouaké, Côte d'Ivoire.

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Abstract

A growing body of empirical work has raised awareness of the destructive effect of corruption on economic development, although no existing study has considered the threshold value at which corruption impedes economic growth. This study assesses the effect of corruption on economic growth by adopting a non-linear approach to determining the corruption threshold. By analyzing the effect of corruption on economic growth in Mali over the period 1988 to 2021, this study examines whether there is evidence of an inverted U-shaped relationship between economic growth and corruption. The threshold effect of corruption is assessed using an augmented quadratic model. The results confirm the existence of an inverted U-shaped relationship between corruption and economic growth on the one hand and show the existence of a long-run relationship between these variables on the other hand, thus validating our initial hypothesis. Furthermore, the results show that economic growth peaks when the corruption perception index reaches 0.07 points. The main lessons to be drawn from these results are that below this threshold, corruption becomes a lubricant for economic growth, while above this threshold, it constitutes a brake on economic growth in Mali.

Keywords: economic growth, corruption, Mali

JEL: K19, I29, O49, O55

1. Introduction

The relationship between corruption and economic growth has been the subject of several studies in the economic literature. However, the results of this work seem to be inconclusive. Thus, there are two opposing views. On the one hand, there are authors such as Mauro, (1995) and Blackburn et al. (2006), who support the hypothesis that corruption is detrimental to growth. However, on the other hand, there are authors such as Méon and Weill, (2010) and Kato and Sato (2015), who provide evidence to support the "greasing the wheels" hypothesis and argue that corruption enhances economic growth.

Indeed, in Mali, economic growth has been declining since 2014. This is due to a deterioration of national institutions. Its rate in real terms has fallen from 4.8 in 2019 to -1.2 in 2020 (WDI, 2022). For the latter period, economic growth in Mali is well below that of the entire WAEMU zone, whose real rate is 6% according to the same source. In the face of this alarming situation, coupled with poor governance characterized by increased corruption and political-military instability, and a lack of consensus on the effects of corruption on economic growth, this study addresses two research questions. First, is there not a corruption threshold below which corruption is a factor of growth and above which corruption is a brake on growth in Mali ? Second, does the quality of institutions improve growth in Mali?

The objective of this paper is to analyze the effects of corruption on economic growth in Mali, and the hypothesis supported is that there is a threshold effect between these two variables.

The rest of the paper is organized as follows: The next section summarises the literature on the theoretical and empirical links between corruption and economic growth. Section 3 presents the methodology of the study, followed by the results and discussion in Section 4. Finally, the conclusion and policy implications will be the subject of section 5.

2. Literature Review

To our knowledge, there is no consensus on the effect of corruption on economic growth, either theoretically or empirically

2.1 Theoretical Literature Review

A review of the literature on the effect of corruption on economic growth shows that there is still no consensus, either

theoretically or empirically. The analysis highlights two main hypotheses. On the one hand, the 'grease the wheels' hypothesis, which highlights the importance of corruption in driving economic activity, and the 'sand in the wheels' hypothesis, shows the destructive effect of corruption on the economy.

The grease hypothesis states that corruption is desirable for economic growth. For Huntington (1968), corruption can act as a grease by speeding up transactions, creating incentives to act, and setting up procedures that would not only save time, but also provide satisfaction for those who engage in it. Such procedures cannot exist in the absence of a 'bribe'. According to Leff (1964), bribery can be an incentive to correct the market against inefficient regulation and bureaucracy by introducing competition into a non-existent or monopolistic sector.

In contrast to the greasing the wheels' hypothesis, the sand in the wheels' hypothesis states that corruption generates adverse effects on economic growth, thus constituting a detrimental factor for the latter. In this perception, Kaufman (1977) argues that corruption forces entrepreneurs to devote financial and human resources to managing bribes when these resources could be used more productively for other tasks. For Yan and Oum (2011), corruption leads to low levels of efficiency.

2.2 Empirical Literature Review

Empirical work on the link between economic growth and corruption abounds in the economic literature. However, its various works also remain controversial about the effect of corruption on economic growth.

Obad and Outseki (2021) analyzed the impact of corruption on economic growth in six North African countries during the period from 2004 to 2018. The results reveal that in all six countries, corruption hurts economic growth. On the other hand, growth has no effect on public expenditure.

Alfada (2019) studied the effect of corruption on economic growth in the provinces of Indonesia. Through data covering the period from 2004 to 2015, using the two-stage instrumental variable least squares (2SLS) estimator, the results obtained reveal the existence of a threshold effect of corruption. In addition, corruption has a growth-damaging effect for provinces with a corruption level below the 1.765 points threshold, and a growth-destroying effect for provinces with a corruption level above the threshold.

