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The Non-Linear Relationship Between Economic Growth and Public Debt

Karim Bouchrara
IHEC Carthage Business School, Tunisia

Houssem Rachdi
IHEC Carthage Business School, Tunisia & IPAG Business School, Paris, France

Khaled Guesmi
Center of Research for Energy and Climate Change, Paris School of Business, France

Abstract

This paper examines the non-linear relationship between public debt and economic growth while controlling for governance quality in a sample of 36 countries over the period 1990-2013 using a Panel Smooth Transition Regression (PSTR) framework. We document clear evidence of non-linearity in the impact of public debt on economic growth. Results from the PSTR model show that institutional quality including the level of respect for rules of law, low level of corruption and government stability influences the level of public debt, and its impact on economic growth.

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Contact: Karim Bouchrara - kboucherara@yahoo.fr, Houssem Rachdi - rachdih@uvic.ca, Khaled Guesmi - kalloda_fr@yahoo.fr.
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1. Introduction

This study contributes to the existing literature on the non-linear relationship between public debt and economic growth by controlling for the quality of governance. In recent times, empirical studies have emerged with focus on public debt and its negative impact on economic growth in both developed and developing countries. This negative impact has mainly been linked to the level of institutional quality and governance (see e.g., Jalles, 2011; Kourtellos et al., 2013; Cooray et al., 2017; Benfratello et al., 2018; Ivanyna et al., 2018; Raveh and Tsur, 2020; Borissov and Kalk, 2020). In particular, using a panel of 72 developing countries over the 1970-2005 period, Jalles (2011) concludes that the effect of debt on growth becomes negative and even higher in countries with lower corruption levels. The threshold level of debt at which the effect of debt on growth becomes negative should be higher than in countries with poor governance measured by the corruption control and political rights. Using a panel of 82 countries for the period 1980 to 2009, Kourtellos et al. (2013) document that higher public debt results in lower growth for countries in the Low-Democracy regime.

Furthermore, Cooray et al (2017) used the Ordinary Least Squares (OLS) and the system General Method of Moments (system GMM) techniques to test the relationship between corruption, shadow economy and public debt in a large panel of 126 countries over 1996-2012. They find that increase in corruption and a larger shadow economy lead to an increase in public debt. The study emphasized the need to reduce corruption and minimize its adverse effects on government debt through higher government expenditure. Similarly, using the Worldwide Governance Indicators (WGI) which comprises rule of law, control of corruption, government effectiveness, regulatory quality voice and accountability, political stability and the absence of violence/terrorism, Ben Ali and Zidi (2017) found that low governance quality is detrimental to economic growth in 17 countries from the MENA region over the period from 1996 to 2015.

Even more, Ivanyna et al (2018) developed a quantitative theory to analyze how the presence of corruption and tax evasion affect the formation of a country's fiscal policy using the WGI. They conclude that more corrupt economies tend to be associated with higher public debt, which lowers output growth and welfare. With a similar approach used a dataset of 166 advanced and developed countries over the period 1995-2015, Benfratello et al. (2018) found that corruption increases public debt and that this effect is stronger for advanced economies, but weaker for less-developed countries.

In this paper, we investigate the non-linear relationship between public debt and economic growth while controlling for governance quality in a sample of 36 countries using the PSTR framework. The remainder of this paper is as follows. Section 2 presents the methodology. Section 3 reports the main results and section 4 concludes.

2. Empirical strategy

Following past empirical analysis that document non-linear relationship between public debt and economic growth, we use the PSTR framework which enables us to characterise the presence of a threshold. Specifically, the model for this study may written as:

$$GDP_{it} = \alpha + \beta X_{it} + \xi \,\mathrm{DEBT}_{it} + \delta \,\mathrm{DEBT}_{it} * G(z_{it};\gamma;c) + \varepsilon_{it} \qquad (1)$$

Where, GDP is the Real GDP per capita and X_{it} is a k-dimensional vector of standard set of control variables applied in most growth regressions. This may include inflation (INF), trade (TRADE), government consumption (SIZE), investment (INV) and population (POP).

z_{it} is the transition variable. This study uses six measures of governance quality including law and order (LAW), corruption (CORP), external conflict (EXCO), internal conflict (INCO), investment profile (INVP) and government stability (GOVS**)**. Debt is the ratio of public debt to GDP (DEBT). An overview including a detailed description of all variables is provided in Table 1.

