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Debt, economic growth and threshold effects: Evidence from developing countries

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Abstract

Purpose – Most empirical papers on threshold effects between debt and growth focus on developed countries or a mix of developing and developed economies, often using public debt. Evidence for developing economies is inconclusive, as is the analysis of other threshold effects such as those probably caused by the level of relative development or the repayment capacity. The objective of this study was to examine threshold effects for developing economies, including external and total debt, and identify them in the debt-growth relation considering three determinants: debt itself, initial real Gross Domestic Product (GDP) per capita and debt to exports ratio.

Design/methodology/approach – We used a panel threshold regression model (PTRM) and a dynamic panel threshold model (DPTM) for a sample of 47 developing countries from 1970 to 2019.

Findings – We found (1) no evidence of threshold effects applying total debt as a threshold variable; (2) one critical value for external debt of 42.32% (using PTRM) and 67.11% (using DPTM), above which this factor is detrimental to growth; (3) two turning points for initial GDP as a threshold variable, where total and external debt positively affects growth at a very low initial GDP, it becomes nonsignificant between critical values, and it negatively influences growth above the second threshold; (4) one critical value for external debt to exports using PTRM and DPTM, below which external debt positively affects growth and negatively above it.

Originality/value – The outcome suggests that only poorer economies can leverage credits. The level of the threshold for the debt to exports ratio is higher than that found in previous literature, implying that the external restriction could be less relevant in recent periods. However, the threshold for the external debt-to-GDP ratio is lower compared to previous evidence.

Keywords Total debt, External debt, Economic growth, Developing countries, Threshold effects

Paper type Research paper

1. Introduction

The debate on the harmful effects of debt on economic growth has gained more interest in recent decades, since several emerging countries with doubtful capacity of repayment have reached high indebtedness levels.

The Latin American experiences of defaults during the 1980s and 1990s were linked to very poor economic performance. Not long ago, the consequences of the 2008 global crisis in developed countries restricted access to financial markets for developing economies (or even suddenly blocked it) and abruptly increased financial costs. This context highlights the relevance of discussing the relation between debt and economic growth in developing nations.

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An important reference point to address is the possible existence of threshold effects. Nonlinearities in the form of threshold effects imply that the exogenous variable has heterogeneous impacts on the endogenous variable at different stages of the analysis. If threshold effects are identified, sustainable differences may appear in explaining per capita growth rates, even between economies with similar structures (Azariadis & Drazen, 1990). In particular, a parametric threshold model describes the *jumping character* in the relationship between variables (Wang, 2015).

For developed countries, existence of a threshold effects seems achieve consensus in the literature.. In this sense, Baum, Checherita-Westphal, and Rother (2013) found threshold effects between growth and public debt for countries in the eurozone and determined that the debt-to-GDP ratio threshold is 95%, while Cecchetti, Mohanty, and Zampolli (2012) suggested that such threshold is 96%. In contemporary paper, Minea and Parent (2012) employed the panel smooth threshold regression model and observed that there is a negative effect of public debt on growth when the level of debt is between 90% and 115% of GDP. In addition, Greiner (2011) noticed that the optimal level of public debt ranges between 43% and 63% of GDP for 18 countries of the organization for economic co-operation and development (OECD).

However, according to Égert (2015), even though several contributions indicate that there is a threshold of public debt-to-GDP ratio of about 90%, no clear consensus exists over this matter. In this sense, in a recent research, for a wide sample of 20 advanced economies during 1880–2010, Bentour (2020) found a heterogeneous relationship between public debt and growth depending on the sample and the period analyzed. In other words, this link is unstable whether by country, by group of countries or across different periods. In particular, while, for a set of nations, economic growth slows starting from low debt levels during the postwar period, others show a successful performance from low to medium debt levels, and some economies verify flat curves in the debt-growth relationship.

By jointly examining developed and developing countries and applying a panel smooth transition regression, Karadam (2018) observed that the nonlinearity of the relationship between debt and growth is mostly subject to the structure of debt. Meanwhile, the threshold is lower for emerging economies and, both in short-term and public long-term external debt, generates a more pronounced and stronger negative impact on growth for high levels of indebtedness. In a sample of low- and middle-income nations during the period 1990–2007, Presbitero (2012) affirmed that public debt begins to be an obstacle to output growth up to a threshold of 90% of GDP. The same result was obtained by Woo and Kumar (2015) for public debt. For their part, Reinhart and Rogoff (2010) evidenced threshold effects for both emerging and advanced countries: above such threshold, debt reduces economic growth, in particular during prolonged periods of high debt levels. These authors analyzed the difference in behavior according to the level of development of the economies and between public and external debt. In their investigation, they found that the threshold for public debt is similar in advanced and emerging economies, with emerging markets facing lower thresholds for external debt (public and private).

On the other hand, there are studies that did not identify threshold effects between debt and growth. Using the structural threshold regression (STR) model, Kourtellos, Stengos, and Tan (2013) concluded that the relationship between public debt and growth is crucially mitigated by institutional quality. The authors confirmed threshold effects based on democracy, which implies that higher public debt results in lower growth for countries with poor-quality democracy. In this work, the non-linear effect was not observed when the institutional variables were omitted. In this line, Ash, Basu, and Dube (2017), Baglan and Yoldas (2016), Pescatori, Sandri, Simon, and Helbling (2014), and Eberhardt and Presbitero (2013), among others, presented evidence for various groups of countries questioned non-linearities.

