Journal of Business Economics and Management
ISSN 1611-1699 print / ISSN 2029-4433 online
2012 Volume 13(5): 968–993
doi:10.3846/16111699.2012.701224

REVISITING THE ROLE OF EXTERNAL DEBT IN ECONOMIC GROWTH OF DEVELOPING COUNTRIES

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Received 22 July 2011; accepted 25 May 2012

Abstract. This paper proposes a study on the contribution of external debt to the expansion of economic growth for 31 developing countries. Over a period of 36 years, by using dynamic panel data econometrics estimation GMM-system, the results reveal that the accumulation of external debt is associated with a slowdown in the economies of the developing countries. In addition, this paper finds evidence that debt service ratio does not crowd out the investment rate in developing countries. In other words, even though external debt is negatively associated with economic growth, countries are found to be safe from being in the debt overhang hypothesis. Furthermore, there is evidence to support the existence of spatial dependence in the growth model, suggesting the existence of a positive spillover effect of growth among the neighbouring countries.

Keywords: external debt, investment, economic growth, spatial econometrics, developing countries.

Reference to this paper should be made as follows: Mohd Daud, S. N.; Podivinsky, J. M. 2012. Revisiting the role of external debt in economic growth of developing countries, *Journal of Business Economics and Management* 13(5): 968–993.

JEL Classification: F43, F34, H63, E66.

1. Introduction

The issues related to capital flight through foreign direct investment and the importance of external debt has started to gain the concern of policy-makers, investors and academics. Several studies that have analyzed the impact of foreign direct investment in stimulating growth are ambiguous, with mixed results (Choong *et al.* 2010) while the impact of external debt on economic growth remains an important and compelling debate with no clear consensus emerging. In retrospect, the high stock of external indebtedness held by some of the developing countries that are associated with a high incidence of default and poverty has underlined the importance of research to investigate this debatable issue. Thus, the role played by external debt in generating economic growth can be questioned since there has been a high incidence of default.

As has been enlightened by the capital market imperfection view, there is no effective mechanism to prevent the borrower from being in default to the lenders. Even with a high level of indebtedness where debt service could "crowd out" investment or, to a lesser extent, cause stagnant or declining economic growth, being in default is not the best option. This is because the incidence of default could have incurred or imposed costs such as reputational costs (exclusion from the international capital market for future borrowing), international trade exclusion costs, costs to the domestic economy through the financial system, and political costs to the authorities (Borensztein, Panizza 2008). As such, being neither in default nor in a debt-overhang position is not the best way for a country to maintain a sustainable economic position. Thus, by analyzing the effects and relationship between external debt and economic growth, this paper will try to shed light on whether countries have gained from external borrowing over the past 20 years.

Thus, this paper aims to investigate the relationship between external debt and economic growth in developing economies. Furthermore, this paper also aims to analyze the debt-investment relationship for the developing countries. This could provide evidence on the "disincentive effects" of high debts, due to the debt overhang and to macroeconomic instability, as well as the liquidity constraint which could refer to the adverse effect of debt-servicing on investment and growth. This paper is also concerned with the importance of considering spatial dependence among developing countries in the growth model. This analysis is important since any results found from the linkages between external borrowing and economic growth would be useful for policy formulation that could prevent countries from being in default or in a debt-overhang situation. In this case, debt could boost or impede economic growth. Besides that, this paper might give an indirect signal to creditors regarding a country's ability to service its debt in the future. This paper is distinct from past studies in several aspects. Firstly, this paper contributes to the small but growing body of empirical literature on the debt-growth nexus. Furthermore, this analysis investigates in more detail whether the relationship between debt and growth is robust for all the developing countries in the sample. This paper also investigates the existence of the debt-Laffer curve relationship. Thirdly, this is the first attempt to analyze the relationship of the debt-growth nexus by using a spatial correlation approach. Moreover, no empirical study has been carried out to determine whether location matters for the debt-growth model. An analysis of the contribution of external debt to economic growth using a panel spatial econometric approach rather than a cross-sectional or time series (country-specific) analysis could provide a valuable addition to existing empirical studies. Thus, this study attempts to fill this gap in the literature. This paper is organized as follows**.** Section 2 reviews the theoretical model and empirical literature on the debt-growth nexus. The model, procedure of the estimation and the dataset that has been used in the analysis are explained in section 3. The empirical results are presented in section 4, and section 5 concludes the paper.

2. Literature review

In recent decades there has been a scarcity of literature studying the significant roles that external debt plays in long-term economic growth. As an extension of the Harrod-Domar growth model, the dual-gap theory has highlighted the motivation for the intro-

