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Is the relationship between external debt and human development non-linear? A PSTR approach for developing countries

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Abstract

This paper examines the relationship between external debt and human development for a panel data set of 95 developing countries observed during the period 2002 – 2015. By performing a Panel Smooth Threshold Regression (PSTR) model developed by Gonzàlez et al. (2005), estimation results show that this relationship is non-linear and characterized by the presence of an optimal threshold of external debt equals to 41.7775%. Below this debt threshold, external debt has a positive effect on human development. Any 1% increase in the external debt ratio induces an increase in the HDI of 0.02%. However, above the debt threshold, external debt becomes detrimental to human development since HDI decreases by 0.01% when external debt ratio increases by 1%. In a low external debt regime, countries are encouraged not to exceed this threshold to benefit from the leverage effect, and to modify the structure of imports while avoiding unnecessary ones. In a high external debt regime, countries are complelled to reduce their external debt ratio to reach the optimal threshold, avoid the waste of highly remunerated foreign resources and know how to allocate them to the most productive sectors, and control their demographic growth.

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1. Introduction

Human development is defined by the United Nations Development Programme (UNDP) as "a process of enlarging people's choices. The most critical ones are to lead a long and healthy life, to be educated and to enjoy a decent standard of living. Additional choices include political freedom, guaranteed human rights and self respect"[1]. UNDP (1991) measured human development by an index called Human Development Index (henceforth noted HDI) taking into account three basic variables which are life expectancy at birth, literacy rate and per capita GDP. To construct this index, UNDP followed three steps. In the first step, it computed for each variable i an indicator I_i (i = 1, 2, 3). In the second step, it defined an indicator called deprivation indicator relative to each country j. This deprivation indicator is the arithmetic mean of the three indicators. The last step is devoted to calculate the HDI of country j which is equal to one minus the deprivation indicator. This index varies between 0 and 1and gives an idea about the importance of the individual in the development of any country. If HDI is low, people live in great suffering and serve the accumulation of income and wealth. If HDI is very high, the development is centered on people who are the real wealth of countries. With the construction of HDI, we no longer have confusion between growth and development. The socio-economic progress of countries is hereafter measured by this composite index. As done in the past with economic growth, several authors have sought to highlight the main determinants of human development proxied by HDI.

The existing literature can be divided into two groups. The first group includes studies that have stressed the determinants of HDI rather than external debt (Ariman, 2018; Çaglayan-Akay and Van, 2017; Shah, 2016; Sofilda et al. 2015; Doli and Fadli, 2015; Singariya, 2014; Fazleen et al. 2012, etc.). The second group emphasized the implications of external debt for the human development of countries. Unlike the first group that insisted on the composite index HDI, the second group of works examined the effects of external debt on the three main components of the HDI taken separately which are health, education and living standards. Fosu (2008), Dessy and Vencatachellum (2007), etc. focused on the first component of the HDI, which is health, and sought the effects of the external debt on governments' health sector spending and investment. Egungwu (2018), Murshed and Saleh (2013), Fosu (2007), etc. investigated the impact of external debt on education sector spending. Sadia and Hafiz (2015), Fosu (2010), Eduardo and Mauricio (2007), Loko et al. (2003), Baqir (2002) surveyed, among other factors, the effects of external debt on social sector spending, particularly health and education. Okokondem and Monday (2017), Zaghdoudi and Hakimi (2017), Azam et al. (2016), Babu et al. (2014), Oloruntoba et al. (2013), Saugweme and Mufaedza (2013), Ayyoub et al. (2012), Checherita-Westphal and Rother (2012), Akpan (2009), Clements et al. (2003), Pattillo et al. (2002), etc. focused on living standards.

These studies, non exclusive of others, are methodologically based on econometric techniques used in the estimation of linear relationships. It is true that these diversified studies have yielded different results according to which external debt is beneficial, detrimental or without effects on human development, but nothing was mentioned about the optimal threshold beyond which external debt can affect negatively or positively HDI. Even the works that studied the direct effect of external debt on HDI, which are very scarce, have used the same methodological approach. As far as we know, Rojas' study (2015) is the only one available

[1] United Nations Development Programme (UNDP), Human Development Report, 1990. p. 10.

online, having examined the direct effects of external debt and foreign direct investment on human development measured by HDI. This study is based on linear regression model unable to detect the threshold effect and the loss in HDI beyond certain points of the debt threshold. Reasoning in a linear framework, these studies lead to the results that the impact of external debt on HDI does not change sign and remains the same regardless of its stocks as a share of gross national income. However, these conclusions can mislead decision-makers in their debt policy.

This paper tries to fill this gap and contributes to the existing literature by studying the direct relationship between external debt and HDI by using new econometric approach based on the PSTR model since the others fail to detect the regime changes and the debt threshold beyond which HDI is affected. To our best knowledge and up to this time, there are no published empirical studies which apply the PSTR model to investigate the non-linear relationship between external debt and HDI for developing countries. It is time to reexamine this association by performing this recent econometric approach which allows us to renew research on the relationship between external debt and human development.

In recent years, non-linear econometric models have become particularly important, mainly because of the inability of the usual models such as ARCH, GARCH, VAR, etc. to consider the transition from the lower regime to the upper regime. Hence, new models were developed in order to address this shortcoming. Quandt (1958) and Goldfeld and Quandt (1972) are the first to use non-linear models with a piecewise and locally linear autoregressive (AR) process. Starting from this achievement, Tong and Lim (1980) and Tong (1983) developed the threshold autoregressive (TAR) model which required the introduction of lagged variable. When the lagged variable is the value of the process in previous period, the threshold autoregressive (TAR) model process becomes self-exciting threshold autoregressive (SETAR). However, the SETAR model fails to account for continuous and smooth transitions. From where, the development of the Smooth Transition Autoregressive (STAR) model by Teräsvirta and Anderson (1992), Granger and Teräsvirta (1993) and Teräsvirta (1994) to overcome this weakness. Recently, González et al. (2005) focused on panel data and contributed to the development of the Panel Smooth Threshold Regression (PSTR) model which is largely used in several studies.

Contrary to other econometric approaches pursued in previous studies, the PSTR model has the advantage of determining endogenously both the transition parameter and the debt threshold beyond which HDI is negatively or positively affected by external debt. Also, it allows us to estimate losses or gains in HDI when external debt exceeds its optimal threshold. Moreover, the PSTR model helps us to analyze the joint effects of the explanatory variables and the transition function on HDI beyond the optimal debt threshold and shows that the effects of the variables on HDI differ according to the optimal threshold. Dissimilar to earlier works where they lead to positive or negative effects, this econometric technique proves that the same variable can have opposite effects below and above the debt threshold.

The advantages of this new econometric approach should not hide however its limits. To study the nonlinear relationship between variables, Hansen (1999) and Singh (2012) rely on seasonal data, since annual data fail to detect seasonal transitions. In our paper, we banked on annual data because of the inexistence of data in lower frequencies (monthly, quarterly or half-yearly data) and this can be viewed as a limitation for this study. Nevertheless, the unavailability of lower frequency data for the HDI, which is our dependent variable, makes this limit understandable and does not call into question the relevance of the found results.