Bitterhout and Simo-Kengne (2020) conduct a study to identify the effect of corruption on growth in the BRICS countries. To do so, they use the fixed-effect model and the random-effect model, applied to data covering the period 1996-2014. At the end of this study, the results obtained establish a negative effect in the first case, and the existence of a positive effect of corruption on economic growth in the second case.

Thach and *al* (2017) analyzed the effects of corruption on economic growth in 19 Asian countries. With the annual data of 2014-2015 estimated by the DGGM technique, the study comes up with the results that corruption is a hindrance to economic growth in Asian countries.

Farooq and *al* (2013) test whether corruption hinders growth in Pakistan. They use the ARDL technique, which is the annual data from 1987-2009 and find the results that highlight the existence of the negative effect of corruption on economic growth in Pakistan.

Regarding the existence of positive effects of corruption on economic growth, the results found by Ondo (2017), using the data from 2005 to 2015, and the random effect panel data model in the framework of the Economic and Monetary Community of Central Africa, showed that corruption exerts a positive effect on economic growth, by eliminating administrative bottlenecks that hinder access to basic public goods as well as the creation and development of the enterprise.

Similarly, Biru (2010), in the context of the Bangladesh economy, using data covering the period 1985 to 2009 and the ordinary least square method, obtained the results that corruption positively affects the level of economic growth.

In addition, some works have highlighted the cointegrating relationship between economic growth and corruption. For example, Hakizimana (2021) studied the effects of corruption on economic growth in the Republic of Congo using a non-linear autoregressive lag model (NARDL). The results reveal the existence of asymmetric effects of corruption on economic growth in the short and long run, thus validating the hypothesis of non-linearity between the two variables.

3. Methodology

The methodological approach adopted in this work is structured in two points.

3.1 Theoretical Model

Our analysis is based on the neoclassical growth model of Solow (1956), which highlights the technological factor as an endogenous variable. Thus, we have :

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha} \tag{1}$$

with :

Y refers to aggregate output; A refers to the productivity of the factors of production; K refers to the capital stock; L refers to the labor force; α refers to the parameter measuring the contribution of capital to production; $1-\alpha$ refers to the parameter measuring the contribution of labor to production; t refers to temporal space.

Dividing equation (1) by the labor input (L_t) gives :

$$\frac{Y_t}{L_t} = \frac{A_t K_t^{\alpha} L_t^{1-\alpha}}{L_t} = \frac{A_t K_t^{\alpha} L_t}{L_t L_t^{\alpha}} = \frac{A_t K_t^{\alpha}}{L_t^{\alpha}} \tag{2}$$

Linearising equation (2), we get :

$$\ln\left(\frac{Y_t}{L_t}\right) = \ln\left(\frac{A_t K_t^{\alpha}}{L_t^{\alpha}}\right) \tag{3.a}$$

$$\ln(Y_t) - \ln(L_t) = \ln\left(A_t K_t^{\alpha}\right) - \ln(L_t) \tag{3.b}$$

$$\ln(Y_t) - \ln(L_t) = \ln(A_t) + \ln\left(K_t^{\alpha}\right) - \ln(L_t) \tag{3.c}$$

$$\ln(Y_t) = \ln(A_t) + \alpha \ln(K_t) + (1-\alpha)\ln(L_t) \tag{3}$$

Let's assume that : $\beta = (1-\alpha)$. Equation (3) becomes :

$$\ln(Y_t) = \ln(A_t) + \alpha \ln(K_t) + \beta \ln(L_t) \tag{4}$$

According to (North, 1990), the quality of a country's institutions is fundamental in determining its economic performance. From this perspective, del Mar Salinas-Jiménez and Salinas-Jiménez (2011) show that corruption can affect growth through its effect on total factor productivity. Thus, symbolizing corruption in period t by CPI_t (corruption perception index) under the assumption that technical progress grows at a constant rate υ ; we have :

$$A_t = A_0 e^{\upsilon COR_t} \tag{5}$$

Placing equation (5) back into equation (4) gives :

$$\ln(Y_t) = \ln\left(A_0 e^{\upsilon COR_t}\right) + \alpha \ln(K_t) + \beta \ln(L_t) \tag{6.a}$$

$$\ln(Y_t) = \ln(A_0) + \ln\left(e^{\upsilon COR_t}\right) + \alpha \ln(K_t) + \beta \ln(L_t) \tag{6.b}$$

$$\ln(Y_t) = \ln(A_0) + \upsilon CPI_t + \alpha \ln(K_t) + \beta \ln(L_t) \tag{6}$$

3.2 Empirical Model

In the framework of our study, we have opted in the first instance for an approach that consists of determining the optimal level of corruption through the method that consists of regressing the logarithm of GDP on the variable of interest as well as on its square (quadratic model). In the second step, we will use a linear model.