duction of external debt in a growth model. Furthermore, in the era of high mobility of resources, the interdependence among countries has inspired Otani and Villaneuva (1989), Agenor (2000), Villaneuva (2003), and Mariano and Villaneuva (2006) to develop a growth model for the open economy that incorporates a global capital market role. Otani and Villanueva (1989), who initiated the study of this area, have developed a simple aggregate growth model that is capable of assessing the impact of macroeconomic policies on the long-term performance of a developing country where the model analyzes the accumulation of capital and the dynamic of external debt. Meanwhile, the aggregate capital stock is defined as the accumulated sum of domestic saving, global capital market, and net external borrowing (Villaneuva 2003). In addition, the difference between the expected marginal product capital, net of depreciation, and the marginal cost of funds in the international capital market determine the proportionate rate of change in the external debt-capital ratio. Furthermore, Villaneuva (2003) added that, when the expected net marginal product of capital matches the marginal cost of funds at the equilibrium capital-labour ratio, the proportionate increase in net external debt is fixed by the economy's steady-state output growth and the external debt-to-output ratio stabilizes at a constant level. Meanwhile Mariano and Villaneuva (2006) correct the shortcomings of the Villanueva (2003) model which is unable to settle the steady-state external debt ratio that is consistent with maximum consumer welfare. As such, on the balance-growth path, Mariano and Villanaeuva (2006) choose the domestic savings rates that maximize social welfare by maximizing long-run consumption per unit of effective labour[1].

Theoretically, a country will benefit from the positive effect of external debt if it has been efficiently allocated to domestic investment, resulting in a higher rate of growth. In addition, a well-functioning financial institution that supports the investment environment climate will result in a positive impact of private capital flow (which includes foreign direct investment, portfolio investment and foreign debt) on economic growth (Choong *et al.* 2010). Furthermore, a country could improve its capability to service debt without crowding out investment. However, empirical studies have sought to provide evidence of the negative effect of external debt on economic growth (Chowdhury 2001; Clements *et al.* 2003; Wijeweera *et al.* 2005; Sen *et al.* 2007). A high level of indebtedness incorporated with a low level of economic growth and low capability to repay external debt has highlighted the symptoms of a country in the debt overhang problem[2]. A country with a debt overhang problem would be burdened with a high

[1] Furthermore, the development of human capital is also essential when the external debt burden is already excessive. In addition, the fiscal policy adjustment does not only reduce the foreign debt burden, by raising the capital effective labour ratio, but also has a permanent positive growth effect (Agenor 2000).

[2] Krugman (1988) defines debt overhang as a situation in which the expected repayment on external debt falls short of the contractual value of the debt. The debt-overhang could be explained where, with additional external debt, a country has too much debt that is not effectively contributing to economic growth. In addition, this could affect the ability of the country to repay its debt and interest payments while more arrears are added when the country delays the repayment. On the other hand, the debt-servicing could also affect the investment rate and to a lesser extent the economic growth.

level of indebtedness; it would not be able to generate growth, its investment would be squeezed, it would fail to repay its debts and its economic growth would be reduced. Besides that, high debts have a negative impact on the rate of investment and economic growth because of disincentive, cash flow and moral hazard effects (Claessens *et al.* 1997). At the other end of the spectrum, at a reasonable level of foreign borrowing, a country might possibly experience both effects: a positive effect (when the debt benefits the country's growth), followed by a negative effect (when a country is burdened with a heavy external debt) as represented by a "Laffer Curve". In other words, if the outstanding debt increases beyond a threshold level, the required repayments begin to fall as a consequence of adverse effect[3].

According to Krugman (1988), high debts have adverse effects on economic growth, and this situation could be related to the debt-overhang theory. If there is some likelihood that, in the future, debt will be larger than the country's repayment ability, the expected debt-service cost will discourage further domestic and foreign investment (Pattillo *et al.* 2002). However, at a reasonable level of foreign borrowing, external debt could have a positive impact on investment and growth. The relationship between the face value of debt and investment can be represented by a "Laffer Curve". If the outstanding debt increases beyond a threshold level, the expected repayment begins to fall as a consequence of adverse effect. Besides that, the uncertain condition of the outstanding stock of external debt could result in a low level of economic growth[4]. Pattillo *et al.* (2004) argue that the main channel through which debt affects economic growth is the quality and efficiency of investment rather than its level, because the exclusion of the investment rate from the growth regression does not significantly change the adverse debt effect.

However, to the best of the authors' knowledge, there have been few empirical studies carried out to analyze the linkages between debt and economic growth, and most of the empirical studies have investigated the period 1969–1999. Furthermore, in all the above-mentioned studies, none of the analyses considered spatial factors as factors that contribute to economic growth. Published studies on the effect of external debt on economic growth have found mixed results to support the debt-overhang hypothesis. Clements *et al.* (2003), Mohamed (2005), Chowdhury (2001), Wijeweera, Dollery and Pathberiya (2005) and Sen *et al.* (2007) found evidence that the external debt has a negative impact on a country's economic growth. Meanwhile, a study by Pattillo *et al.* (2004) indicates that the negative impact of high debt on growth mainly operates through a strong negative effect on physical capital accumulation and on total produc-

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[3] The upward-sloping curve implies that an increase in the face value of debt is associated with an increase in expected repayment up to threshold level. Along the bad section of the "Laffer Curve", an increase in the face value of debt reduces expected payments.

[4] Risk of default, rescheduling and arrears are likely to increase the volatility of future inflows and additional lending, while the access to capital market depends on the perceived sustainability (Gunning, Mash 1998). As a result, investors will choose to wait before entering the market. Moreover, an unstable macroeconomic environment could lead to misallocation of resources which reduces the efficiency and productivity of capital and leads to a slowdown in economic growth.

tivity growth. In a case-study of Sri Lanka, Wijeweera *et al.* (2005) found a negative but insignificant long-run relationship between debt and economic growth. On the other hand, the stock of external debt has an indirect effect on growth through its effect on public investment (Clements *et al.* 2003).