In this paper, we use the composite index HDI as proxy of human development contrary to previous studies which focused in one specific dimension. The different aspects of the individual's life (living a long and healthy life, acquiring knowledge, enjoying a decent standard of living, access to drinking water, enjoying political, economic and social freedom, etc.) are closely related and constitute an inseparable whole requiring an aggregate index to track their evolution. HDI is a composite index that addresses this need because it takes into account the three essential components that define human development. For this reason, HDI is considered by UNDP as the most reliable measure of countries' socio-economic progress.

Unlike previous studies including Rojas (2015), the purpose of this paper is to demonstrate that the relationship between external debt and HDI is non-linear and characterized by the presence of a threshold effect beyond which external debt can affect human development. To do this, we used a panel data set of 95 developing countries observed during the period 2002–2015 and we performed an econometric approach based on the Panel Smooth Threshold Regression (PSTR) model developed by González et al. (2005).

In our study, we have selected four types of variables that reflect the characteristics of developing countries and that we think are the most appropriate to explain the evolution of their HDI. It's about the main variables that represent foreign funds flowing (external debt and foreign direct investment), the main variables of economic growth (gross fixed capital formation and trade openness), the demographic variable (population growth rate) and the governance's variables which reflects institutional development of countries (control of corruption and political stability and the absence of violence and terrorism).

The remainder of this paper is organized as follows. Section 2 presents some stylized facts. Data and PSTR model specification are given in section 3. Estimation results and interpretations are presented in section 4. Section 5 concludes and proposes some relevant policy implications.

2. Stylized facts

In this section, we present some stylized facts on external debt and HDI to examine the trends in both variables over the sample period 2002-2015. One of the characteristics of the economies of selected developing countries is the dominance of external debt, which accounts for 54.456% of their gross national income as shown in Table II relative to descriptive statistics.

Table I: Global trends in external debt ratio and HDI of selected developing countries, 2002-2015.

	External debt stocks (% of GNI)	**HDI**	**GNI per capita growth (annual %)**	**Life expectancy at birth, total (years)**	**Literacy rate, adult total (% of people ages 15 and above)**	**Military expenditure (% of central government expenditure)**
2002	82.461	0.548	2.553	62.944	72.553	8.059
2003	85.692	0.552	2.956	63.185	59.881	7.756
2004	77.365	0.56	5.464	63.614	69.760	7.778
2005	64.977	0.566	4.050	64.047	73.706	7.382
2006	54.313	0.574	4.899	64.527	71.390	7.506
2007	47.879	0.582	5.502	65.019	77.425	7.202

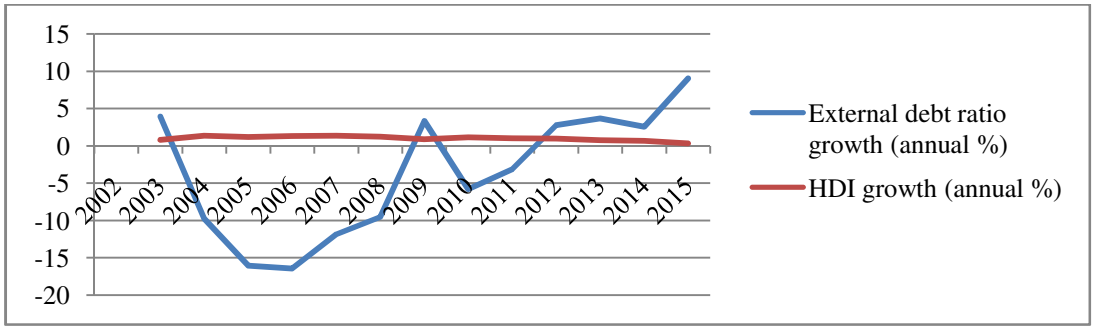
2008	43.314	0.589	3.224	65.498	78.684	6.912
2009	44.747	0.594	0.457	65.994	82.022	7.029
2010	42.147	0.601	3.007	66.436	80.240	6.734
2011	40.829	0.607	2.649	66.882	82.039	6.578
2012	41.957	0.613	3.219	67.292	79.485	6.335
2013	43.506	0.618	2.449	67.679	79.332	6.630
2014	44.611	0.623	3.193	68.022	81.007	6.573
2015	48.637	0.625	1.709	68.335	84.239	6.680

Source: Author calculation from WDI and UNDP database.

The selected period 2002-2015 can be divided into two sub-periods which are (2002 - 2011) and (2012-2015). Over the first sub-period, the annual growth rates of external debt are negative except for 2003 and 2009 while those of HDI are positive. This sub-period can be considered as a period during which external debt has favored human development. Gross national income (GNI) per capita growth (annual %) has increased from 2,553% in 2002 to 2,649% in 2011. Life expectancy at birth also rose from 62,944 years in 2002 to 66,882 years in 2011, recording an average annual growth rate of 0.609%. Literacy rate, adult total (% of people age 15 and above) has grown at an average annual growth rate of 1.236%, from 72.553% in 2002 to 82.039% in 2011. Military spending as a percentage of overall government spending decreased from 8.059% in 2002 to 6.578% in 2011.

However starting from 2012, the adverse effects of external debt on human development began to be noticed, since annual growth rate of external debt has further increased while those of the HDI have more declined as shown in Figure 1 below. Moreover, external debt growth rates are greater than those of HDI.

Figure 1: Annual growth rates of external debt and HDI.



Source: Author.

High external debt affected human development through its adverse impact on government budgetary allocation between sectors. Life expectancy at birth increased but at a lower rate than the previous period, from 67,292 years in 2012 to 68,335 years in 2015, recording hence an average annual growth rate of 0.366%. Living standards of citizens deteriorated since GNI per capita growth (annual %) dropped dramatically, from 3,219% in 2012 to 1,709% in 2015. Military spending, as a percentage of general government spending, increased from 6.335% in 2012 to 6.68% in 2015.

In particular, between 2011 and 2012, the two curves of average annual growth rates of external debt and HDI intersected. The annual growth rate of external debt increased from -3.128% in 2011 to 2.761% in 2012. In contrast, the annual growth rate of HDI has decreased from 1.045% in 2011 to 0.998% in 2012. This opposite evolution of the annual growth rates

of both external debt and HDI which occurred between 2011 and 2012 may suggest the existence of a non-linear relationship between the two variables. The optimal threshold of external debt may be between 40.829% and 41.957% which are the ratios of external debt in 2011 and 2012 respectively. To determine the exact value of the optimal threshold of external debt, we will adopt the PSTR model which will be described in detail in section 3.