- ***The non-linear model : augmented quadratic model***

The estimation of the quadratic equation model shows whether there is an inversion effect of the corruption variable on the logarithm of economic growth. Thus, the model is written :

$$\log(GDPC_t) = \alpha_0 + \alpha_1 (CPI_t) + \alpha_2 \left(CPI_t^2\right) + \varepsilon_t \tag{7}$$

$\log(GDPC_t)$ denotes the logarithm of GDP per capita, CPI_t denotes the corruption perception index, $\alpha_0, \alpha_1 \text{ and } \alpha_2$ are the parameters of the model to be estimated. Finally, ε_t means the specification of the specific error term. We will insert control variables in our basic model. These variables are : fiscal pressure (FP), agricultural value added (AGVA), gross fixed capital formation (GFCF), terrorism (TERRO) and a dummy variable indicating military takeover (M_TAKEOVER). Thus, the model used in this study is formulated as follows:

$$\log(GDPC_t) = \alpha_0 + \alpha_1(CPI_t) + \alpha_2(CPI_t^2) + \alpha_3(GFCF_t) + \alpha_4(AGVA_t) + \alpha_5(DEMO_t) + \alpha_6(TERRO_t) + \alpha_7(M\_TAKEOVER_t) + \varepsilon_t \quad (8)$$

This study aims to determine the level of corruption that maximizes economic growth. Mathematically, the following operation will be performed:

$$\frac{d\left[\log(GDPC_t)\right]}{d\left[CPI_t\right]} = 0 \Leftrightarrow \alpha_1 + 2\alpha_2 CPI_t = 0 \quad (9.a)$$

The optimal level of corruption that maximizes economic growth is obtained by the following relationship:

$$CPI_t^* = -\frac{\alpha_1}{2\alpha_2} \text{ with } \alpha_1 > 0 \text{ et } \alpha_2 < 0. \quad (9)$$

Thus, at the level of this model, the coefficient of the threshold variable and that of its square must be of the opposite sign before one can speak of a reversal or the existence of a threshold. This threshold, if it exists, is obtained by deriving the logarithm of the GDP per capita as a function of corruption.

- ***The linear model***

The econometric model to be estimated is as follows:

$$\log(GDPC_t) = \alpha_0 + \alpha_1(CPI_t) + \alpha_2(GFCF_t) + \alpha_3(AGVA_t) + \alpha_4(DEMO_t) + \alpha_5(TERRO_t) + \alpha_6(M\_TAKEOVER_t) + \varepsilon_t \quad (10)$$

The variables that will be included in this model are presented in the table below:

Table 1. Description of the variables in our study

Variable	Definition	Source	Expected sign
GDPC	Gross domestic product per capita which is the	WDI (2022)	endogenous variable
CPI	Corruption Perception Index	ICRG (2022)	Positive (+)
CPI ²	Corruption Perceptions Index squared	Authors	Negative (-)
GFCF	Gross fixed capital formation	WDI 2022	Positive (+)
DEMO	Democracy	ICRG (2022)	Positive (+)
AGVA	Agricultural value added to GDP	WDI (2022)	Positive (+)
TERRO	Dummy variable indicating the manifestation of terrorist attacks in Mali since 2013.	Authors	Negative (-)
M_TAKEOVER	Dummy variable indicating military takeover	Authors	Negative (-)

***Source**:* authors' construction

The data cover the period 1988-2021, and come from the Central Bank of World Development Indicator (WDI 2022). The institutional variable (corruption perception index) is taken from the International Country Risk Guide (ICRG 2022) held by Political Risk Services. Finally, we constructed the terrorism and the dummy variable indicating a military takeover.

4. Empirical Results

Before presenting the results of the estimations, we will present the results of the preliminary tests. These tests allow us to know the quality and the nature of the variables studied.

4.1 Preliminary Tests

Before any statistical analysis, it is important to ensure the quality of the data to be analyzed. To do this, two tests are essential in the context of a time series study: the test for measuring multicollinearity and the descriptive statistics of the variables.