Pattillo *et al.* (2002, 2004), Cordella, Ricci and Ruiz-Arranz (2005) and Imbs and Ranciere (2005) found evidence of non-linearity in the debt-growth relationship. Furthermore, Pattillo *et al.* (2002) found that the average impact of debt on per capita growth appears to become negative for debt levels above 160–170 percent of exports and 35–40 percent of GDP. Furthermore, Clements *et al.* (2003) found that, above the threshold of 20–25 percent of GDP and 101–105 percent of exports, external debt is associated with lower rates of growth for 55 low-income countries. In contrast, the study conducted by Schclarek (2004) found no evidence of non-linearity (inverted–U shape relationship) for selected developing countries.

Meanwhile, the flow of debt could affect growth by crowding out private investment or public spending. A study by Iyoha (1999) confirmed the crowding out effect in the sub-Saharan African countries, implying that the heavy external debt stock and debt service payment act to reduce investment. Clement *et al.* (2003) also support the crowding-out effect for 55 low-income countries. Pattillo *et al.* (2004) found that one third of the effect of debt on growth occurs via physical capital accumulation and two thirds via total factor productivity growth. A high-level stock of indebtedness and low level of investment in the 1980s by several Latin America countries has inspired Cohen (1995) to analyze whether the high debt stock could be the best predictor for the low level of investment rate. However, large debtors do not expect to service their debt; thus investment should not be crowded out. Surprisingly, the impact of debt flows (debt service) could affect economic growth by crowding out private investment or altering the composition of public spending. Higher debt service can raise the government budget deficit, thus reducing the public savings**.** This in turn may either raise interest rates or crowd out credit available for private investment, dampening economic growth (Clements *et al.* 2003). Higher debt service payments can also have adverse effects on the composition of public spending by shrinking the amount of resources available for infrastructure and human capital, with a negative effect on growth. Meanwhile, an empirical study conducted by Rutkauskas and Dudzevičiūtė (2005) highlights that a high proportion of foreign capital in the banking sectors of the Central and Eastern European countries has a positive effect on the quality and amount of banking sector loans.

3. Model, data, and method

3.1. Model

In analyzing the impact of external debt on a country's economic growth, this paper employs a specification of the debt-growth model by Sen *et al.* (2007) to investigate the effect of external debt on growth. The model could be expressed as follows:

$$Y_{it} = \delta y_{it-1} + \varphi_i + X'_{it}\beta + \varepsilon_{it};\ \ \varepsilon_{it} \approx IN(0, \sigma^2)\,, \tag{1}$$

where Y is the dependent variable, X is k-vector of regressors, and the subscripts (i =

1,….*N* and *t* = 1,….,T) identify the cross-section dimension and the time dimensions; β is $k \times 1$ and X_{it} is the *it*-th observation on *k* explanatory variable. *Y* represents the growth rate in per capita GDP and *X* includes gross investment rate, population, fiscal balance, trade openness, external debt and debt service payment, secondary education, changes in terms of trade, while ε_{it} represent the error term. The lagged of initial income and external debt to GDP are expressed in natural logarithmic form. Lagged per capita income is included as in the standard Barro growth model in order to test for convergence across countries over time. Population and gross investment represent the rates of growth of factor inputs in the production function, while secondary school enrolment rate is used as a proxy for the quality of human capital. Meanwhile, changes in terms of trade variables represent the external shocks to the economy, and openness is included as an additional control variable. The fiscal balance captures the role of government in economic growth. In addition, external debt, gross investment, fiscal balance and trade openness are calculated as percentages of Gross Domestic Product (GDP), while debt service ratio is calculated as a percentage of Gross National Income (GNI).

In addition, to provide an in-depth analysis of the debt-growth nexus, the investment model proposed by Presbitero (2005) is utilized in this study to analyze the impact of external debt and debt service on investment directly. The investment model is

$$I_{it} = \delta I_{it-1} + \varphi_i + X'_{it}\beta + \varepsilon_{it}. \quad (2)$$

I represents the gross investment rate while *X* is lagged of investment rate, debt service ratio, external debt, GDP growth rate, aid, secondary school enrolment rate, domestic credit, openness, and government revenue. The growth of GDP is expected to capture the investment accelerator (Iyoha 1999) while the external debt is expressed in natural logarithmic terms. Besides that, total aid and debt service payment are computed as a percentage GNI. Meanwhile, domestic credit, government revenue, trade openness and external debt are calculated as a percentage of GDP. In addition, this paper tries to examine the debt-growth relationship for the developing countries with tested hypothesis of

Ho: There is no impact of external debt on the economic growth,

Ha: There is an impact of external debt on the economic growth.