3. Data and PSTR model specification

To highlight the possible non-linear relationship between external debt and human development index, we relied on one of the econometric techniques used to estimate non-linear relations, namely the Panel Smooth Threshold Regression (PSTR) model developed by González et al. (2005), who extended Hansen's PTR (Panel Threshold Regression) model (1999). Theoretical form of the PSTR model is presented as follows:

$$y_{it} = \mu_i + \beta^0 x_{it} + \beta^1 x_{it} g(q_{it}, \gamma, c) + \varepsilon_{it} \quad (1)$$

Where i and t represent respectively cross-section and time dimensions of the panel. μi indicates the vector of the individual fixed effects. ε_{it} is the error term. β^0 and β^1 indicate respectively the parameter vectors of linear and non-linear models. y_{it} and x_{it} represent respectively dependent and independent variables. $g(q_{it}, \gamma, c)$ is the function of transition which depends on the transition variable q_{it}, the transition parameter (γ) and the parameter of threshold (c). This transition function of the PSTR model is continuous and normalized taking values between 0 and 1. It allows system to transit from one regime to another. In order for this function of transition to be operational, Granger and Teräsvirta (1993), Teräsvirta (1994), Jansen and Teräsvirta (1996) and González et al. (2005) proposed the following logistic form of order m:

$$g(q_{it}, \gamma, c) = \left(1 + exp\left(-\gamma \prod_{j=1}^{m} (q_{it} - c_j)\right)\right)^{-1} \quad (2)$$

With $c = (c_1, \ldots., c_j, \ldots, c_m)$ is a vector of threshold parameters with $c_1 < \ldots.. < c_m$ and $\gamma > 0$. When $\gamma \rightarrow 0$, the transition function approaches a constant and the PSTR model becomes homogenous linear panel with fixed effects. However, when $\gamma \rightarrow + \infty$, the function of transition $g(q_{it}, \gamma, c)$ tends to an indicator function $g(q_{it}, c_j)$ which takes 1 if $q_{it} > c_j$. Ibarra and Trupkin (2011) showed that if γ is very high, the PSTR model can be confused with a two-regime model (or one threshold). Given this function of transition $g(q_{it}, \gamma, c)$, equation (1) can be written as follows:

$$y_{it} = \mu_i + \beta^0 x_{it} + \sum_{j=1}^{m} \beta_j x_{it} g\left(q_{ij}^{j}, \gamma_j, c_j\right) + \varepsilon_{it} \quad (3)$$

In this paper, we used an unbalanced annual data of 1271 observations for 95 developing countries[2] observed during the period 2002 – 2015 to investigate the effect of external debt on human development index by using the PSTR model which can be written as follows:

$$hdi_{it} = \mu_i + \beta^0 x_{it} + \beta^1 x_{it} g(exdb_{it}, \gamma, c) + \varepsilon_{it} \quad (4)$$

Where i refers to country (i = 1,.., 95) and t represents time period in years (t = 2002,...., 2015). μ_i, ε_{it}, β^0 and β^1 keep the same definitions mentioned above. hdi is human development index which represents the dependent variable. $g(exdb_{it}, \gamma, c)$ represents the function of transition. $x_{it} = (x_{it}^1, \ldots\ldots\ldots, x_{it}^7)$ is a vector of seven independent variables divided as follows:
- One variable of transition which is the external debt "EXDB".
- Four explanatory variables which are the foreign direct investment"FDI", the trade openness "TRADE", the gross fixed capital formation "GCF" and the population growth rate "GPOP".
- Two exogenous variables which are control of corruption"CCOR" and political stability and absence of violence and terrorism"POLIS."

The external debt "EXDB" is defined by total external debt stocks to gross national income. In this study, we have emphasized on the external debt, since the selected developing countries continue to rely on this foreign resource, which represented on average 54.456% of their gross national income over the period 2002-2015. We think that high debt services may harm human development through their adverse impact on governments' social sector spending. In addition, the results of empirical works that addressed the implications of external debt on human development are not consensual (Zaghdoudi and Hakimi, 2017; Rojas, 2015; Akpan, 2009; etc.).

In recent years, the majority of developing countries have embarked on comprehensive economic, financial and tax reforms to, among other things, attract FDI, which provides host countries with several advantages. It is recognized that FDI is one of the main determinants of economic growth. The results of most empirical studies agree on their positive impact on growth. However, with the construction of the HDI by UNDP, the concept of growth has given way to the concept of development. The HDI is the most relevant indicator for understanding the socio-economic progress of countries. That's why, we introduce in the econometric model the foreign direct investment "FDI" defined by the foreign direct investment net inflows as percentage of GDP, to examine its impacts on human development (Gokmenoglu et al. 2018; Neumayer and De Soysa, 2005; Sharma and Gani, 2004; etc.). We expected that if certain conditions are met by the host country, FDI can limit external debt and reduce its adverse effects on human development.

According to the expenditure approach, gross fixed capital formation (GCF) and trade (TRADE) are the main components of GDP. The gross fixed capital formation "GCF" is

[2] These countries are Albania, Algeria, Angola, Argentina, Armenia, Azerbaijan, Bangladesh, Belarus, Belize, Benin, Bolivia, Botswana, Brazil, Bulgaria, Burundi, Cabo Verde, Cambodia, Cameroon, Central African Republic, Chad, China, Colombia, Congo Democratic Republic, Congo Republic, Cote d'Ivoire, Dominica, Dominican Republic, Ecuador, Egypt Arab Republic, El Salvador, Ethiopia, Fiji, Gabon, Gambia, Ghana, Guatemala, Guinea, Guyana, Haiti, Honduras, India, Indonesia, Iran Islamic Republic, Jamaica, Jordan, Kazakhstan, Kenya, Kyrgyz Republic, Lao PDR, Lesotho, Liberia, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Morocco, Mozambique, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Panama, Paraguay, Peru, Philippines, Romania, Russian Federation, Rwanda, Senegal, Serbia, Sierra Leone, Solomon Islands, Sri Lanka, Sudan, Swaziland, Tajikistan, Tanzania, Thailand, Togo, Tonga, Tunisia, Turkey, Uganda, Ukraine, Venezuela, Vietnam, Yemen Republic, Zambia and Zimbabwe.

measured by the gross fixed capital formation as percentage of GDP. The trade openness "TRADE" is defined as the sum of exports and imports of goods and services as a share of GDP. The choice of these two variables is justified by their direct effect on standard of living of citizens (measured by gross national income (GNI) per capita), which is a component of the HDI (Mustafa et al. 2017; Hukom, 2015; Kojo, 2014; Grier, 2005; Eusufsai, 1996; etc.).

In this paper, we retain also the population growth rate"GPOP" as an explicative variable because the selected countries are the most populous in the world. This variable can affect HDI given its direct effects on the three main component of HDI (health, education and living standards). Empirical works on the impact of population growth on human development are inconclusive. Population growth can either enhance, deteriorate or even has no impact on HDI (Fumitaka and Qaiser, 2011; Tournemaine, 2007; Zgheib et al. 2006; etc.).

The quality of institutions in countries in which people live and work can affect their human development. That's why we introduce in our econometric model two governance variables, which are control of corruption "CCOR" and political stability and absence of violence and terrorism "POLIS" which vary from -2.5 to 2.5. Human development can be threatened by corruption which takes various forms that are fraud, money laundering, extortion, kickback, peddling influence, etc. The majority of studies found that corruption is harmful to human development by changing the composition of public expenditures at the expense of education and health sectors, increasing so inflation and poverty, discouraging investment and impeding innovation (Cooray et al. 2016; Justesen and Bjornskov, 2014; Reiter and Steensma, 2010; Gupta et al. 2002; Al-Marhubi, 2000; Mauro, 1998; etc.). As for political stability and absence of conflicts and terrorism, authors consented to their positive impact on human development (Liang and Mirelman, 2014; Ahmad and Saleem, 2014; etc.). In a stable global environment, the quality of institutions improves, the waste of resources decreases, the social sectors, particularly health and education, receive adequate expenditure, economic and political freedoms are guaranteed, and human rights are ensured.