Finally, for developing nations the data is more recent. Imbs and Ranciere (2005) detected threshold effects between debt and growth, by applying non-parametric techniques in a sample of 87 developing countries from 1969 to 2002. This is significantly negative once the debt-to-GDP and debt to exports ratios surpass the thresholds of 60% and 200%, respectively. For their part, Cordella, Ricci, and Ruiz-Arranz (2005) noted a negative marginal relationship between intermediate levels of stock debt and product growth in heavily indebted poor countries (HIPCs). However, the authors found threshold effects between stock debt and economic growth. They showed that the former does not seem to have any effect at high and low levels, but it does at intermediate ones. Similarly, for a large panel data set of 93 developing nations over 1969–1998, Poirson, Ricci, and Pattillo (2002) stated that external debt negatively affects economic growth from a debt-to-GDP higher than 35% and a debt to exports ratio of 160%. However, these effects are lower in developed economies.

For African countries, by means of a panel smooth transition regression approach and dynamics methods, Ndoricimpa (2020) identified a public debt threshold in the range of 62%–66% and, while low public debt is found to be either growth neutral or growth enhancing, high public debt is consistently detrimental to growth. Moreover, Law, Ng, Kutan, and Law (2021) calculated the threshold value of public debt-to-GDP in 71 ratio developing nations from 1984 to 2015, which was 51.65%. Debt has a negative and statistically significant impact on economic growth at a high level of public debt, but this is an insignificant at a low level.

In sum, literature on threshold effects focuses, to a larger extent, on developed countries or a mix of developing and developed economies using mostly public debt as debt definition, with some agreement regarding a possible threshold of 90% in the public debt-to-GDP ratio. On the contrary the studies evaluating the relationship for developing economies obtained more heterogeneous results, both in the existence of thresholds and, if any, in their value. Another aspect under discussion refers to the debt indicator that should be used when exploring this potential nonlinear relationship. Additionally, implementing of threshold effect models is the most accepted strategy to evaluate nonlinearities.

Thus, the objective of this paper was to analyze how total and external debt affect economic growth in a sample of 47 developing countries for the recent period 1970–2019. This assessment considered potential threshold effects of the initial relative development degree (approximated by the initial real GDP per capita), the external debt burden or repayment capacity (indicated by the external debt to export ratio) and the level of total and external debt itself (as debt-to-GDP ratios). To determine if the behavior of debt on growth changes at different debts levels, stages of development and burden of indebtedness, panel threshold regression models (PTRMs) were estimated following the methodology of Hansen (1999). Moreover in order to have robust results and to evaluate the existence of endogeneity for the threshold variables, the dynamic panel threshold models (DPTMs) were applied based on Seo and Shin (2016) and Seo, Kim, and Kim (2019).

In this article, we incorporated two concepts of debt: total debt and external debt. The first is from the global debt database (GDD) of the international monetary fund (IMF) and is defined as the total gross debt of the nonfinancial sector (private and public) as a percentage of GDP. The second is from the world development indicators (WDI), of the World Bank (WB) and refers to the total external debt stocks to gross national income. Furthermore, the relation between external debt and exports was considered as a factor influencing threshold effects since exports are the genuine source of foreign exchange earnings and developing economies have historical disadvantages in exploiting their balance of payments. A vast literature asserts that external restrictions seriously hinder debt repayment and to growth (Fischer, 2018; Tanna, Li, & De Vita, 2018; Basu, Boz, Gopinath, Roch, & Unsal, 2020). In addition, economies with endemic deficits in the external balance tend to incur external debt in order to bridge the gap between inflows and outflows of foreign exchange.

The particular interest in developing countries is explained in several ways. On the one hand, these economies have demonstrated different performance regarding indebtedness and growth in spite of considering having relatively homogeneous economic structures. On the other, it is precisely developing nations that show higher levels of external debt (hence the interest in adopting this definition of debt for the study) and have sometimes required debt relief policies (i.e. HIPCs).

The contribution of the paper is summarized in four aspects. First, this study presents further evidence on the profile of the debt-economic growth relationship and, in particular, on the limits of indebtedness for a large sample of developing countries for the period 1970–2019. These new results are especially relevant because they cover the debt crisis episodes of the 1970s and 1980s, and the last ten years since the 2008 crisis. Second, our estimations found different thresholds than those previously found in the literature for developed countries or a set of developed and developing economies. Third, this analysis addresses different definitions of debt without specifying public debt, which is the variable mostly used by authors that evaluate nonlinearities for developed and developing nations. In turn, the economic policy recommendations that arise from our results are that governments should adopt a prudent borrowing strategy, to avoid the detrimental effect of a large debt burden on economic growth. Finally, we revealed a robust nonlinear relationship between debt and economic growth but the most powerful variable as a threshold is the initial level of development. This indicates that the nonlinear relationship depends strongly on the initial GDP of the economies, showing that the total and external debt is an instrument that promotes growth in economies with low levels of development but not those with better performance within the group of developing nations. In other words, the latter have a heterogeneous behavior regarding incurring on debt to promote their growth.