3.2. Data

The dataset consists of a panel of 31 developing countries during the period 1970 to 2005[5]. Due to unavailability of data, the analysis could proceed with only 31 out of 149 developing countries. Data are collected from the World Bank, World Development Indicator (WDI) and Global Development Finance (GDF), IMF/IFS statistics, World Economic Outlook database, and Barro-Lee dataset. Distance measurements (latitude and longitude of the main important city) are taken from Centre D'Etudes Prospectives Et D'information Internationales (CEPII)[6]. The use of flow of borrowing could provide evidence of the immediate effect on a country's economic growth ('credit impulse').

[5] Details on the countries are in Appendix 1

[6] http://www.cepii.fr/anglaisgraph/bdd/distances.htm

However, due to the unavailability of data on international borrowing, the analysis is estimated using the stock of debt variable. The observations were averaged over 5-year intervals which resulted in t = 7. This is to avoid modelling the cyclical dynamic of the output variable, which is a highly persistent series (Bond *et al.* 2001).

3.3. Method

Within a dynamic panel data of Generalized Method of Moments (GMM) framework, this paper examines the role of external debt in economic growth for a sample of 31 developing countries. A general dynamic panel model for country *i* at time *t*:

$$y_{it} - y_{i,t-1} = (\alpha - 1)y_{it-1} + \beta X_{it} + \eta_i + \varepsilon_{it}, \tag{3}$$

where *y* is a log of real percapita GDP, *X* is a N x *p* matrix of *p* explanatory variables, η is the vector of unobserved country-specific effect, and ε_t is the error term and is assumed to be normally distributed. Thus equation (3) can rewritten as

$$y_{it} = \alpha y_{it-1} + \beta X_{it} + \eta_i + \varepsilon_{it}\,. \tag{4}$$

A common approach to estimate a dynamic panel data model in the first difference Generalized Method of Moments (GMM-difference) estimator has been proposed by Arellano and Bond (1991) to eliminate the unobserved effect, where equation (4) is transform into first difference equation

$$y_{it} - y_{it-1} = \alpha(y_{it-1} - y_{i,t-2}) + \beta(X_{it} - X_{i,t-2}) + (\varepsilon_{it} - \varepsilon_{i,t-2})\,. \tag{5}$$

The idea of GMM-difference is to take the first differences that eliminate the source of inconsistency (country-specific effect φ_i). While, to eliminate the endogeneity and simultaneity bias the levels of the explanatory variable lagged two and further periods are used as instruments. However, Blundell and Bond (1998) point out that, when explanatory variables are persistent, the lagged level of the explanatory variables is a weak instrument for the variables in differences. Thus, by adding the level equation (4) to the difference equation (5), the GMM-system estimators are particularly useful in controlling for country-specific effects, and preserve the cross-country dimension of the data (Arellano, Bover 1995; Blundell, Bond 1998).

In other words, the GMM-system estimators control for the potential endogeneity of all explanatory variables by using the instrumented variable. In order to use these additional instruments, we need the identifying assumption that the first difference of the explanatory variables is not correlated to the explanatory variables; the correlation is supposed to be constant over time. If the moment conditions are valid, Blundell and Bond (1998) show that, in Monte Carlo simulations, the GMM-system estimators perform better than the GMM-difference estimator. We test the validity of the moment conditions by using the conventional test of over-identifying restrictions proposed by Sargan (1958), testing the null hypothesis that the error term is not second-order serially correlated. The GMM-system procedure has several advantages in analyzing the economic growth model. In particular, by taking a first difference to remove unobserved time-invariant country-specific effect, this has eliminated the bias caused by any omitted variable that is constant over time (Bond *et al.* 2001). In addition, the use of instrumental variables

allows the parameter to be estimated consistently, which could eliminate the potential endogeneity problem as well as the presence of measurement error.

On the other hand, spatial econometrics is a subfield of econometrics that deals with the treatment of spatial interaction, spatial autocorrelation, and spatial structure (spatial heterogeneity) in regression models for cross-sectional and panel data (Anselin 1988). Despite the fact that the theoretical mechanisms of technology diffusion, factor mobility and transfer payment, which arguably drive the regional convergence phenomenon, have an explicit geographical component, the role of spatial effects in regional studies has been ignored (Rey, Montouri 1999)[7]. Moreover, the assumption of independence across units is inappropriate because countries are probably going to be exposed to common disturbances which will produce correlation among efforts from different cross-sectional units (Driscoll, Kraay 1995). On the other hand, the spatial econometrics field has first been introduced and analyzed from a cross-sectional approach. This latter approach has been extended to a panel approach since panel data give more information, more variability, less collinearity among the variables, a larger degree of freedom, and more efficiency (Hsiao 1986; Baltagi 1995).