Replacing the vector x_{it} with its seven components, we get the empirical model to be estimated which is presented as follows:

$$hdi_{it} = \mu_i + \beta_0^0 exdb_{it} + \beta_1^0 fdi_{it} + \beta_2^0 trade_{it} + \beta_3^0 gfc_{it} + \beta_4^0 gpop_{it} + \beta_5^0 ccor_{it} + \beta_6^0 polis_{it}$$
$$+[\beta_0^1 exdb_{it} + \beta_1^1 fdi_{it} + \beta_2^1 trade_{it} + \beta_3^1 gfc_{it} + \beta_4^1 gpop_{it} + \beta_5^1 ccor_{it} + \beta_6^1 polis_{it}]g(exdb_{it}, \gamma, c) + \varepsilon_{it} \quad (5)$$

All variables of this PSTR model meet international definitions and were issued from three sources. The data relative to HDI were derived from the database of UNDP official website[3]. Those of the variables (EXDB, FDI, GCF, TRADE and GPOP) were taken from World Bank Development Indicators (WDI) online database. As for governance variables (CCOR and POLIS), they were obtained from Worldwide Governance Indicators (WGI)[4] produced by Daniel Kaufmann (Natural Resource Governance Institute and Brookings Institution) and Aart Kraay (World Bank Development Research Group).

[3] For more details on HDI, see please this link: http://hdr.undp.org/en/content/human-development-index-hdi-table.

[4] Kaufmann et al. (2010).

4. Estimation results and interpretations

The econometric approach employed is based on five steps. We start with presenting variable descriptive statistics used in the PSTR model. The second step is devoted to studying the stationarity of each variable. When the variables are stationary in level, we move to the third stage to linearity tests between external debt and human development index. Once the non-linearity is verified, we find out in the fourth step the number of regimes in the PSTR model. In fine, we estimate the PSTR model and discuss the results.

4.1. Descriptive Statistics

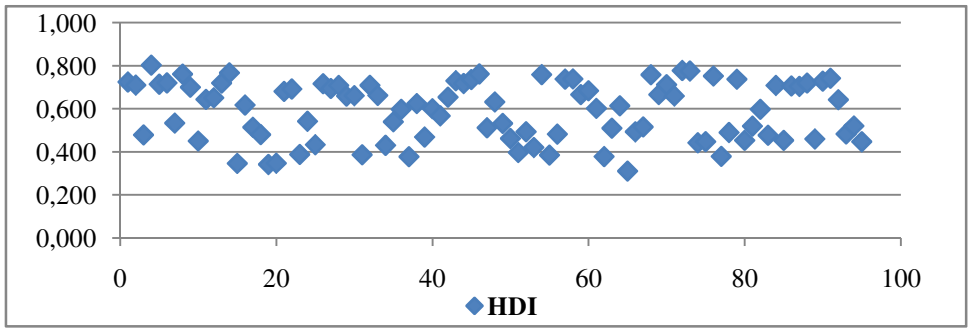
Descriptive statistics are presented to reveal the main characteristics of data used in this study. For each variable, we display mean, standard deviation, minimum and maximum values. Table II below summarizes variable descriptive statistics of the PSTR model.

Table II: Variable Descriptive Statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
HDI	1329	0.589	0.136	0.266	0.827
EXDB (%)	1320	54.456	76.270	1.258	1380.766
FDI (%)	1327	4.796	6.718	-5.978	89.476
TRADE (%)	1313	80.338	35.851	19.101	311.355
GCF(%)	1291	23.998	9.002	0.001	61.469
GPOP (%)	1330	1.698	1.142	-2.171	5.367
CCOR	1330	-0.599	0.485	-1.816	1.250
POLIS	1329	-0.553	0.796	-2.806	1.209

The average value of human development index (HDI) is equal to 0.589 with a maximum value of 0.827 and a minimum value of 0.266. More precisely, 61 out of 95 countries had HDI values between 0.377 and 0.699 and 91 had HDI values between 0.377 and 0.802.

Figure 2: Average country HDI during the period 2002-2015.



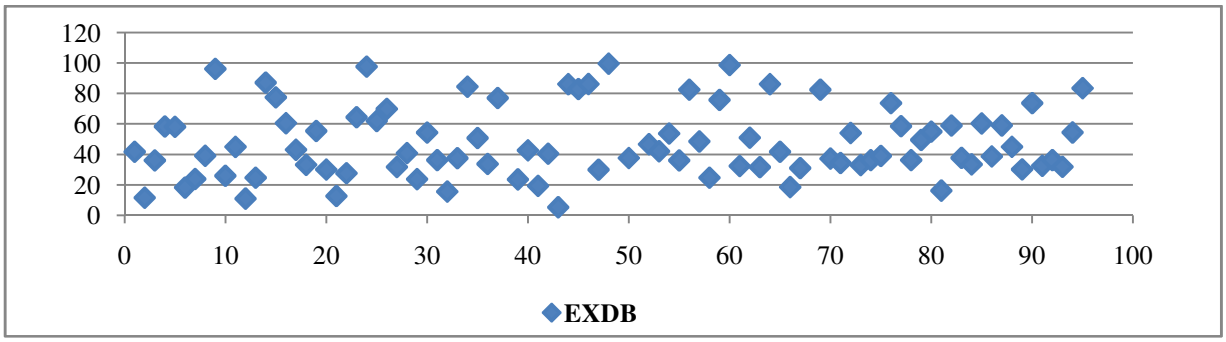
Source: The author.

The majority of the selected countries have HDI values around the mean value of the entire sample as shown in Figure 2. The difference between the average values of their HDI is not high over the sample period.

External debt (EXDB) of selected countries has an average value equal to 54.456% with minimum and maximum values of 1.258% and 1380.766% respectively. It is worth

mentioning that the very high maximum value of external debt ratio is relative to Liberia, which recorded the highest rate in 2003; that is 1380.766%. This country experienced a debt crisis from 2002 to 2009. Except for Liberia, Panama, Lao PDR and Guyana which had average debt ratios of 495.706%, 126.214%, 114.354% and 103.52% respectively over the sample period 2002-2015, other countries had average debt ratios below 100% as shown in Figure 3.

Figure 3: Average External Debt (EXDB) of countries during the period 2002-2015.



Source: The author.

More precisely, 61 out of 95 countries had an average external debt ratio between 20% and 60%. The difference between the average values of their EXDB is not high over the sample period. The majority of the selected countries had average debt ratios around the average debt ratio of the sample.

The foreign direct investment variable (FDI) registered on average a value of 4.796% with a maximum value of 89.475% and a minimum value of -5.978% relative to Angola in 2012. The majority of selected countries suffer from low FDI, which is not expected to contribute to improving their human development. With regard to trade openness (TRADE), the average value for the sample is 80.338% with minimum and maximum values of 19.101% and 311.355% respectively. Several countries are very open to the outside world through trade which is expected to enhance their human development. Gross fixed capital formation (GCF) represents on average 23.998% of the GDP of countries with a maximum value of 61.469% and a minimum value close to zero relative to Ethiopia for the period 2002-2010. Investment is an important component of GDP and is expected to favorably affect their socio-economic progress. Over the period 2002-2015, the population growth rate (GPOP) is equal on average to 1.698% with a maximum value of 5.367% and a minimum value of -2.171%. The countries in the sample include countries that are the most populous in the world. The effect of this variable on human development is ambiguous. Population growth can be a catalyst or a brake on their human development. For the two governance variables (CCOR and POLIS), their average values are negative and are equal to - 0.599 and - 0.553 respectively. Most countries are characterized by the poor quality of their institutions, which can be detrimental to their human development.