2. Methodology

2.1 Data

We employed a balanced panel data set of five years covering 47 developing countries in 1970–2019 (Table A.1 in Appendix). The dependent variable was computed as the mean of the growth rate of the real GDP per capita over each time interval. The independent variable of main interest is the debt-to-GDP ratio (debt, hereinafter), which was obtained from two different sources in order to strengthen the analysis: the global debt dataset of the IMF and the external debt and financial flows statistics of the WB. Then, the two proxies of debt have dissimilar definitions. The IMF debt variable refers to the total gross debt of the non-financial sector (private and public) as a percentage of GDP, while the WB indicator is the total external debt stocks to gross national income. Here, external debt is the sum of the public, publicly guaranteed and private nonguaranteed long-term debt, the use of IMF credit, and the short-term debt. This decision was based on the fact that the interpretation of debt throughout the literature, reviewed in the introduction, is changing and definitions of external, public debt and private were adopted. For this reason, since the interest of this article was to analyze the relationship between debt and growth in a broad sense, we considered two different definitions and estimated the models on both concepts.

In addition, we also included eight control variables according to the growth literature (Levine & Renelt, 1992; Dabús & Laumann, 2006; Rojas, Monterubbianesi, & Dabús, 2019). All variables were taken as five-year nonoverlapping averages [1] and sampled from the WDI. The human capital variable, extracted from the Penn World Table (PTW), is provided in five-year periods, so it was not constructed but rather collected from the information source. The control variables are defined below:

(1) Investment is the log of gross capital formation as a percentage of GDP.

(2) Initial GDP is the lagged real GDP per capita (in logs).

(3) Openness is the log of exports plus imports to GDP.

(4) Life expectancy is the log of the average life expectancy at birth.

(5) Public expenditure is the log of government consumption to GDP.

(6) Inflation is a semi-log transformation of the average variation of the GDP deflactor.

(7) Population is the log of the average population growth rates plus 0.05.

(8) Human capital is the index of human capital proposed by the PWT 7.0 (variable).

The threshold variables considered are the initial GDP (as defined above) and the debt to exports ratio, which was computed as external debt-to-GDP divided by exports-to-GDP obtained from the WDI. Table A.2 in Appendix summarizes the descriptive statistics of the variables.

We also included institutional variables (i.e. corruption, histories of non-compliance with debt commitments). However, when incorporating these variables, due since the methodology requires strongly balanced panels, these were sharply reduced in the set of countries and in the feasible time period to be analyzed. This reduction in the panels did not allow making estimates with all the control variables, losing the robustness of the results obtained. Therefore, this assessment is not reported in the body of the paper. However, the absence of variables that reflect these issues is recognized as a weakness of the study.

2.2 Econometrics

As mentioned, the main purpose of this paper was to analyze the existence of a threshold effects between debt and economic growth from different perspectives. To this end, in a first stage, the methodology of threshold effect models introduced by Hansen (1999) was applied. Threshold regression models maintain that individual estimates can be divided into classes according to the value of an observable.

Due to the objective of the paper, the estimated model is shown below:

$$\begin{aligned} Growth_{it} = u_i + \beta_1 \frac{debt}{GDP_{it}} (I(q_{it}(\gamma)) + \beta_2 Investment_{it} + \beta_3 initial\ GDP_{it} \\ + \beta_4 life\ expectancy_{it} + HC_{it} + \beta_6 Open_{it} \\ + \beta_7 Pop_{it} + \beta_8 Inflation_{it} + \beta_9 PE_{it} + e_{it} \end{aligned} \quad (1)$$

q_{it} could be debt-to-GDP, initial GDP, debt to exports ratio based on the corresponding estimate.

In this paper, following Hansen (1999), a nondynamic PTRM with individual fixed effects was estimated. The technique required a balanced panel data (Wang, 2015). The general definition of the model for a set of i individuals (countries in this study) and t time periods is given by the following equation:

$$y_{it} = u_i + \beta_1' x_{it} I(q_{it} \leq \gamma) + \beta_2' x_{it} I(q_{it} > \gamma) + e_{it} \quad (2)$$

where $I(\cdot)$ is the indicator function (that is, it defines the value of the estimation coefficients according to the value of the threshold variables); u_i is the fixed effect; q_{it} is a scalar of the threshold variables; x_{it} is a vector of the explanatory variables (it is assumed that there are k explanatory variables); β represents the coefficients to be estimated, which indicate the effect of each endogenous variable on the exogenous one; γ is the threshold parameter; and e is a random error term (it is assumed to be independent and identically distributed [iid] with mean

zero and finite variance σ^2). Since the indicator function expresses a set of values for β depending on the thresholds values, an alternative way of expressing (2) is shown below:

$$y_{it} = \{ u_i + \beta_1' x_{it} + e_{it}, \qquad q_{it} \leq \gamma \; u_i + \beta_2' x_{it} + e_{it,} \qquad q_{it} > \gamma \} \tag{3}$$

and a compact representation of (2), with $\beta = (\beta_1' \beta_2')'$ is as follow:

$$x_{it}(\gamma) = \begin{pmatrix} x_{it} I(q_{it} \leq \gamma) \\ x_{it} I(q_{it} > \gamma) \end{pmatrix} \tag{4}$$

The model can be estimated by non-linear least squares (NLLS), and Equation (3) is reformulated as shown below:

$$y_{it} = u_i + x_{it}(\gamma) + e_{it} \tag{5}$$

The observations were divided into two "regimes," depending on whether the threshold variable q is smaller or larger than the threshold γ. The regimes are distinguished by β_1 and β_2, as regression slopes. Ti identify of β_1 and β_2, the elements of x_{it} were required to be nontime invariant (Hansen, 1999).