Table 1. Data Sources and Definitions

Variables	Definition	Source
Economic Growth (GDP)	Real GDP per capita growth	WDI
Inflation (INF)	Consumer price index	WDI
Trade (TRADE)	Terms of trade divided to GDP	WDI
Government consumption (SIZE)	Ratio of Government consumption to GDP	WDI
Population (POP)	Growth rate of total population	WDI
Investment (INV)	Gross fixed capital formation (% of GDP)	WDI
Public Debt (DEBT)	Public debt (% of GDP)	WDI
Law and Order (LAW)	"Law and Order" form a single component, but its two elements are assessed separately, with each element being scored from zero to three points. To assess the "Law" element, the strength and impartiality of the legal system are considered, while the "Order" element is an assessment of popular observance of the law. Thus, a country can enjoy a high rating – 3 – in terms of its judicial system, but a low rating – 1 – if it suffers from a very high crime rate if the law is routinely ignored without effective sanction (for example, widespread illegal strikes).	International Country Risk Guide (ICRG)
Corruption (CORP)	This is an assessment of corruption within the political system. Such corruption is a threat to foreign investment for several reasons: it distorts the economic and financial environment; it reduces the efficiency of government and business by enabling people to assume positions of power through patronage rather than ability; and, finally, introduces an inherent instability into the political process.	International Country Risk Guide (ICRG)
Internal Conflict (INCO)	This is an assessment of political violence in the country and its actual or potential impact on governance. The highest rating is given to those countries where there is no armed or civil opposition to the government and the government does not indulge in arbitrary violence, direct or indirect, against its own people. The lowest rating is given to a country embroiled in an on-going civil war. The risk rating assigned is the sum of three subcomponents, each with a maximum score of four points and a minimum score of 0 points. A score of 4 points equates to Very Low Risk and a score of 0 points to Very High Risk.	International Country Risk Guide (ICRG)
External Conflict (EXCO)	The external conflict measure is an assessment both risk to the incumbent government from foreign action, ranging from non-violent external pressure (diplomatic pressures, withholding of aid, trade restrictions, territorial disputes, sanctions, etc) to violent external pressure (cross-border conflicts to all-out war). The risk rating assigned is the sum of three subcomponents, each with a maximum score of four points and a minimum score of 0 points. A score of 4 points equates to Very Low Risk and a score of 0 points to Very High Risk.	International Country Risk Guide (ICRG)
Investment Profile (INVP)	This is an assessment of factors affecting the risk to investment that are not covered by other political, economic and financial risk components. The risk rating assigned is the sum of three subcomponents, each with a maximum score of four points and a minimum score of 0 points. A score of 4 points equates to Very Low Risk and a score of 0 points to Very High Risk.	International Country Risk Guide (ICRG)
Government Stability (GOVS)	This is an assessment both government's ability to carry out its declared program(s), and its ability to stay in office. The risk rating assigned is the sum of three subcomponents, each with a maximum score of four points and a minimum score of 0 points. A score of 4 points equates to Very Low Risk and a score of 0 points to Very High Risk.	International Country Risk Guide (ICRG)