The descriptive statistics displayed in Table II therefore give some ideas about the characteristics of the countries which in fact have some different economic characteristics and human development challenges. But, they show also some socio-economic similarities. During the sample period, China and Dominica[5], for example, do not rely heavily on agriculture, which accounts for an average of 10% of their GDP. For these two countries,

[5] For more details, see Tables I, II and III in Appendix.

industry and services constitute the driving sectors of their economies. In recent years, the economic growth of these two countries is driven by both exports and imports of goods and services, which account for at least 50% of their GDP. However, the export structure differs from one country to another. China specializes in the High-technology exports which represent 27.129 % of its manufactured exports against 5.947% for Dominica. China and Dominica have almost the same GNI per capita which is equal to 8341.428 and 8781.429 current international $ respectively. These two countries have also approximately the same life expectancy at birth in years and mortality rate less than five years per 1000 live births. China and Dominica have on average HDI values of 0.681 and 0.715 respectively which are very close although China's human development challenges are large compared to Dominica's. These two countries belong to the group of high human development countries according to the UNDP (2016) classification. As for Haiti and Mexico, their economies are open to the outside, as exports and imports as a percentage of their GDP are close to 60%. For these two countries, the added value of agriculture in GDP ranks third. Priority is given to the other two sectors of activity. Over the selected period, gross fixed capital formation as share of GDP is equal to 21.602% for Haiti and 16.839% for Mexico. The difference between them is not so high. Moreover, these two countries suffer from high poverty rates. Sudan and Brazil have also some socio-economic similarities. Over the sample period, both countries rely heavily on services sector in their GDP. Gross fixed capital formation as share of their GDP is very close, which are equal to 16.525% for Sudan and 15.078% for Brazil. Exports of goods and services as share of their GDP are also very close, and account for 15.605% and 13.053% respectively. These two countries suffer from the problem of the sustainability of the external debt, since external debt stocks as share of exports of goods, services and primary income are 368.046% for Sudan and 174.98% for Brazil.

4.2. Stationary tests

To test the stationarity of variables in equation “(5)”, we used four unit root tests, which are Levin, Lin and Chu (LLC), Im, Pesaran and Shin (IPS), Augmented Dickey Fuller (ADF) and Phillips and Perron (PP) tests. Table III presents results of panel unit root tests.

Table III: Panel Unit Root Tests.

	LLC		**IPS**		**ADF**		**PP**	
Variables	Statistic	P-value	Statistic	P-value	Statistic	P-value	Statistic	P-value
HDI	-17.2506	0.0000	-1.23746	0.1080	288.377	0.0000	436.662	0.0000
EXDB	-13.258	0.0000	-4.86907	0.0000	318.666	0.0000	316.493	0.0000
FDI	-20.2485	0.0000	-11.4447	0.0000	431.687	0.0000	475.527	0.0000
TRADE	-7.88306	0.0000	-2.81575	0.0024	258.573	0.0007	243.787	0.0051
GCF	-10.412	0.0000	-3.56328	0.0002	262.473	0.0004	267.404	0.0002
GPOP	-6.15033	0.0000	-8.08051	0.0000	464.365	0.0000	248.85	0.0027
CCOR	-7.96725	0.0000	-3.31587	0.0005	271.664	0.0001	379.924	0.0000
POLIS	-9.7225	0.0000	-5.60238	0.0000	342.452	0.0000	333.616	0.0000

Results displayed in table III indicate that LLC, IPS, ADF and PP tests reject the null hypothesis at 1% significance level for all variables used in this study except HDI variable for IPS test. The latter is stationary in three tests out of four. In general, we can conclude that all variables in equation “(5)” are I (0) process.

4.3. Linearity tests

After verifying stationarity in level of all variables, we move to show the non-linearity relationship between external debt and human development index by applying linearity test based on two hypotheses presented as follows: null hypothesis is $H_0 : \beta^1 = 0$ against alternative hypothesis $H_1 : \beta^1 \neq 0$. However, this test of linearity is not standard, since under the null hypothesis, the PSTR model contains unidentified nuisance parameters (Hansen, 1999). To solve this problem, Luukkonen et al. (1988) proposed to replace the transition function with Taylor's limited first-order development around $\gamma = 0$. Null hypothesis becomes $H_0 : \gamma = 0$. Equation "(4)" can be written as follows:

$$hdi_{it} = \mu_i + \beta^{*0} x_{it} + \beta^{*1} x_{it}\, g(exdb_{it}, \gamma, c) + \varepsilon^{*}_{it}$$

After replacing the vector x_{it} with its components, we get the following equation:

$$hdi_{it} = \mu_i + \beta_0^{*0} exdb_{it} + \beta_1^{*0} fdi_{it} + \beta_2^{*0} trade_{it} + \beta_3^{*0} gfc_{it} + \beta_4^{*0} gpop_{it} + \beta_5^{*0} ccor_{it} + \beta_6^{*0} polis_{it}$$
$$+ [\beta_0^{*1} exdb_{it} + \beta_1^{*1} fdi_{it} + \beta_2^{*1} trade_{it} + \beta_3^{*1} gfc_{it} + \beta_4^{*1} gpop_{it} + \beta_5^{*1} ccor_{it} + \beta_6^{*1} polis_{it}]\, g(exdb_{it}, \gamma, c) + \varepsilon^{*}_{it}$$

Where the parameters $\beta_0^{*1}, \beta_1^{*1}$, ….., β_6^{*1} are multiples of γ and $\varepsilon^{*}_{it} = \varepsilon_{it}$ + residual of Taylor's limited first-order development. The null hypothesis of linearity test becomes $H_0 : \beta_0^{*1} = ... = \beta_6^{*1} = 0$. To test this null hypothesis, we use three tests which are Wald test (LM_W), Fisher test (LM_F) and likelihood ratio test (LRT).

The Wald test (LM_W) is written as follows: $LM_w = \dfrac{NT(SSR_0 - SSR_1)}{SSR_0}$ Where SSR_0 is the panel sum of squared residuals under H_0 (linear panel model with individual effects) and SSR_1 is the panel sum of squared residuals under H_1 (PSTR model with m regimes). N and T represent respectively cross-section and time.

The Fisher test (LM_F) is defined as: $LM_F = \dfrac{NT(SSR_0 - SSR_1)/mk}{SSR_0/TN - N - mk}$ with k and m are respectively the numbers of explanatory variables and regimes.

The likelihood ratio test (LRT) is expressed as follows: LRT = -2 [log (SSR_1) – log(SSR_0)].

Under null hypothesis, Wald and likelihood statistics follow Chi (2) distribution with k degrees of freedom ($\chi^2(k)$) while Fisher Statistic pursues a Fisher distribution (F (mk, NT-N-mk)).

González et al. (2005) proposed to work with a logistic transition function of order one (m = 1) or two (m = 2). Results of these three tests are presented in Table IV.