It has been mentioned in the spatial econometrics literature that the Ordinary Least Squares (OLS) estimation of the response parameter will lose its properties of unbiasedness and consistency in the case of a spatially lagged dependent variable while, in the case of spatial error autocorrelation, the OLS estimation of the response parameter will lose its property of efficiency even though it is unbiased (Elhorst 2003). In general terms, spatial dependence can be explained in two distinct ways: in the error structure $(E[\varepsilon_j, \varepsilon_j] \neq 0)$ or as an additional regressor in the form of spatially lagged dependent variable (Wy). As such, according to Anselin (1988) spatial correlation among the observations could be described by a model of spatial autoregressive process in error terms, known as spatial error model (SEM), while a model that contains a spatial autoregressive dependent variable is called a spatial lagged dependent model (SAR). The SEM could be specified as

$$y = X\beta + \phi. \tag{6}$$

$$\phi = \delta W\phi + \varepsilon, \tag{7}$$

$$E(\varepsilon) = 0, \quad E(\varepsilon, \varepsilon') = \Omega(\theta).$$

Equations (6) and (7) could be rewritten as

$$(I - \delta W)\phi = \varepsilon,$$

$$\phi = (I - \delta W)^{-1}\varepsilon,$$

$$y = X\beta + (I - \delta W)^{-1}\varepsilon, \tag{8}$$

where δ is spatial autocorrelation coefficient (with W the weight matrix) displaying the

[7] If the first law of geography – "everything is related to everything else, but near things are more related than distant things" – holds, the i.i.d. assumption (independently, identically, distributed) of efficient and unbiased ordinary least squares (OLS) estimator is void. Thus the OLS estimators could produce biased and inefficient results and, to a lesser extent, a misleading conclusion. In other words the OLS estimation is inappropriate for the model that includes spatial effect.

strength of correlation between the disturbance term ϕ and the weighted average of the disturbance terms of neighbouring countries W_{φ}, and θ is a vector of parameter. A SEM is a special case of regression with a non-spherical error term, in which the off-diagonal elements of the covariance matrix express the structure of spatial dependence (Anselin 1999). In spatial econometrics, W denotes a ($N \times N$) spatial weight matrix describing the spatial arrangement of the spatial units and w_{ij}, the (i,j)th element of W, where i and j = (1,…, N). It is assumed that W is a matrix of known constant, where all diagonal elements of the weight matrix are zero and the characteristic roots of W denoted ω_i. Meanwhile, the traditional model with spatially lagged dependent (SAR) is defined as

$$y = \delta W y + X\beta + \varepsilon, \tag{9}$$
$$E(\varepsilon\ ) = 0\ ,\ E(\varepsilon\ ,\varepsilon') = \sigma^2 I_N$$

in which W is the weight matrix, δ is the spatial autoregressive coefficient and ε_{it} is vector of error term which is assumed independently of the probability model under the hypothesis that all spatial dependence effects are captured by the spatially lagged variable. Thus, it could be rewritten as

$$y\ = (I - \delta W)^{-1} X\beta + (I - \delta W)^{-1}\varepsilon \tag{10}$$

in which each inverse can be expanded including both the explanatory variable and the error term at all locations. Consequently, the spatial lag term must be treated as an endogenous variable and a proper estimation method must correct for this endogeneity (OLS estimation will be biased and inconsistent due to the simultaneity bias). Furthermore, to capture the neighbouring effect, the GMM-system with spatial lag interaction is employed. Kukenova and Jose-Antonio (2008) describe the structure of spatial dynamic panel model as

$$y_{it} = \alpha y_{it-1} + \rho(W_{1t}Y_t)_i + \beta X_{it} + \eta_i + \varepsilon_{it},$$
$$\varepsilon_{it} = \varphi_i + \lambda(W_{2t}Y_t)_i + \mu_{it}, \tag{11}$$

where y_{it} is a N x 1 vector, and W_t and W_{2t} are N x N spatial weight matrices which are non-stochastic and exogenous to the model. η is the vector of country effect, μ_t is the vector of time effect, while μ_{it} is assumed to be normally distributed. Thus, two general spatial models are derived from (11), namely the spatial lag model and dynamic spatial error model where this spatial lag interaction ρ captures the impact of Y_t from neighbourhood locations. The lag spatial dependent variable allows us to determine whether the variable y is positively affected by the Y_t from other nearby locations weighted by distance. Furthermore, Kukenova and Jose-Antonio (2008) proposed to use the GMM-system (which estimates the level and difference simultaneously in one system equation) in which the estimation is proved to be consistent.

The W matrix represents a weight matrix associated with the autoregressive spatial process of dependent variables. W is a block of diagonals matrix of dimension $N \times N$ and is time-invariant. The spatial weight matrix is calculated using a simple inverse distance function which is based on the latitude and longitude coordinates of the main important

city (in terms of population)[8]. Beside the assumption that excludes the possibility of the spatial weight being parametric, there is no spatial unit that can be viewed as its own neighbour. In addition, the row and column sum of W must be bounded uniformly in absolute value as $N \to \infty$ [9]. Thus the condition is satisfied when the spatial weight matrix is a binary contiguity matrix and is an inverse distance matrix. However, there is no agreement as to which type of weight matrix should be used in spatial econometric analysis (Anselin 1988). This paper uses spatial weight matrix that is calculated using a simple inverse distance function which is based on the latitude and longitude coordinates of the main important city (in terms of population). This weight matrix enables us to capture the geographical proximity of the "island" countries (Eliste, Fredriksson 2004). It could represent the real picture of the dependency relationship between countries in the region since this study involved missing sample countries due to unavailability of data.