Table 2. Descriptive statistics of variables

	LOGGDPC	CPI	GFCF	AGVA	DEMO
Mean	6.4670	2.0649	20.2142	35.4253	2.8333
Median	6.5263	2.0000	20.6696	36.4704	3.0000
Maximum	6.7036	3.0000	24.1179	39.9456	4.0000
Minimum	6.2084	1.0000	15.4644	29.7905	1.0000
Std. Dev.	0.1633	0.5032	2.2828	2.8743	0.7385
Jarque-Bera	3.2474	0.7240	0.6585	2.7042	21.1529
Probability	0.1971	0.6962	0.7194	0.2586	0.0000
Observations	34	34	34	34	34

Source : authors using data from WDI (2022) and ICRG (2022)

The results of the descriptive statistics of the variables provide information on the volatility of the variables studied during the period under consideration, as well as their distributions. The volatility of the variables is highlighted by the value of the standard deviation. Thus, the standard deviation highlights the level of dispersion of the variables around their respective means. From these results, it can be seen that democracy has a very high volatility (0.73), which highlights a strong dispersion around its mean. For the other variables, the value of the respective standard deviations is low (less than or equal to 0.5). This suggests that the dispersion of these variables around their respective means is relatively small. Concerning the distribution of the variables, the results suggest that all the variables are normally distributed except for democracy. This normality is highlighted by the value of the p-value associated with the Jarque-Bera statistic, which is greater than 5%, thus allowing us to accept the null hypothesis of the normality of the variables, and to reject the alternative hypothesis H1, according to which the variables are not normally distributed. Furthermore, these results reveal that the mean and the median are very close, which implies that the data do not suffer from an "outlier" problem.

Table 3. Correlation matrix of variables

Probability	LOGGDPC	CPI	GFCF	AGVA	DEMO
LOGGDPC	1.0000				

CPI	-0.1520	1.0000			
	(0.3905)	-----			
GFCF	0.3692	-0.0419	1.0000		
	(0.0316)	(0.8139)	-----		
AGVA	-0.2808	-0.2008	-0.3131	1.0000	
	(0.1076)	(0.2546	(0.0713)	-----	
DEMO	0.4391	0.3832	0.0550	-0.4805	1.0000
	(0.0094)	(0.0252)	(0.7572)	(0.0040)	-----

Source : authors using data from WDI (2022) and ICRG (2022)

The results in Table 3 above provide information on the existence or not of a statistical link between the variables. Indeed, it appears that corruption and agricultural value added to GDP are negatively correlated with economic growth, while the other variables are positively correlated. However, these correlation coefficients remain very low. This leads to the conclusion that there is no multi-collinearity problem. Therefore, all variables can be subject to an econometric study.

4.2 Cointegration Test

In our further investigations, all our variables (except the dummy variables) were found to have a unit root (Dickey-Fuller-Augmented é and Phillip-Perron test at the 5% significance level) and to be integrated of unit order I (1). This led us to analyze the presence of a cointegrating relationship between the variables using the Johansen test (1988). This Johansen (1988) cointegration test is very important because the estimation method will depend on the number of cointegrating relationships. The results are shown in the table below.

Table 4. Johansen cointegration test (1988)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob. **
None *	0.9554	246.7960	125.6154	0.0000
At most 1 *	0.8576	150.3828	95.7536	0.0000
At most 2 *	0.7554	89.9501	69.8188	0.0006
At most 3	0.5278	46.2909	47.8561	0.0696
At most 4	0.2802	23.0255	29.7970	0.2448
At most 5	0.2699	12.8311	15.4947	0.1211
At most 6	0.0944	3.0758	3.8414	0.0795

Source : authors using data from WDI (2022) and ICRG (2022)

The Johansen cointegration test reveals a long-run relationship between the variables. Moreover, there is more than one cointegrating relationship. Since we are interested in the long-run relationship, we opt for a Fully Modified Least Squares (FMOLS) estimation method.

4.3 Estimation Results

After applying a quadratic model to the data, it is necessary to test whether or not the underlying model from which the data were generated is compatible with the linearity assumption. Indeed, if linearity is not rejected, it is preferable to apply a classical linear model to the data rather than a non-linear model, due to the greater simplicity of estimating them as well as the extensive theory developed for these models. For the quadratic model, the test of non-linearity is done by studying the sign of the coefficient of the threshold variable and its square. Thus, if $\alpha_1 > 0$ *and* $\alpha_2 < 0$ then linearity is rejected. Thus, the application of a non-linear model seems sensible.

The estimation results of our models are more or less satisfactory from both an econometric and an economic interpretation point of view. economic interpretation. It should be noted that the coefficients are elasticities that can be interpreted as relative variations that provide information on the variation of a series (endogenous variable) following the variation of an exogenous variable.

The table below shows the results of the estimations.