Table IV: Linearity tests.

	m = 1		*m = 2*	
Tests	*Statistic*	*P-value*	*Statistic*	*P-value*
Wald Test (LM_W)	137.561	0.0000	262.503	0.0000
Fisher Test (LM_F)	28.423	0.0000	30.350	0.0000
Likelihood Ratio Test (LRT)	145.590	0.0000	294.037	0.0000

Table IV shows that the null hypothesis (linear model) is rejected at 1% level of significance for the three tests. Consequently, the relationship between external debt and human development index is non-linear.

4.4. Determination of the number of regimes

After rejecting linear model and verifying non-linearity, PSTR model has hence at least one threshold. To find out the number of regimes (or thresholds) in the PSTR model, we test the following hypothesis H2: PSTR model has at least two thresholds (r = 2). Of course, alternative hypothesis is the following Ha : PSTR model has one threshold (r = 1). To check hypothesis H2, we use two tests which are Fisher test (LM_F) and likelihood ratio test (LRT). If Fisher and likelihood statistics are significant, we reject the hypothesis H2 and we conclude that the PSTR model has one threshold and has then two regimes. Results of these two tests are reported in Table V.

Table V : Tests for the number of regimes.

	r = 2	
Tests	*Statistic*	*P-value*
Fisher Test (LM_F)	414.638	0.0000
Likelihood Ratio Test (LRT)	1082.839	0.0000

Results from Table V indicate that hypothesis H2 is rejected at 1% level of significance for the two tests. The PSTR model has only one threshold and It is therefore a two-regime model.

4.5. PSTR model estimation

We use hence PSTR model with two regimes to estimate the relationship between external debt and HDI for 95 developing countries by applying non-linear least squares technique. Results of the PSTR model estimation are presented in Table VI.

Table VI: PSTR model estimation.

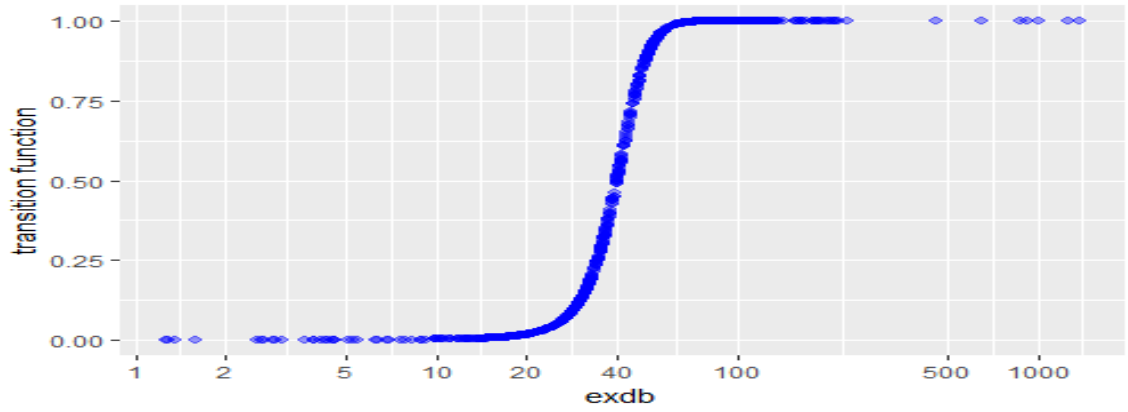
Variables	**Coefficients**	**T-Statistics**
EXDB	0.0002	1.704*
FDI	-0.00111	-3.876***
TRADE	-0.0003	-4.945***
GCF	0.0012	6.186***
GPOP	0.0312	11.919***
CCOR	-0.0050	-1.297
POLIS	0.0029	1.395
EXDB * $g(exdb_{it},\gamma,c)$	-0.0003	-2.069**
FDI * $g(exdb_{it},\gamma,c)$	0.00106	2.662***
TRADE * $g(exdb_{it},\gamma,c)$	0.0005	5.35***
GCF * $g(exdb_{it},\gamma,c)$	0.0002	0.752
GPOP * $g(exdb_{it},\gamma,c)$	-0.0367	-17.411***
Transition Parameters		

C	**41.7775%**
ϒ	0.200
AIC	-7.6223
BIC	-7.5656

*Note: ***. ** and * indicate level of significance respectively at 1%. 5% and 10%.*

Estimation results of PSTR model reported in table VI show that the relationship between external debt and HDI is non-linear and characterized by the presence of a threshold effect of external debt which is equal to 41.7775%. Dissimilar to previous works, our study is the first, as far as we know, to estimate the optimal debt threshold beyond which human development is affected for the case of developing countries. Also, the estimate of the transition parameter (γ), which is equal to 0.2, means that the transition from low external debt regime to high external debt regime is smooth as shown by the following figure 4.

Figure 4: Estimated transition function for developing countries.



Source: Author.

Below the threshold of 41.7775%, external debt exerts a positive and significant effect at 10% level of significance on human development. In a low external debt regime, this positive effect can be explained by the fact that as long as external debt ratio does not exceed the estimated optimal threshold, leverage effect outweighs crowding out effect. Low debt services do not reduce government budgetary allocations to social sectors. External debt has also supplemented deficit in terms of domestic savings, which is low, thus taking advantage of the leverage effect. A significant share of external debt has been used to finance basic infrastructure, improve public services, valorize human resources through health and education spendings, and increase productivity. It has contributed to increasing investment, promoting economic growth, creating new jobs, reducing unemployment and poverty, and improving human development (Hukom, 2015 and Kojo, 2014). In addition, external debt has freed up financial constraints and budget deficits of some countries that have escaped the rise in inflation which causes poverty (Azam et al. 2016). Moreover, when the stock of external debt is weak, institutions that manage these foreign resources are strongly controlled even by citizens. As a result, opportunities for waste and capital flight are limited. Dessy and Vencatachellum (2007) showed that debt relief provided to some African countries, which have improved the quality of their institutions, has a positive effect on human development by appropriately allocating part of this debt to health and educational sectors.

In addition to endogenously determining the optimal debt threshold and the transition parameter, our study differs from other works by estimating loss in HDI when the external debt ratio exceeds the threshold of 41.7775 %. Indeed, in the PSTR[6] model, β^0 and $(\beta^0 + \beta^1)$ respectively represent the coefficients of the transition variable below and above the debt threshold. Therefore, below 41.7775%, any 1% increase in the external debt ratio induces an increase in the HDI of 0.02%. On the other hand, above the debt threshold, the HDI is reduced by 0.01%[7] if the external debt ratio increases by 1%. Furthermore and unlike preceding works where they reached positive, negative or no effects, this paper provides and discusses the joint effects of explanatory variables on HDI taking into account the transition function $g(exdb_{it},\gamma,c)$. The same variable may have opposite effects below and above the optimal debt threshold. In fact, contrary to its positive effect below 41.7775%, external debt (EXDB * $g(exdb_{it},\gamma,c)$) becomes detrimental to human development in high external debt regime.

This negative effect is attributed to the undesirable impact of external debt on public investment and per capita income growth. The obligation to pay high external debt services exerts a crowding-out effect on public spending leading to a fall in expenditure especially in social sectors such as health, education, water, sanitation, environmental protection, etc. For the private sector, when the external debt exceeds the optimal threshold, it discourages investors who predict an increase of taxes in the future to repay the debt services. To avoid this taxation, investors influence the quality of investment by intervening in short-term projects, which generally have a limited impact on factors' productivity, per capita income growth and socio-economic progress. For both sectors, high debt services is damaging to human development (Murshed and Saleh, 2013; Fosu, 2008, and Eduardo and Mauricio, 2007).