4. Empirical results

A GMM-system has been employed to analyze the role and impact of external debt on growth. Furthermore, the effect of debt service payment on investment rate has also been estimated in the investment model. In addition, the growth model has also been estimated by quadratic function to investigate the existence of the Laffer-Curve (inverted U-shaped) relationship. On the other hand, to provide robust evidence on the relationship between external debts and growth, this paper also estimates the growth and investment model, samples of which are divided into subsamples; HIPC and non-HIPC.

4.1. Growth model

Table 1 reports the results of GMM-difference and GMM-system estimation of the growth for the period 1970 to 2005. The reported results are based on the one-step GMM estimators where standard errors are asymptotically robust to heteroscedasticity[10]. The results show that the external debt to GDP variable has a negative and significant (at least at 5 percent significance level) impact on economic growth. The estimated coefficient is –5.71, indicating that an increase of 1 percent of external debt stock is

[8] This weight matrix enables us to capture the geographical proximity of the "island" countries (Eliste, Fredriksson 2004). Furthermore, it could represent the real picture of the dependency relationship between countries in the region since this study involved missing sample countries due to unavailability of data.

[9] Three different spatial weight matrices have been applied in spatial econometrics literature. The first method reflects the relative position in space of one regional unit of observations to another unit which is known as a contiguity matrix. The simple contiguity matrix schemes are where countries are defined as neighbours if they share a common border. The second method is based on the shortest great circle distance between each country; the third distance-based weight matrix is specified as a general contiguity matrix where the two countries are defined as neighbours if the distance between the centroids is less than a predetermined critical value.

[10] According to Blundell and Bond (1998), the one-step GMM estimators are also reliable for finite sample inference. On the other hand, Monte Carlo analysis has shown that the efficiency gains of the two-step estimator are generally small and has the problem of converging to its asymptotic distribution (Bond *et al.* 2001).

associated with a decline in growth of GDP per capita of least 0.06 percent. This could support the negative impact of external debt to economic growth. These results are found to be in line with the study by Pattillo *et al.* (2004), who also found that a high level of external debt caused a significant slowdown in economic growth. In addition, the result shows that the debt service has a negative but insignificant effect in explaining the growth rate of GDP per capita. However, the elasticity of the debt service with regard to economic growth is –0.03, implying that an increase of 1 percent in debt service payment is associated with a slowdown in the economy by at least 0.03 percent of per capita income.

Other control variables, such as gross investment, fiscal balance and population growth, are found to have a positive and significant (at 5 percent significance level) effect in explaining the growth rate of GDP per capita, while the openness variable is significant

Table 1. Debt-growth nexus in developing countries

	1970–2005	1996–2005	
	Overall	Non-HIPC	Overall
Initial income$_{(t-1)}$	–13.123 (5.626)*	–58.46 (11.178)*	–59.94 (17.03)*
External debt	–5.714 (2.040)*	–3.923 (2.885)	–6.440 (2.308)*
Debt Service	–0.035 (0.028)	–0.098 (0.144)	–0.299 (0.124)*
Secondary education	0.146 (0.097)	0.255 (0.271)	–0.088 (0.302)
Gross investment	0.364 (0.099)*	0.338 (0.156)*	0.165 (0.110)
Fiscal balance	0.123 (0.041)*	0.129 (0.119)	0.107 (0.077)
Openness	0.081 (0.041)**	–0.018 (0.034)	–0.008 (0.028)
Term of trade	0.000 (0.000)*	0.001 (0.000)	0.001 (0.000)
Population growth	1.908 (0.292)*	4.490 (5.987)	2.860 (2.252)
Constant	85.929 (113.06)	–186.17 (432.95)	–428.51 (354.14)
Sargan test (*p-value*)	0.569	0.979	0.996

Notes: * and ** denotes significant at 5 and 10 percent significance levels respectively. Numbers in brackets and parenthesis represent the robust standard error and p-value respectively. The initial income and external debt are expressed in natural logarithm. The number of observations for the non-HIPC countries is 22 out of a total number of 31 countries. The value reported for Sargan test is the p-value for the null hypothesis, valid specification

in contributing to economic growth with a positive sign and significant at 10 percent significance level. Despite the positive relationship between gross investment and fiscal balance, the changes in terms of trade variable are found to have a negative and significant (at 5 percent significance level) effect on economic growth. This indicates that external shock contributes negatively to economic growth in developing countries (Clements *et al.* 2003). In other words, countries will receive a positive effect when they open their economies to the rest of world but need to be prepared with a precaution guideline to face any sudden shock to their economies. Besides that, the p-values of 0.87 reported by Sargan test could not reject the null hypothesis of no over-identifying restriction for the estimation, suggesting that the estimators are using a valid instrument and the additional instruments of the GMM-system are correct. This shows that the GMM-system estimator does not indicate a serious problem with the validity of these instrument variables.

To provide robust evidence of the relationship between external debt and economic growth, this paper split the sample into two subgroups: Heavily-Indebted and Poor Countries (HIPC) and non-Heavily-Indebted and Poor Countries (non-HIPC). By dividing the sample, we could establish evidence of the impact of external debt on the economy, and examine whether the negative relationship represents the real relationship between external debt and economic growth for all developing countries. Furthermore, this paper estimates the growth model for the overall and non-HIPC group for the period 1996 to 2005. Out of 31 countries in the sample, only 9 are classified as heavily-indebted poor countries (HIPC) by the World Bank. The HIPC group is a set of countries that are eligible to receive debt relief due to several debt indicator variables that are above the HIPC initiatives thresholds[11].