The use of PSTR methodology offer some theoretical advantages. For instance, the PSTR allows the public-debt-economic growth coefficient to vary according to the country and with the time. That is, it provides a parametric approach to the cross-country heterogeneity and time instability of the public-debt-economic growth coefficients, since these parameters are assumed to change smoothly as a function of the threshold variable (Jude, 2010). Indeed, the non-linear effect (direct effect) is represented by a continuum of

parameters between two extreme regimes. The first extreme regime corresponds to $G(z_{it};\gamma;c)=0$ and is associated with low values of z_{it} while the second regime corresponds to $G(z_{it};\gamma;c)=1$ and is associated with high values of z_{it}. Therefore, as z_{it} increases, the effect of DEBT evolves from ξ to $\xi+\delta$ following a single monotonic transition centered around the value c of z_{it}. According to the properties of the transition function, we have $\xi \le e_{it} \le \xi+\delta$ if $\delta \succ 0$ or $\xi+\delta \le e_{it} \le \xi$ if $\delta \prec 0$ because $0 \le G(z_{it};\gamma;c) \le 1$. We note that the public debt-economic growth coefficient can be defined as a weighted average of parameters ξ and δ as follows:

$$e_{it}=\frac{\partial GDP}{\partial DEBT}=\xi+\delta * G(z_{it};\gamma;c) \tag{2}$$

Where ξ corresponds to the direct effect of public debt on growth only when the transition function $G(z_{it};\gamma;c)$ tends towards 0. In contrast, when $G(z_{it};\gamma;c)$ tends towards 1, the public debt-growth coefficient is equal to the sum of ξ and δ parameters.

Following Saidi et al. 2017, the empirical procedure for the PSTR model consists of the following 4 steps. In the first step , we test the null hypothesis of linearity (homogeneity) against the alternative of PSTR-type nonlinearity. We use the Fisher LM test $LM_F=\left[(SSR_0-SSR_1)/K\right]/\left[SSR_0/(NT-N-K)\right]$; where SSR_0 is the panel sum of squared residuals under the null hypothesis (H_0) of linear panel model with individual effects while SSR_1 is the panel sum of squared residuals under the alternative hypothesis (H_1) of PSTR model. *K* is the number of explanatory variables with an approximate $F(K, NT-N-K)$ distribution.

In the second step, if assumption of linearity is rejected, we proceed to choose between the Panel Exponential Smooth Transition Regression (PLSTR) and the Panel Logistic Smooth Transition Regression (PESTR) models using a sequence of tests of nested hypothesis. To do this, we rely on Teräsvirta (1994) which proposed a short sequence of ordinary Fisher test to decide between PESTR and PLSTR models. Furthermore, in the third step, we determine the number of regimes using a similar logic to the testing of the number of transition functions (r) in the model or an equivalent order of extreme regimes (r + 1). In this regard, Gonzalez et al. (2005) proposes a sequential approach for testing the null hypothesis of no remaining nonlinearity in the transition function. It starts with the test of whether there is one transition function $(H_0: r=1)$, or whether there are at least two transition functions $(H_1: r=2)$. The testing procedure continues until the first acceptance of the null hypothesis. Lastly, the fourth step proceeds with the estimation of the parameters in the selected PSTR model. Once the transition variable and its transition function are selected, the estimation of the PSTR model parameters become relatively straightforward through the application of fixed effect estimator and nonlinear least squares.

3. Data Collection and Empirical Results

The sample for this study consists of 36 countries including Albania, Argentina, Armenia, Azerbaijan, Brazil, Bulgaria, Belarus, Bosnia and Herzegovina, Chile, Costa Rica, Czech Republic, Estonia, Greece, Hungary, Kyrgyz Republic, Kazakhstan, Kirghizstan, Kosovo, Lithuania, Macedonia, Moldova, Poland, Portugal, Romania, Russian Federation, Slovenia, Slovak Republic, Spain, South Africa, Turkmenistan, Tajikistan, Tunisia, Uruguay, Uzbekistan, Ukraine and Venezuela.