Moreover, high external debt services rises inflation rate, destroys purchasing power of citizens, increases unemployment rate and aggravates poverty (Arisman, 2018 and Apkan, 2009). Examining the implications of external debt on poverty alleviation in Nigeria over the period 1980-2005, Apkan (2009) realized that external debt does not contribute to the increase of poverty, which is due to low economic growth, inadequate expenditure on social sectors and high rate of inflation. In an inflationary environment, terms of trade deteriorate, exported products become less competitive, per capita GDP growth decreases leading to the worsening of human development.

Additionally, in a high external debt regime, external debt affects negatively HDI through the behavior of lenders and donors, which require often the allocation of funds to specific regions or sectors. In the same country, we find regions with more modern infrastructures than others and sectors that are more developed than others. External debt therefore modifies the structure of countries' GDP and creates regional disparities leading to economic inequality, which accentuates income inequality. Shah (2016), who searched the main factors affecting the HDI of 188 countries belonging to six different regions, proved that income inequality has a negative and significant effect on their HDI.

The unhelpful impact of external debt on human development is also elucidated by the implications of this foreign resource itself on financial systems of highly indebted countries, which have remained fragile, underdeveloped and unable to mobilize sufficient resources which can reduce external debt. In most developing countries, banks are undercapitalized and small. They find difficulties to reconcile between both their economic and social roles. On the

[6] See please equation "(1)" in page 5.

[7] According to Table 6, $\beta^0 = 0.0002$ and $\beta^1 = -0.0003$, then $(\beta^0 + \beta^1) = -0.0001 = -0.01\%$.

other side, financial markets have remained narrow and limited to few sectors of activity. The majority of companies listed in the various stock exchanges do not belong to the social sectors.

Therefore, our results differ from those of previous studies which stated that external debt is beneficial, harmful or without effects on human development. The differences are basically explained by the adoption of a new methodological approach based on the PSTR model. Unlike other works which rely on econometric techniques used to estimate linear relationships that are unable to detect regime changes, this paper renews research on the raised question and enriches the existing literature by focusing on the non-linear relationship between external debt and HDI which does not exist for the case of developing countries.

Regarding the effects of the other independent variables, results displayed in Table VI reveal that in a low external debt regime, FDI is negatively and significantly associated with HDI at 1% level of significance. In the majority of developing countries, FDI focuses on labor-intensive industries mainly characterized by low wages. Furthermore, the majority of FDI is involved in polluting activities that affect health conditions. The population suffers from the degradation of the quality of the environment in which they live. That is why we have witnessed the proliferation of deadly diseases in these countries. However, in a high external debt regime, foreign direct investment (FDI * $g(exdb_{it},\gamma,c)$) has a positive and significant impact on HDI. This result confirms the findings of Gokmenoglu et al. (2018), Fazleen et al. (2012), and Sharma and Gani (2004). This positive effect can be explained by the fact that FDI provides host countries with technologies without excessive costs, a qualification to the workforce in the form of know-how improving the employability of people and reducing unemployment, ensures export markets and facilitate the import of capital goods and new medical technologies, etc.

Distinct from previous works, the empirical approach based on the PSTR model has the merit of determining loss in HDI above the debt threshold. Indeed, when the external debt ratio exceeds 41.7775%, any 1% FDI increase reduces HDI by 0.00005%[8]. This result shows that in overall, the disadvantages of FDI outweigh their benefits. This finding is expected, since the majority of countries suffer from the timidity of FDI, which represents on average 4.796% of their GDP. FDI is controlled by transnational corporations, which are the main actor responsible of capital transfers around the world. Obeying to the logic of capitalism, these transnational corporations seek generally the maximization of profit by targeting the most profitable investment projects. They are worried about financing non-immediate profitability projects such as social sectors.

As for the effect of trade, our findings are different from those found by preceding studies which did not consider the joint effect of trade openness and transition function on HDI. Taking into account the debt threshold of 41.7775%, results displayed in Table VI show that trade openness acts negatively and positively on HDI at 1% level of significance when the external debt ratio is below and above the estimated threshold respectively. In a low external debt regime, the undesirable effect of trade on HDI can be explained by the behavior of transnational corporations, which control also global trade. They will not support low-indebted countries, which find difficulties both to find and access to new markets. This had a negative impact on per capita income growth and human development. Our results validate the finding of Neumayer and De Soysa (2005). However, trade openness (TRADE *

[8] According to Table VI, $\beta^0 = -0.00111$ and $\beta^1 = +0.00106$, then coefficient relative to FDI beyond the debt threshold is equal to $(\beta^0 + \beta^1) = -0.00005$.

$g(exdb_{it},\gamma,c)$) is positively and significantly associated with HDI in high external debt regime. Any increase in trade of 1% leads to an increase in HDI by 0.0002%. This positive impact, although small, is justified, among other things, by the conquest of new markets to export goods and services and to import capital goods that increase labor's productivity and per capita income. The import of new medical technologies reduced infant mortality and improved life expectancy at birth. This finding is in line with those found by Mustafa et al. (2017) and Fazleen et al. (2012).

Estimation results show that the gross fixed capital formation (GCF) has a positive and significant impact at 1% level of significance on HDI only in low external debt regime. Our findings confirm those of Hukom (2015), Kojo (2014) and Grier (2005). The investment improves HDI when the external debt is sufficiently low. That is why in a high external debt regime, the gross fixed capital formation (GCF * $g(exdb_{it},\gamma,c)$) does not exert any significant effect on human development. Unlike early studies, this paper has the advantage to estimate gains in HDI below 41.7775%. Any increase in the GCF of 1% is accompanied by an increase in the HDI of 0.0012%. In a low external debt regime, external debt has not had a crowding-out effect on investment, which continues to promote economic growth which in turn affects human development through creation of jobs, reduction of unemployment, improvement of living conditions, development of infrastructure, etc. Also, the stock of physical capital is measured by gross fixed capital formation which is a measure of capital spending. Several studies showed that both physical and human capitals are highly linked. Therefore, an increase in the level of physical capital raises the stock of human capital and enhances human development.

Concerning the population growth rate (GPOP), estimation results reveal that its effects on HDI depend on the threshold of external debt. In a low external debt regime, population growth has a positive and significant impact at 1% level of significance on HDI. In most developing countries, wealth-creating sectors are labor intensive, which provides income for the population and reduces unemployment. While in high external debt regime, population growth (GPOP * $g(exdb_{it},\gamma,c)$) impedes human development. Any 1% population growth reduces HDI by 0.0055%. The payment of debt services has the effect of crowding-out the investment, which in turn reduces domestic production that can not meet the needs of the entire population leading to the rise of famine and mortality and declining enrollment. Moreover, high debt services directly reduces government budgetary allocations on health, education, water and sanitation, electricity, infrastructure, import of new medical technologies, recruitment of highly qualified foreign personnel, etc. This result confirms findings of Arisman (2018), Sofilda et al. (2015) and Pattillo et al. (2002), but opposes that of Singariya (2014).