Results for the growth model on the overall sample reveal a negative and significant (at 5 percent significance level) effect of external debt on economic growth. In addition, the coefficient of external debt shows that an increase in external debt stock by 1 percent is associated with a decline of 0.064 percent in the growth rate per capita. The results are consistent with regard to the negative and significant effect of external debt on economic growth for the overall sample (31 developing countries) which is useful for further analysis. However, when estimating the non-HIPC growth model, the external debt variable is found to be negative but insignificant in contributing to economic growth.

Intuitively, it can be said that the strong evidence of negative effect of external debt on economic growth provided by the overall sample represents the existence of a negative relationship between external debt and economic growth for the HIPC-group and has left the relationship of the debt to growth for the non-HIPC group ambiguous. However, it is noted that even though the external debt variable is not significant, the sign of the coefficient is negative with respect to growth. On the other hand, the debt service pay-

[11] The HIPC initiatives were launched in 1996, when 33 countries were defined as heavily indebted poor countries and eligible to receive debt relief. Debt relief provided is in terms of reducing the external public and publicly guaranteed debt.

ment was also found to have a negative and significant (at 5 percent significant level) impact on a country's economic growth for the overall sample for the period 1996 to 2005. An increase in 1 percent of debt service payment has a negatively significant impact on growth with a decline in economic growth of 0.30 percent. The elasticity of the debt service payment in the growth model for the overall period (1970–2005) is found to be smaller than the estimation for the sample 1996 to 2005.

This could be due to the post-crisis (recovery period) effect for several Asian and Latin America countries when the recovery process has slowed down the growth while the debt is required to be repaid at the scheduled time. In particular, estimation of debt service payment in the growth model for the non-HIPC countries was found to have a negative and insignificant effect on economic growth. In addition, the elasticity (coefficient) is relatively small as compared to the overall sample (for the period 1996–2005), implying that an increase in debt service payment in the non-HIPC countries has a slower effect on economic growth when compared to the HIPC or the overall sample. Therefore, the results also suggest that the negative effect exists predominantly among the HIPC countries.

Table 2. Debt-Laffer curve of growth model

	GMM- System
Initial income$_{(t-1)}$	–18.89 (7.076)*
External debt	–6.950 (3.077)*
External debt^2	–0.493 (0.984)
Debt Service	–0.022 (0.038)
Secondary education	0.185 (0.110)**
Gross investment	0.402 (0.085)*
Fiscal balance	0.103 (0.049)**
Openness	0.065 (0.034)**
Term of trade	–0.000 (0.000)*
Population growth	0.674 (0.399)**
Constant	144.94 (127.14)
Sargan test	0.99

Notes: * and ** denotes significant at 5 and 10 percent significance levels respectively. Numbers in brackets represent the robust standard error. The initial income and external debt are expressed in natural logarithm. Data are for five-year intervals

As shown in Table 2, there is no evidence to support the existence of an inverted-U-shape relationship between the debt stock and growth. The inverted-U relationship explains that an increase in debt stock has a positive effect on economic growth until it achieves its optimal level (up to a certain level). Beyond the threshold level, an increase of stock of indebtedness is associated with a negative effect on economic growth. The negative effect could be related where it has not been efficiently allocated to investment and if there is too much debt-holding, which might squeeze the investment through debt repayment. However, the results show that the external debt ^2 variables are insignificant, which suggests that there is no evidence of an inverted-U-shape relationship in the debt-growth model. This finding is also in line with the study conducted by Schclarek (2004).

4.2. Spatial independence

To allow for the spatial interaction in the debt-growth model, this paper makes use of the aforementioned method of GMM-system with spatially lagged dependent. Prior to the GMM-system with spatial correlation test, the method proposed by Pesaran (2004) is conducted to detect the existence of spatial correlation and is presented in Table 3. The results were found to reject the null of cross-sectional independence, suggesting the existence of cross-sectional dependence among the countries in the debt-growth model.

Table 3. Pesaran (2004) test of cross-sectional dependence

Test statistics	5.479[0.00]
Average absolute value of the off-diagonal elements	0.345

Notes: * and ** denotes significant at 5 and 10 percent significance levels respectively. Numbers in parenthesis represent the p-value

In the presence of a spatially lagged dependent variable, simultaneity will result in OLS estimates which are both biased and inefficient. According to Anselin (1988), the spatial lag model (SAR) faces a simultaneity and endogeneity problem which could lead to bias and inconsistent estimation. This problem could be solved through instrumentation (IV and GMM). Meanwhile, Kukenova and Jose-Antonio (2008) show that the GMM-system can consistently estimate the spatial lag coefficient which takes into account the endogeneity and simultaneity problem. Table 4 shows the results of the growth model, estimated by GMM-system with a spatially lagged dependent variable.