We analyse the relationship between public debt, governance and economic growth over the period 1990-2013. As discussed earlier, we start with a homogeneity tests as proposed by

Peseran and Yamagata (2008). As presented in Table 2, the null hypothesis (H_0: *Slope coefficients are homogeneous*) requires the rejection that slope coefficients are homogeneous if the probability values of test statistic are within the significant level.

Table 2. Peseran and Yamagata (2008)'s Homogeneity Test

	Test Statistic	*P*-value
Δ	-1.719	0.943
Δ adjusted	-2.142	0.997

As shown in Table 1, the null hypothesis that homogeneity is accepted following the non- significant value of the delta test statistic. This is intended to determine whether the slope coefficients are different among cross sections. The non-significant delta value leads us to accept that slope coefficients are homogenous, which makes sense given the similarities of countries in the sample for this study.

The descriptive statistics of the variables for this study is presented in Table 3 below while Table 4 presents the correlation coefficients. Results show the absence of bi-variable multi-colinearity given that the highest correlation value is about 0.372.

Table 3. Descriptive Statistics Related to the Study Variables

VARIABLES	Observation	Mean	St.Deviation	Min	Max
GDP	805	2.516	7.660	-40.769	92.360
SIZE (%GDP)	815	81.596	14.780	14.634	171.821
INV (%GDP)	815	22.723	6.310	5.199	57.709
INF	701	61.998	323.410	-10.630	4734.915
POP	863	0.363	1.148	-10.955	2.864
TRADE (%GDP)	819	82.917	34.979	13.753	199.675
DEBT (%GDP)	299	42.641	30.605	0 .263	181.929
LAW	582	4.062	0.961	1	6
CORP	573	2.981	1.075	1	5
INCO	559	10.623	1.185	6.25	12
EXCO	561	10.122	1.269	4.416	12
INVP	547	8.473	2.461	2	12
GOVS	565	8.269	1.787	2.916	12

Note: Real GDP per capita growth (GDP), Inflation (INF), Trade (TRADE), Population (POP), Investment (INV), Government consumption (SIZE), Public Debt (DEBT), Law and Order (LAW), Corruption (CORP), Internal Conflict (INCO), External Conflict (EXCO), Investment Profile (INVP) and Government Stability (GOVS).

Table 4. Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
SIZE (1)	1.000						
INV (2)	-0.233	1.000					
INF (3)	0.012	-0.076	1.000				
POP (4)	-0.135	-0.077	-0.049	1.000			
TRADE (5)	-0.032	0.367	-0.006	-0.344	1.000		
DEBT (6)	0.224	-0.491	-0.078	-0.011	-0.148	1.000	
LAW (7)	0.101	0.332	-0.167	-0.253	0.061	0.070	1.000
CORP (7)	-0.066	-0.038	0.060	0.326	-0.356	0.134	1.000
INCO (7)	-0.146	0.326	-0.268	-0.207	0.372	-0.009	1.000
EXCO (7)	0.016	0.069	-0.083	-0.004	-0.002	0.080	1.000
INVP (7)	-0.252	0.005	-0.411	-0.067	0.200	0.120	1.000
GOVS (7)	-0.0009	-0.014	0.102	-0.002	-0.016	-0.099	1.000

Note: Inflation (INF), Trade (TRADE), Population (POP), Investment (INV), Government consumption (SIZE), Public Debt (DEBT), Law and Order (LAW), Corruption (CORP), Internal Conflict (INCO), External Conflict (EXCO), Investment Profile (INVP) and Government Stability (GOVS).

We proceed with the linearity test using the Fisher LM test as presented in Table 5. As we can observe, the null hypothesis that the model is linear is rejected for all the transition variables. We can conclude that the relationship is non-linear. After rejecting the null hypothesis of linearity, we proceed to choose between a PSTR and a PESTR model using the

sequence test of Fisher as presented in Table 6. Results from Table 6 permits us to choose the PESTR over the PLSTR model.