With regards to the two governance variables, control of corruption (CCOR) and political stability and absence of violence and terrorism (POLIS), results show that they do not exert any significant effect on HDI. In a high external debt regime, the adverse effect of external debt can be attributed to the bad institutional quality of the majority of countries. They fail to use judiciously and prudently the external debt which is not reallocated to increase technical skills and professional capabilities of their citizens. Abundance of foreign resources in countries which have an external debt ratio above 41.777% can lead to the leakage and the waste of resources. Notably, it can trigger and stimulate corruption which reduces State tax revenues and distorts resource allocation contributing hence to a fall in social sectors' spending and an increase in unemployment, income inequality and poverty (Gupta et al. 2002). Corruption undermines also the image of the country, discourages foreign investors

from setting up and worsens human development (Reiter and Steensma, 2010). The insignificant effect of governance variables on HDI can be attributed also to democratization deficit in most developing countries. Colossal sums of highly paid foreign debt are allocated to prestigious projects (building palaces, purchases of new luxury cars, travel, etc.) and inflated expenses that ensure the maintenance of governments in power. Baqir (2002), who stressed the political factor to explain social sector spending in a panel of countries observed during the period 1985-1998, found that democratization favors social sector since it increases social expenditures particularly in education and health sectors.

5. Conclusion and policy implications

This paper investigates the relationship between external debt and human development for a panel data set of 95 developing countries observed during the period 2002–2015. To do this, we performed the Panel Smooth Threshold Regression (PSTR) model developed by González et al. (2005).

Dissimilar to foregoing studies, our results prove that the association between external debt and HDI is non-linear and characterized by the presence of an optimal threshold of external debt which is equal to 41.7775%. The estimate of the transition parameter which is equal to 0.2 shows that the transition from low external debt regime to high external debt regime is smooth. Contrary to its positive effect, external debt becomes detrimental to human development in high external debt regime. This negative effect on HDI can be explained by the adverse impact of external debt on public and private investments, income growth and public social spending especially in health, education, water, sanitation, environmental protection, etc. Moreover, high external debt raises inflation rates, deteriorates terms of trade, and impedes financial systems, which remained fragile and underdeveloped. Our finding also differs from those of previous works by estimating loss in HDI when the debt ratio exceeds the threshold of 41.7775%. Below this debt threshold, any increase in the debt ratio of 1% induces an increase in the HDI of 0.02%. But, above the debt threshold, the HDI is reduced by 0.01% when the debt ratio increases by 1%.

For the other variables, results reported in Table VI show that foreign direct investment (FDI) and trade (TRADE) affect negatively and significantly HDI in low external debt regime. Unlike other previous works, this negative effect is not continuous. From the optimal threshold of external debt, the effects of these two variables become positive and significant. This change in effects can be explained by the behavior of the transnational corporations which control international trade and capital transfers around the world. As for the population growth rate (GPOP), it is positively and significantly associated with HDI when the external debt ratio is sufficiently low. While, beyond the threshold of external debt of 41.7775%, population growth becomes a brake on human development. High debt services directly reduce public investment and social sector spending.

Results displayed in Table VI show also that the gross fixed capital formation (GCF) improves significantly at 1% level of significance HDI only in low external debt regime. GCF develops infrastructure, reduces unemployment, ameliorates factors' productivity, raises the stock of human capital, increases per capita income growth, stimulates economic growth and enhances human development. However, when external debt exceeds 41.777%, the effect of this variable becomes insignificant. This result is explained by the crowding-out effect of external debt on both public and private investments. For governance variables, results prove

that they do not exert any significant effects on HDI due to the poor institutional quality of the majority of the selected countries.

Different from previous studies, our paper has the advantage of endogenously determining an external debt threshold above which its effect on HDI is negative, considering the smooth transition from low to high external debt regime. The debt threshold can be considered as a target threshold that selected countries have an interest to take into account in their debt policy. Results of this paper could be of great importance for both groups of countries which have an external debt ratios below and above 41.7775%. The first group of countries are encouraged not to exceed this threshold to continue to benefit from the leverage effect. They should also modify the structure of imports through avoiding unnecessary ones. The second group of countries are obliged to reduce their external debt ratio, avoid the waste of highly remunerated foreign resources and know how to allocate them to the most productive sectors, and control their demographic growth.

Our findings are also useful for the selected countries which should continue to boost the gross fixed capital formation, enhance the quality of exported products, diversify exports, and avoid useless imports. Furthermore, they are encouraged to improve the quality of their institutions and deeply reform their financial systems so that they can mobilize sufficient local resources to finance development, attract FDI and reduce external debt.

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Appendix

Table I: Comparison between countries.

	China	Dominica	Haiti	Mexico	Sudan	Brazil
hdi	0.681	0.715	0.469	0.738	0.454	0.719
exdb (%)	12.567	69.776	23.478	24.591	54.893	24.571
fdi (%)	3.473	6.721	1.276	2.663	3.918	2.973
trade (%)	52.059	87.613	63.854	59.250	33.986	25.815
gcf (%)	44.031	16.787	28.776	22.470	23.748	19.455
gpop (%)	0.537	0.349	1.491	1.429	2.316	1.052
ccor	-0.503	0.652	-1.348	-0.365	-1.337	-0.090
polis	-0.512	0.946	-1.177	-0.595	-2.230	-0.133

Table II: Economic indicators, average values for the period 2002-2015.

	China	Dominica	Haiti	Mexico	Sudan	Brazil
GDP per capita growth (annual %)	9.17	1.43	-0.14	0.71	4.4	1.89
Agriculture,forestry, and fishing, value added (% of GDP)	10.48	11.88	19.2	3.19	30	4.68
Industry (including construction), value added (% of GDP)	45.45	12.74	44.08	32.66	18.98	22.52
Services, value added (annual % growth)	44.39	60.07	32.52	59.98	41.91	58.05
Gross fixed capital formation, private sector (% of GDP)	—	—	21.6	16.84	16.53	15.08
Exports of goods and services (% of GDP)	27.89	37.35	15.66	29.02	15.61	13.05
Imports of goods and services (% of GDP)	23.78	53.11	48.19	30.58	18.38	12.76
High-technology exports (% of manufactured exports)	27.13	5.95	—	17.87	—	11.84
External debt stocks (% of exports of goods, services and primary income)	44.33	178.86	170.73	81.51	368.05	174.98

Table III: Social indicators, average values for the period 2002-2015.

	China	Dominica	Haiti	Mexico	Sudan	Brazil
GNI per capita, PPP (current international $)	8341.43	8781.43	1527.14	14097.86	2898.57	12692.86
Life expectancy at birth, total (years)	74.75	76.6	60.65	75.88	61.88	73.24
Literacy rate, adult total (% of people ages 15 and above)	95.12	—	53.71	92.89	53.52	90.49
Mortality rate, under-5 (per 1,000 live births)	19.04	21.59	91.81	18.61	80.99	22.24
Mortality rate, infant (per 1,000 live births)	16.17	19.45	62.79	15.92	53.74	19.77
Poverty headcount ratio at national poverty lines (% of population)	10.25	—	58.5	45.55	46.5	15.19
Unemployment, total (% of total labor force) (national estimate)	4.14	—	18.77	4.2	16.42	7.92

Source: Author Calculations, World Bank, WDI. Last updated: 28/08/2018.