As already mentioned, fixed effects were applied in this paper. In fixed effects models, the individual effects for each unit u_i are not observable; therefore, they must be eliminated for the estimation. For this, the within transformation was used; that is, the variables were redefined as the distance with respect to their mean. Hence, the model is expressed in accordance with Equation (6).

$$y_{it}^{*} = \beta' x_{it}^{*} + e_{it}^{*} \tag{6}$$

The variables indicated with * represent the deviation from their mean. One of the great strengths of this methodology is that it allows calculating the value of the coefficients for each section of the threshold variable and, also, the value of those thresholds endogenously from the minimization of the sum of the squared residuals. In the case of this study, the values assessed correspond to the various levels of GDP per capita and the debt to exports ratio from which the debt to growth relationship changes their behavior. Given $\widehat{\gamma}$, the value of β can be obtained from (5) as follows:

$$\widehat{\beta} = \beta(\widehat{\gamma}) = (\beta_1(\widehat{\gamma}) \, \beta_2(\widehat{\gamma}) \,) \tag{7}$$

The model can be generalized considering the existence of r thresholds s $\gamma_1, \ldots, \gamma_r$ as shown below:

$$y_{it} = u_i + \sum_{j=1}^{r} \beta_j' x_{it} \leq (\gamma_{j-1} \leq q_{it} \leq \gamma_j) + e_{it} \tag{8}$$

Hansen (1999) observed that, by means of an inference analysis through an F test, it is possible to find the optimal number of regimes. In this case, two alternative numbers of thresholds were considered, starting, in principle, from the hypothesis of nonexistence of thresholds versus existence of a threshold, followed by existence of a threshold versus two thresholds, and so on. For example, for the first case, the null hypothesis will be $H_0 : \beta_1 = \beta_2$ and the value of the statistic will be given by (9):

$$F_1 = \frac{SSR_0 - SSR_1(\widehat{\gamma})}{(\widehat{\sigma^2})} \tag{9}$$

If the null hypothesis were rejected, this would imply that the slopes of the estimated models with and without thresholds vary and, thus, it would be necessary to consider the existence of different regimes. Additionally, we used robust standard errors estimators for the fixed effects regression to correct for heteroscedasticity.

In order to deal with potential endogeneity of the threshold variables and check the robustness of the results, we also applied the DPTM technique developed by Seo and Shin (2016). Unlike Hansen's methodology, DPTM only detects one threshold (and two regimes), but admits heterogeneous parameters for all explanatory variables. Specifically, the authors extended the approaches of Hansen (1999) and Caner and Hansen (2004) to the dynamic panel data model with endogenous threshold variable and regressors. DPTM uses a general GMM approach based on first difference (FD) transformation, allowing both the threshold variable and the regressors to be endogenous. This strategy was proposed to overcome the limitation implied by the assumption of exogeneity of the regressors and/or the transition variable used in static estimates such as the one introduced by Hansen (1999). Within the technique of Seo and Shin (2016) a t-statistic was developed to test the exogeneity of the threshold variable, with the null hypothesis of the test being the strict exogeneity of the variable that would have a nonlinear effect.

3. Results and discussion

3.1 Empirical evidence: PTRM

The first group of estimations in Table 1 use total debt from the IMF (models A and B) and external debt from the WB (models C and D) both as a threshold and as an independent variable. Table 2 summarizes the threshold levels calculated for each model and the confidence intervals. Table A.3 in Appendix exhibits the threshold effect test. The null hypothesis is the nonexistence of threshold against the alternative hypothesis of one threshold existence. If the null hypothesis is rejected, the subsequent tests allow obtaining the number of significant thresholds. In search of robustness, the existence of a threshold is confirmed with a minimum level of 5% of significance.

As Table 2 and Table A.3 show there is no evidence of threshold effects using total debt as a threshold variable. The levels of total debt-to-GDP of 1.4341 and 0.9551 calculated in models A and B, respectively, are not significant. In this sense, we cannot affirm that total debt has a heterogeneous behavior on growth for different levels of debt.

Conversely, the estimations confirm a threshold of 42.32% at 5% significance levels using external debt as a threshold variable (models C and D). This outcome suggests that a country's external debt below the level of 42.32% promotes its economic growth, whereas it is not significant as an explanatory variable for growth above said threshold.

In addition, the other explanatory variables such as investment, initial GDP, human capital and inflation have the expected signs. Investment is positively and significantly correlated with growth, while inflation has a negative relation with economic performance. The negative sign of the initial GDP coefficient is evidence in favor of the conditional convergence hypothesis. Life expectancy is only significant as an explanatory variable in model B, showing a positive correlation with growth. On the other hand, openness and public expenditure seem to have a nonsignificant effect on growth. Finally, population positively affects economic growth only in models C and D, with a 10% significance level.