Table 5. LM Fisher linearity test

Variables de transition	Test LM_F	P-Value
LAW	3.614**	(0.012)
CORP	21.16***	(0.000)
INCO	14.99***	(0.000)
EXCO	5.496***	(0.000)
INVP	4.754***	(0.001)
GOVS	7.266***	(0.000)

Note: H_0: linear model Vs H_1: PSTR model with at least one threshold. The numbers in parentheses are p- values of F-statistics. Law and Order (LAW), Corruption (CORP), Internal Conflict (INCO), External Conflict (EXCO), Investment Profile (INVP) and Government Stability (GOVS).

Table 6. Sequence test of Fisher: Choice between PESTR and PLSTR

Non-linear Variables	PLSTR		PESTR
LAW		**F stat**	**P-value**
	H01	0.9216	0.3982
	H02	2.5500	0.0786
	H03	0.2433	0.7840
CORP		**F stat**	**P-value**
	H01	18.231	0.000
	H02	33.322	0.000
	H03	9.5416	0.000
INCO		**F stat**	**P-value**
	H01	4.859	0.008
	H02	30.276	0.000
	H03	8.9125	0.000
EXCO		**F stat**	**P-value**
	H01	11.357	0.000
	H02	25.747	0.000
	H03	36.019	0.000
INVP		**F stat**	**P-value**
	H01	8.069	0.047
	H02	6.526	0.004
	H03	4.593	0.075
GOVS		**F stat**	**P-value**
	H01	5.423	0.000
	H02	3.981	0.007
	H03	2.779	0.000

Note: Law and Order (LAW), Corruption (CORP), Internal Conflict (INCO), External Conflict (EXCO), Investment Profile (INVP) and Government Stability (GOVS).

Having confirmed the presence of non-linear relationships and that the PSTR is the appropriate choice of model, we proceed to identify the number of transition functions. To achieve this, we rely on the sequential F-test. The LM_F is generally used for the no remaining nonlinearity test, enabling us to test for the number of regimes as presented in Table 7.

Table 7. No remaining nonlinearity test: Test of number of regimes

Transition variables	H_0 : 1 regime vs H_1 : 2 regimes	H_0 : 2 regimes vs H_1 : 3 regimes
LAW	F = 35.601 (0.000)	F = 1.315 (0.896)
CORP	F = 20.010 (0.000)	F = 0.241 (0.997)
EXCO	F = 3.476 (0.062)	F = 0.173 (0.995)
INCO	F = 60.133 (0.000)	F = 0.23 (0.873)
INVP	F = 76.614 (0.000)	F = 0.614 (0.975)
GOVS	F = 71.651 (0.000)	F = 0.634 (0.963)

Note: The numbers in parentheses are p- values of F-statistics. Law and Order (LAW), Corruption (CORP), Internal Conflict (INCO), External Conflict (EXCO), Investment Profile (INVP) and Government Stability (GOVS).

As shown in Table 7, we can observe that the model with one threshold (i.e two regimes), adequately captures the non-linear relationship. Thus, a PSTR model with one transition function appear to be appropriate for the objectives of this paper. Table 8 presents the PSTR estimates using the Nonlinear Least Squares method as explained in the fourth step of our estimation stages.

Table 8. Public debt, governance and Economic Growth: PSTR model estimation with two regimes