Table 5. Estimation results with the FMOLS estimation method

	Model 1-linear		**Model 2-Nonlinear**	
Variables	**Coefficient**	**p-value**	**Coefficient**	**p-value**
Corruption Perception Index	-0.0431***	0,0687	0.4785**	0.0038
Corruption Perception Index squared	-	-	-3.1191*	0.0013
Investment	0.0093***	0.0570	0.0117**	0.0187
Agricultural added value	-0.0281*	0.0000	-0.0190*	0.0005
Democracy	0.0389**	0.0291	0.0348**	0.0434
Terrorism	0.2835*	0.0000	-0.2329*	0.0000
M_TAKEOVER	0.0216	0.4609	0.0409	0.1861
Constant	7.1833*	0.0000	6.2961*	0.0000
Adjusted R-squared	0.7472		0.8040	
Long-run variance	0.0024		0.0023	
Normality test	3.9403	0.1394	2.1554	0.3403

$$CORR_i^* = -\frac{\alpha_1}{2\alpha_2} = \frac{0.4785}{2(-3.1191)} = 0.0767$$

Optimum	-

Note : (*), (**), (***)*Indicator of significance at the 1%, 5% and 10% levels respectively.*

Source: authors using data from WDI (2022) and ICRG (2022)

A remarkable observation of these results is that there is an inverted U-shaped relationship between economic growth and the corruption perception index in Mali. Indeed, the signs of the coefficients of the democracy variable and its square are respectively positive and negative. Thus, when the perception index is below 0.0767 points, corruption positively affects economic growth in Mali with an elasticity of 0.4785. However, when corruption exceeds this value, it becomes detrimental to economic growth in Mali. The finding is that over the period 1988-2021, the corruption perception index in Mali exceeds this threshold. This indicates that current corruption in Mali is a brake on economic growth. These results are not consistent with those of Obad et al. (2021), Viet et al. (2020), Aliyu et al. (2008), Ondo (2017) and Biru (2010) who found a linear relationship between economic growth and corruption.

The results of the econometric estimations point to the existence of a non-linear relationship between corruption and economic activity. This would mean that there is an optimal threshold of corruption that maximizes economic growth:

this threshold is 0.0767 points. Thus, when corruption is below 0.0767 points, corruption positively affects Malian economic growth with an elasticity of 0.4785. However, when corruption exceeds this value, it becomes detrimental to Malian economic growth

In addition, the results of the estimation of the non-linear model reveal that in the long term, investment has a positive and significant effect on economic growth in Mali at the 1% threshold. This means that investment and growth move in the same direction. Thus, an increase in the gross fixed capital formation of 1%, all other things being equal, induces a growth level of 0.01%. In addition to the investment, the results show that agricultural value added is also a deteriorating factor in economic growth in Mali. Indeed, all other things being equal, a 1% increase in agricultural value added reduces economic growth in Mali by about 0.01%. The results also show that democracy is an important factor for economic growth in Mali. Indeed, the coefficient associated with the democracy variable is positive and significant, which suggests that an increase in the democracy index has positive effects on economic growth. Furthermore, the results showed that terrorism reduces economic growth in Mali. All else being equal, a 1% increase in terrorist actions reduces Mali's GDP per capita by about 0.23%. However, the dummy variable indicating the military takeover in Mali has a positive but insignificant effect on the variation of economic growth in Mali

Furthermore, the explanatory power of the non-linear model is better than that of the linear model, i.e. 80.40 % against 74.72 %.

5. Conclusion

The main objective of this study is to determine the threshold of corruption that maximizes economic growth in Mali. To achieve this general objective, we used a threshold effect model, namely a quadratic model. Indeed, our study covers the period from 1988 to 2021 and the results show that the optimal threshold of corruption that maximizes Malian economic growth is 0.0767 points. Thus, when corruption is below 0.0767 points, corruption positively affects Malian economic growth with an elasticity of 0. 3364. However, the corruption perception index in 2021 is well above this threshold, so Mali is on the right side of the curve. Above this threshold, corruption becomes detrimental to Malian economic growth. Furthermore, the results of the study showed that the quality of institutions and investment are the drivers of economic growth in Mali.

The results obtained in this study imply that measures to combat corruption in all its forms should be promoted, reinforced, and implemented. The easing of bureaucracy should also be a concern for policymakers. While these findings suggest that the promotion of economic growth requires the reduction of corruption, the latter requires knowledge of the sources of corruption, and the channels through which corruption affects economic growth. Thus, future research will focus on the determinants of corruption and on identifying the channels through which corruption affects economic growth.

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