Table 3 shows the estimations using initial GDP as a threshold variable. Total and external debts are the explanatory variables considered in models A-B and C-D, respectively. Once again, Table 4 summarizes the levels of threshold determined in the different estimations, and Table A.4 in Appendix exhibits the threshold effect tests.

There is strong evidence of threshold effects of initial GDP in the debt-economic growth relation. From Table 3, model A shows only one significant threshold of U$S372.71 below

Dependent variable: Economic growth Independent variables	(A)	(B)	(C)	(D)
Investment	0.0250***	0.0268***	0.0225***	0.0257***
	(0.0059)	(0.0052)	(0.0057)	(0.0060)
Initial GDP	−0.041***	−0.0431***	−0.0416***	−0.0418***
	(0.0078)	(0.0074)	(0.0086)	(0.0084)
Life expectancy	0.0226	0.0407**	0.0170	
	(0.0198)	(0.0192)	(0.0189)	
Human capital	0.0343***	0.0295***	0.0348***	0.0409***
	(0.1157)	(0.0075)	(0.0118)	(0.0090)
Openness	0.0128		0.0165	
	(0.0090)		(0.0106)	
Population	0.0280		0.0304*	0.0321*
	(0.1878)		(0.0177)	(0.0161)
Inflation	−0.0090***	−0.0069**	−0.0084***	−0.0084**
	(0.0022)	(0.0027)	(0.0027)	(0.0032)
Public expenditure	−0.0077		−0.0073	
	(0.0062)		(0.0059)	
Constant	0.0426	0.0332	0.0561	0.0947
	(0.0056)	(0.0805)	(0.0778)	(0.0633)
Debt				
β_1	−0.0111*	−0.0146**	0.0352***	0.0340***
	(0.0056)	(0.0059)	(0.0079)	(0.0078)
β_2	0.0037**	−0.0001	0.0031	0.0025
	(0.0017)	(0.0028)	(0.0022)	(0.0022)
No.	45	45	41	41
F stat	21.59	27.54	28.18	14.36

Table 1.
Estimations using total and external debt as threshold variables

Note(s): Standard errors are in parentheses. The estimations under robust variance and covariance errors automatically eliminate some countries from the panel. ***, ** and * indicate the 1, 5, and 10% significance levels, respectively
Source(s): Table by authors

Debt indicator	Model	Threshold level ratio	Confidence interval (95%)	
Total debt as threshold variable	(A)	1.4341	1.3514	1.4626
	(B)	0.9551	0.9230	0.9606
External debt as threshold variable	(C)	0.4232**	0.4086	0.4280
	(D)	0.4232**	0.4086	0.4280

Table 2.
Estimated threshold levels for total and external debt

Note(s): *** and ** indicate the 1% and 5% significance levels, respectively
Source(s): Table by authors

which total debt positively affects growth, becoming non-significant above such initial GDP level. The other three estimations (B, C and D) suggest the existence of two thresholds of initial GDP. Thas means that, at low initial GDP levels, debt (total and external) promotes economic growth (β_1 is positive and statistically significant at 1% in A, B, C and D). Then, for medium levels of initial product, it would not be possible to support a relationship between debt and growth (β_2 is not significant for all models in Table 1). Meanwhile, debt negatively affects economic growth in countries with a higher initial GDP.

Then, we could establish three regimes in models B, C and D. For example, the first one in model D includes those economies whose initial GDP per capita is below $373.08. The second

Dependent variable: Economic growth Independent variables	(A)	(B)	(C)	(D)
Investment	0.0274***	0.0279***	0.0261***	0.0264***
	(0.0055)	(0.0051)	(0.0052)	(0.0050)
Initial GDP	−0.0383***	−0.0346***	−0.0355***	−0.0346***
	(0.0074)	(0.0073)	(0.0084)	(0.0076)
Life expectancy	0.0354**	0.0477**	0.0326*	0.0535**
	(0.0170)	(0.0208)	(0.0182)	(0.0202)
Human capital	0.0301**	0.0242***	0.0286**	0.0224***
	(0.0099)	(0.0072)	(0.0107)	(0.0077)
Openness	0.0080		0.0138	
	(0.0086)		(0.0106)	
Population	0.0180		0.0227	
	(0.0182)		(0.0168)	
Inflation	−0.0064***	−0.0044***	−0.0026	
	(0.0018)	(0.0014)	(0.0019)	
Public expenditure	−0.0064		−0.0019	
	(0.0050)		(0.0059)	
Constant	−0.0138	−0.0539	−0.0351	−0.0670
	(0.0725)	(0.0856)	(0.0749)	(0.0842)
Debt				
β_1	0.0351***	0.0401***	0.0373***	0.0462***
	(0.0075)	(0.0097)	(0.0079)	(0.0109)
β_2	−0.0004	0.0002	−0.0007	−0.0019
	(0.0033)	(0.0015)	(0.0018)	(0.0013)
β_3		−0.0127**	−0.0148**	−0.0169***
		(0.0062)	(0.0066)	(0.0050)
No.	45	45	41	41
F stat	38.1	49.57	23.89	22.26

Note(s): Standard errors are in parentheses. The estimations under robust variance and covariance errors automatically eliminate some countries from the panel. ***, ** and * indicate the 1, 5 and 10% significance levels, respectively
Source(s): Own elaboration