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	LAW	CORP	EXCO	INCO	INVP	GOVS
SIZE	-0.093***	-0.090***	-0.095***	-0.112***	-0.170***	-0.113***
	(4.637)	(4.720)	(4.720)	(4.771)	(4.070)	(4.041)
INF	0.613*	0.601*	0.559*	0.766**	-0.207***	-2.187*
	(1.666)	(1.641)	(1.568)	(2.043)	(2.834)	(1.177)
TRADE	0.010***	0.008**	0.009***	0.008**	-0.546***	-5.601*
	(3.100)	(2.442)	(2.905)	(2.576)	(3.154)	(1.665)
POP	0.026	0.023	0.019	0.024	-0.493	-4.583
	(0.860)	(0.765)	(0.661)	(0.797)	(0.063)	(0.063)
INV	-1.328***	-1.284***	-1.343***	-1.354***	-4.054**	4.248***
	(5.482)	(5.310)	(5.567)	(5.390)	(2.043)	(5.072)
DEBT	-1.407	-22.744	0.199	-1.073	1.409	1.571
	(0.767)	(0.003)	(0.046)	(0.571)	(0.073)	(0.073)
DEBT*G	0.186***	0.203***	0.185***	0.194***	0.142*	1.853*
	(5.800)	(6.382)	(5.766)	(5.592)	(1.824)	(1.668)
γ	0.322	0.631	1.261***	8.143	1.147	5.147***
	(1.456)	(0.233)	(2.758)	(0.287)	(0.731)	(2.834)
c	3.122**	2.636***	9.533***	9.166**	7.571**	8.073**
	(2.148)	(3.300)	(2.671)	(2.392)	(2.651)	(2.472)

Note: c: the threshold. parameter and γ the slope parameter.

The numbers in parentheses are absolute value of t-statistics. *, **, and *** indicate statistical significance at the 1%, 5%, and 10% level. Dependent variable is the Real GDP per capita growth.

Explanatory variables are: Inflation (INF), Trade (TRADE), Population (POP), Investment (INV), Government consumption (SIZE), Public Debt (DEBT), Law and Order (LAW), Corruption (CORP), Internal Conflict (INCO), External Conflict (EXCO), Investment Profile (INVP) and Government Stability (GOVS).

We can observe from Table 8 that all the control variables have the expected signs. The slope parameter γ appears to be low for all the transition variables with the highest value being about 8.143. We may therefore conclude that a smooth transition and consequently, the PSTR model is an appropriate model for this study. The implication of this finding is that when we control for these variables, the relationship between public debt and economic growth should not be restricted to a limited number of regimes. Also, we found that the shift between the two extreme regimes occurs around the location parameter c. The 6 location parameters seem far from their respective mean values as reported in Table 3. This permits us to conclude that only countries with good institutions can exploit the advantages of public debt on economic growth. These results also confirm the existence of non-linear relationship between public debt and economic growth.

Economic growth is less sensible to public debt in countries with low institutions. We find an instable direct negative impact of public debt on economic growth as measured by ξ, with insignificant coefficient values for the six models having values as follows -1.407, -22.744, -0.199, -1.073, -1.409 and -1.571, respectively. This result is consistent with the findings of previous studies including Reinhart and Rogoff, 2010; Egbetunde, 2012; Baum et al, 2013; Kasidi and Said, 2013; Égert, 2015; Lopez DaVeiga et al, 2015; Woo and Kumar, 2015; Owusu-Nantwi and Erickson, 2016; Jilenga et al., 2016; Bahal et al, 2018; De Vita et

al, 2018. In particular, these studies demonstrate that there is a negative relationship between public debt and economic growth.

Lastly, we find that for all the transition variables, public debt-economic growth coefficient as represented by δ is positive and statistically significant with values ranging between 0.142 and 0.203. This implies that an increase in the transition variables entails an increase of public debt-growth coefficient. In Countries with high level of institutional quality, there is positive effect of public debt on economic growth. This is consistent with the findings of Cooray and Schneider (2013); Cooray et al (2017). This confirms the idea that good institutions including respect for rules of law, low level of corruption and government stability are considered one of the main factors for outcome maximization for all countries. This clearly points out that high institutional quality influences the level of public debt and consequently growth.

4. Conclusion

This paper has sheds new light on the relationship between public debt and economic growth by considering the role of governance on using a panel of 36 countries over the period 1990-2013. We demonstrate that the effect of public debt on economic growth is conditioned by the level of institutional quality. However, these results should be interpreted with caution given that they appear to sensitive, particularly the parameter measuring transition smoothness and the small estimation period.

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