Table 3.
Estimations using initial GDP as a threshold variable

Model	Threshold levels In *logs*	Confidence interval (95%)		Threshold levels In levels
(A)				
Threshold 1	5.9208***	5.8923	5.9218	372.71
(B)				
Threshold 1	5.9208***	5.8996	5.9218	372.71
Threshold 2	7.3028**	7.2449	7.3065	1484.5
(C)				
Threshold 1	5.9005***	5.8914	5.9165	365.22
Threshold 2	7.2635**	7.2206	7.2655	1427.24
(D)				
Threshold 1	5.9218***	5.9003	5.9246	373.08
Threshold 2	7.2635***	7.2206	7.2655	1427.24

Note(s): ***and ** indicate the 1 and 5%, significance levels, respectively
Source(s): Table by authors

Table 4.
Estimated threshold levels for initial GDP

regime comprises countries with initial GDP between such value and $1427.24. Lastly, the third, corresponding to a negative sign of the β coefficient, contains those economies with initial GDP above $1427.24. These values were obtained by calculating the antilog on the threshold values noted in the second column of Table 4.

Table 5 illustrates the behavior of the countries with respect to external debt and growth, taking into accounts regression D. It shows the percentage of observations for each economy in each regime over 1970–2019.

Let us consider the following example in order to interpret Table 5: while Algeria or Argentina remained in regime 3 throughout the period, Bangladesh switched between regime 1 and 2 with 22% of the temporal observations being in the lowest regime and 78% in the medium one. Based on the results of Tables 1 and 2, debt positively affects growth in those countries contained in regime 1, it loses it impacts in nations of regime 2 and is detrimental to growth in the economies of the last regime.

Investment, initial GDP, human capital and life expectancy show a consistent behavior with respect to the first estimations, exhibiting the expected signs. Openness, population and public expenditure have a non-significant effect on growth. Finally, inflation negatively affects economic growth only in A and B for the IMF data [2].

Then, we analyzed if external restriction can develop different patterns in the external debt-growth relationship. In this case, only the indicator of external debt from the WB was considered since the foreign trade surplus give the economy a solid foundation of foreign currency to meet the external debt repayment. Table 6 presents the estimations using the debt to exports ratio as a threshold variable.

Models A and B in Table 6 provide some evidence of the threshold effect of the debt to exports ratio. In both models, the thresholds are statistically significant at 5% (see Table A.5).

Table 5.
Permanence of countries in each regime (percentage). Threshold variable: Initial GDP

Country	Regime 1	Regime 2	Regime 3	Country	Regime 1	Regime 2	Regime 3
Algeria	0	0	1	Madagascar	0	1	0
Argentina	0	0	1	Malawi	0.33	0.67	0
Bangladesh	0.22	0.78	0	Mali	0.11	0.89	0
Benin	0	1	0	Mexico	0	0	1
Botswana	0	0.11	0.89	Morocco	0	0.33	0.67
Cameroon	0	0.78	0.22	Nepal	0.44	0.56	0
Central African Rep	0	1	0	Nicaragua	0	0.44	0.56
Colombia	0	0	1	Niger	0	1	0
Costa Rica	0	0	1	Pakistan	0	1	0
Dominican Republic	0	0	1	Peru	0	0	1
Ecuador	0	0	1	Philippines	0	0.11	0.89
El Salvador	0	0	1	Rwanda	0.44	0.56	0
Fiji	0	0	1	Senegal	0	1	0
Gabon	0	0	1	Sierra Leone	0.33	0.67	0
Ghana	0	0.89	0.11	Sri Lanka	0	0.56	0.44
Guatemala	0	0	1	Thailand	0	0	1
Haiti	0	0.67	0.33	Tunisia	0	0	1
Honduras	0	0.11	0.89	Turkey	0	0	1
India	0	0.89	0.11	Zambia	0	0.67	0.33
Jamaica	0	0	1	Zimbabwe	0	0.89	0.11
Kenya	0	1	0				

Source(s): Table by authors based on estimation D in Table 3

Dependent variable: Economic growth Independent variables	(A)	(B)
Investment	0.0318***	0.0317***
	(0.0069)	(0.0069)
Initial GDP	−0.0404***	−0.0416***
	(0.0087)	(0.0089)
Human capital	0.0392***	0.0415***
	(0.0092)	(0.0094)
Population	0.0353**	0.0345**
	(0.0143)	(0.0147)
Inflation	−0.0074**	
	(0.0031)	
Constant	0.068	0.0825
	(0.0592)	(0.0603)
Debt		
β_1	0.0311***	0.0254***
	(0.009)	(0.0087)
β_2	0.0003	−0.0035***
	(0.0026)	(0.0011)
No.	39	39
F stat	32.22	20.78

Note(s): Standard errors are in parentheses. The estimations under robust variance and covariance errors automatically eliminated some countries from the panel. The panel is reduced because of the availability of exports data. ***, **, and * indicate the 1, 5, and 10% significance levels, respectively
Source(s): Table by authors

Table 6. Estimations using debt to exports ratio as a threshold variable

By comparing regressions A and B, external debt seems not to be relevant above the threshold when inflation is included as an explanatory variable. However, once inflation is not considered, external debt becomes strongly significant at 1% with a negative influence on growth. This may suggest a more complex relationship between external debt, external restriction, inflation and economic performance in developing economies with a higher debt to exports ratio. In any case, this result should be addressed in greater detail, as well as a possible correlation between external debt and inflation. The other significant explanatory variables present, again, the expected effect on the dependent one. Finally, when all explanatory variables are put together in the regression, there is little evidence of nonlinearities, and the robustness of estimation is considerably reduced (the regression was omitted from Table 6).

For both estimations in Table 6, external debt has a positive relation with economic growth below the threshold of 152% of external debt as percentage of exports (Table 7). When external debt exceeds 152% of exports, it becomes detrimental to growth.

Model	Threshold level Ratio	Confidence interval (95%)	
(A)	1.5189**	1.4564	1.5374
(B)	1.5189**	1.4564	1.5374

Note(s): *** and ** indicate the 1 and 5% significance levels, respectively
Source(s): Table by authors

Table 7. Estimated threshold levels for debt to exports ratio

Table 8 refers to long the economies remained below or above the threshold level of debt to exports ratio, illustrating regression B. For instance, Argentina or Nicaragua had a percentage of debt to exports higher than 152% over 1970–2019, suffering the negative impact of debt on growth. On the other hand, Botswana or Fiji remained below the threshold of 152% during the whole period analyzed. Hence, those economies that was for most of the period in the second regime of the debt to exports ratio, and in the third of the debt-to-GDP ratio, such as the Argentine and Turkey cases, had to face lower long-term growth.

3.2 Empirical evidence: DPTM

As mentioned in the methodology section, to deal with potential endogeneity of the threshold variables when the debt indicator was not only used as threshold variable but an explanatory one, the DPTM technique developed by Seo and Shin (2016) was applied. The estimation results are reported in Table 9.

The hypothesis of absence of threshold effects is strongly rejected at the 1% level in both regressions. Through the *t*-test to verify the endogeneity of the threshold variable, the null hypothesis of strict exogeneity is not rejected with a significance level of 5%. This result evidences the consistency of the previous outcomes obtained by Hansen (1999) method, confirming the absence of endogeneity of the threshold.

When the external debt-to-GDP ratio is introduced as a threshold variable, the estimated external debt threshold is 67.11%, with a standard error of 16.05% (whereby the confidence interval is from 51.06% to 83.16%). Countries with an external debt-to-GDP ratio over 67.11% will face drops in the growth rate if they incur more external debt. Nevertheless, developing economies with low levels of debt can even increase the indebtedness with positive effects on their growth dynamics. Comparing our latest results with the previous findings in Table 1, the real value of the threshold using DPTM is between 51.06% and 83.16%, whereas implementing PTRM the external debt threshold level is within the interval 40.86% to 42.80%.

Table 8.
Permanence of countries in each regime (percentage). Threshold variable: debt to exports ratio

Country	Regime 1	Regime 2	Country	Regime 1	Regime 2
Algeria	0.44	0.56	Kenya	0.33	0.67
Argentina	0	1	Madagascar	0.44	0.56
Bangladesh	0.33	0.67	Mali	0.33	0.67
Benin	0.33	0.67	Mexico	0.56	0.44
Botswana	1	0	Morocco	0.44	0.56
Cameroon	0.56	0.44	Nepal	0.22	0.78
Central African Republic	0.22	0.78	Nicaragua	0	1
Colombia	0.22	0.78	Niger	0.33	0.67
Costa Rica	0.67	0.33	Pakistan	0	1
Dominican Republic	0.67	0.33	Peru	0.33	0.67
Ecuador	0.33	0.67	Philippines	0.44	0.56
El Salvador	0.22	0.78	Rwanda	0.22	0.78
Fiji	1	0	Senegal	0.33	0.67
Gabon	0.67	0.33	Sierra Leone	0.11	0.89
Ghana	0.33	0.67	Sri Lanka	0.11	0.89
Guatemala	0.67	0.33	Thailand	0.89	0.11
Haiti	0.22	0.78	Tunisia	0.56	0.44
Honduras	0.56	0.44	Turkey	0	1
India	0.44	0.56	Zimbabwe	0.22	0.78
Jamaica	0.11	0.89			

Source(s): Table by authors based on estimation B in Table 6

Dependent variable: Economic growth				
	Threshold variable			
	Debt-to-GDP		Debt to exports	
Independent variables	Lower regime	Upper regime	Lower regime	Upper regime
Investment	−0.0364***	0.0620***	−0.0319	0.0223**
	(0.0065)	(0.0069)	(0.0228)	(0.0127)
Initial GDP	−0.0210***	−0.0798***	−0.0321***	−0.0543***
	(0.0061)	(0.0095)	(0.0057)	(0.0121)
Life expectancy	−0.1460***	−0.0636	0.1022*	0.0038
	(0.0253)	(0.0390)	(0.0557)	(0.0417)
Human capital	0.0708***	0.0708***	−0.0374**	0.0691***
	(0.0149)	(0.0150)	(0.0176)	(0.0119)
Debt	0.0753***	−0.0762***	0.0486***	−0.0456***
	(0.0117)	(0.0113)	(0.0072)	(0.0074)
Threshold level	0.6711***		2.8567**	
	(0.1605)		(1.1443)	
Bootstrap for threshold test[1]	p-value = 0.0000		p-value = 0.0000	

Note(s): Standard errors are in parentheses. ***, ** and * indicate the 1, 5, and 10% significance levels, respectively

[1]The null hypothesis implies the absence of threshold effects. H0 is rejected in both cases

Source(s): Table by authors

Table 9. Estimations using DPTM

For the second estimation in Table 9, the external debt to exports threshold is 286%. It represents a value higher than the threshold level of 151.89% obtained by applying PTRM. Nevertheless, under the DPTM technique, the standard error is 1.14, which means that the true value of the debt to exports threshold could be between 172% and 400%. Below the threshold, the effect of external debt is positive, but above it, debt is detrimental to growth.

Then, in both cases, by implementing DPTM, we verified threshold effects of external debt-to-GDP and external debt to exports, even in presence of potential endogeneity. However, the threshold levels identified are higher than those obtained with PTRM.

4. Conclusions

The results of this paper provided additional evidence supporting the hypothesis of threshold effects between the level of indebtedness and economic growth in developing countries during a long and critical period, which spans from 1970 to 2019. This encompasses five decades with episodes of high indebtedness and economic growth instability in middle-income economies.

Throughout this study, different variables were used to detect threshold effects on growth, as has been explained and justified in due course. The results obtained by applying PTRM can be summarized as follows:

(1) Considering debt as a threshold variable, the outcomes depend on the specification used. In the case of total debt, there is no evidence of threshold effects; this means that total debt does differently not affect economic growth at any level. Nevertheless, external debt has a nonlinear relation with growth: for figures below 42.32% of GDP, it positively impacts growth. Above the critical value, external debt is not significant in explaining economic performance. The existence of only one threshold is aligned with the findings of Poirson *et al.* (2002) and Reinhart and Rogoff (2010), but its value old is higher than 35% and lower than 60% as established by these authors, respectively.

(2) When initial GDP is the threshold variable the outcomes suggested two critical values:

- For total debt, indebtedness positively affects growth in economies with an initial GDP below $372.71, and negatively in those where this figure is above $1484.5.
- For external debt, we observed similar critical values and behaviors: $365.22 (or $373.08 for model D) and $1427.24.
- In the middle of critical values, the relation between debt and growth is not significant. It should be noted that the countries that are below those critical thresholds are, in general, the poorest.
- The above shows that the level of development (approximated by the initial GDP per capita) causes an abrupt change in the performance of developing nations in terms of the effect of total and external debt on economic growth.

(3) Finally, we identified threshold effects for external debt to exports ratio, using external debt as an independent variable. For countries below 151.89%, external debt positively affects growth, whereas it does negatively or not significantly above the critical value. Again, this is in line with Poirson *et al.* (2002), who exhibited a critical value of 160%.

Throughout the DPTM technique, we confirmed the existence of threshold effects and proved the absence of endogeneity problems with thresholds variables. The critical values are different from those obtained with Hansen (1999), although the specification was slightly changed.

(1) There is evidence of nonlinearities for external debt. External debt positively affects growth when is below of 67.11% of GDP and negatively above this critical value

(2) For countries with an external debt to exports ratio below 285.67%, external debt positively affects growth and negatively above this critical value.

The robustness of the initial GDP analysis as a threshold variable implies that poorer economies can leverage credits to boost their growth, while in developing countries with higher initial GDP the indebtedness tends to reduce growth. This result may be related to the noticeable capital shortage in lower-income countries, which could allocate the funds from external sources to expand their productive capital. Furthermore, additional capital there should have higher marginal productivity at lower levels, such as a greater positive impact on economic growth. The intuition is that poorer countries have more capital shortage because of their lower levels of savings. Thus, this limitation can be overcome with external indebtedness aimed at facilitating greater capital accumulation oriented towards productive activities. Likewise, poorer nations access loans with more favorable and lax conditions, in relation to richer ones. Nonetheless, the explanation why debt does not contribute to growth in higher income economies is not clear yet and deserves further investigation.

The external debt-to-GDP threshold given by both methodologies suggests the convenience of a moderate indebtedness policy, in order to avoid that a large debt burden becomes detrimental to growth. In any case, this value may not exceed 67%. As Karadam (2018) indicated, in developing countries the critical values of external debt are lower than those in industrialized economies.

Finally, future extensions of this paper could be the study of the effect with external indebtedness in countries of different levels of income and openness simultaneously. This should determine if, as expected, economies with grater insertion in world trade have a higher threshold above which indebtedness is detrimental to growth due to their greater payment

capacity that comes from their elevated exports. Due to the results found, it was possible to evaluate the existence of structural issues in the relationship between growth and growth. Additionally, as a future extension, the simulated existence of institutional thresholds could be evaluated. To accomplish this, we could use some institutional variable related to the democracies of developing economies available on V-dem, the database of political institutions of the Ibero American Development Bankor of Institute for Democracy and Electoral Assistance (IDEA).

Notes

1. Taking periods of five years, and not shorter, dhat each has at least three observations per country, that is, averages are not obtained with less than three observations. The purpose of this choice was to guarantee that in each period anomalous years in the functioning of each economy were not taken only as a reference.
2. In alternative estimations for external debt, inflation occasionally shows significance at 10% level of confidence. In those cases, the significance of β is reduced.

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Appendix

The supplementary material for this article can be found online.

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