The results found that the external debt variable is statistically negative and significant at 5 percent significance level. The coefficient of –4.906 indicates that an increase (of 1 percent) in the external debt stock led to a decline in economic growth by 0.05 percent. Thus, this evidence supports the existence of a negative relationship between external debt and economic growth, which is in line with the results estimated by GMM-system with the absence of spatial interaction. Furthermore, the debt service payment is found to have a negatively significant effect (at 10 percent significance level) on economic growth. In addition, the gross investment and fiscal balance as well as the trade openness (at 5 percent significance level) were found to have a positive and significant impact on economic growth. However, the inclusion of spatially lagged dependent variable in the standard model does not substantially change the effect of other determinants (independent variables). In other words, the addition of spatially lagged dependent variable does not significantly affect the estimation of the rate for the economies to move towards their steady-state. Even though it does not change the results significantly, this has contributed to the discovery of one important omitted variable in the debt-growth model.

The lagged spatial autoregressive coefficient was positively significant at 5 percent significance level, thus confirming the interdependency among countries in the debt-growth model. In addition, as has been established earlier in the paper by Daud and Podivinsky (2011), the result also proves that the spatial autoregressive specification

Table 4. Impact of external debt on growth in spatial estimation

	GMM-system with spatial lagged
Initial income$_{(t-1)}$	–0.392 (0.144)*
External debt	–4.906 (2.043)*
Debt Service	–0.059 (0.034)**
Secondary education	0.129 (0.110)
Gross investment	0.417 (0.105)*
Fiscal balance	0.075 (0.036)*
Openness	–0.102 (0.042)*
Term of trade	–0.000 (0.000)*
Population growth	1.242 (0.314)*
W*dependent variable	0.154 (0.032)*
Sargan test (p-value)	0.996

Notes: * and ** denotes significant at 5 and 10 percent significance levels respectively. Numbers in brackets and parenthesis represent the robust standard error and p-value respectively

model best represents the data, as has been suggested by the LM specification test[12]. The spatial coefficient represents growth spillover between countries where the spatially lagged dependent variable is estimated to be 0.15 and is statistically different from zero with at least a 95 percent level of confidence. This parameter may also be interpreted directly as elasticity. The spatial coefficient may also be interpreted as elasticity representing growth spillover between countries, where the spatially lagged dependent variable is estimated to be 0.15 and is statistically different from zero. The spatial lag parameter can be interpreted as a 1 percent increase in the GDP per capita growth rate of surrounding countries, and will result in 0.15 percent increase in growth rate of GDP per capita in the home country. In other words, a country whose neighbours are growing is better positioned to enjoy growth spillover and other externalities generated by surrounding countries than those countries which are isolated. In contrast, if a country's neighbouring countries experience a recession or economic downturn, proximity can have the effect of suppressing home country activity.

4.3. Investment model

With the aim of providing an in-depth analysis of the debt growth nexus, this study also analyzed the direct link between debt and investment. The results are shown in Table 5. The negative but insignificant sign obtained from the relationship between external debt and investment rate could also suggest that external debt has not been allocated efficiently to investment. In addition, these findings support the results obtained from the growth model estimation which suggests the negative effect of external debt on economic growth. Meanwhile, other explanatory variables, domestic credit and openness, are found to have a positive and significant impact on investment rate at 10 and 5 percent, respectively.

[12] Four different tests are considered – The Moran's I test, LM error test for spatial correlation in residuals, LR test, and Wald test – to detect the existence of spatial autocorrelation in the residuals from a least-squares model. The analysis is based on the cross-sectional approach. The summary of the diagnostic test is attached in Appendix 3.

Table 5. The impact of external debt in investment model

	1970–2005	1996–2005	
	Overall	Non-HIPC	Overall
Investment rate $_{(t-1)}$	0.222 (0.063)*	0.383 (0.102)*	0.243 (0.186)
Debt service	0.054 (0.035)	–0.066 (0.174)	–0.010 (0.200)
External debt	–0.744 (1.735)	–0.310 (1.552)	–0.205 (2.559)
GDP growth rate	0.225 (0.041)*	0.398 (0.096)	0.332 (0.117)*
Aid	0.040 (0.043)	–0.296 (0.353)	–0.115 (0.154)
Secondary education	0.126 (0.087)	–0.047 (0.187)	–0.278 (0.177)
Domestic credit	0.024 (0.012)**	0.0437 (0.024)**	0.069 (0.060)
Openness	0.113 (0.020)*	0.072 (0.026)*	0.086 (0.033)*
Government revenue	0.004 (0.004)	0.003 (0.005)	–0.010 (0.010)
Constant	65.852 (126.64)	362.14 (1.49)	211.69 (0.89)
Sargan test	0.543	0.99	0.99

Notes: * and ** denotes significant at 5 and 10 percent significance level respectively. Numbers in brackets represent the robust standard error. The value reported for Sargan test is the p-value for the null hypothesis, valid specification. The initial income and external debt are expressed in natural logarithm. Data are for five-year intervals. The number of observations for the non-HIPC countries is 22 out of a total number of 31 countries

The debt service payment is found to have a negative but insignificant impact in explaining the movement in the investment model. The debt repayments coefficient is also found to have a small effect on the investment rate with a very small coefficient of 0.05. Meanwhile the external debt to GDP variable shows a negative but insignificant effect on the investment rate, suggesting no conclusive evidence regarding the relationship between external debt and domestic investment[13].

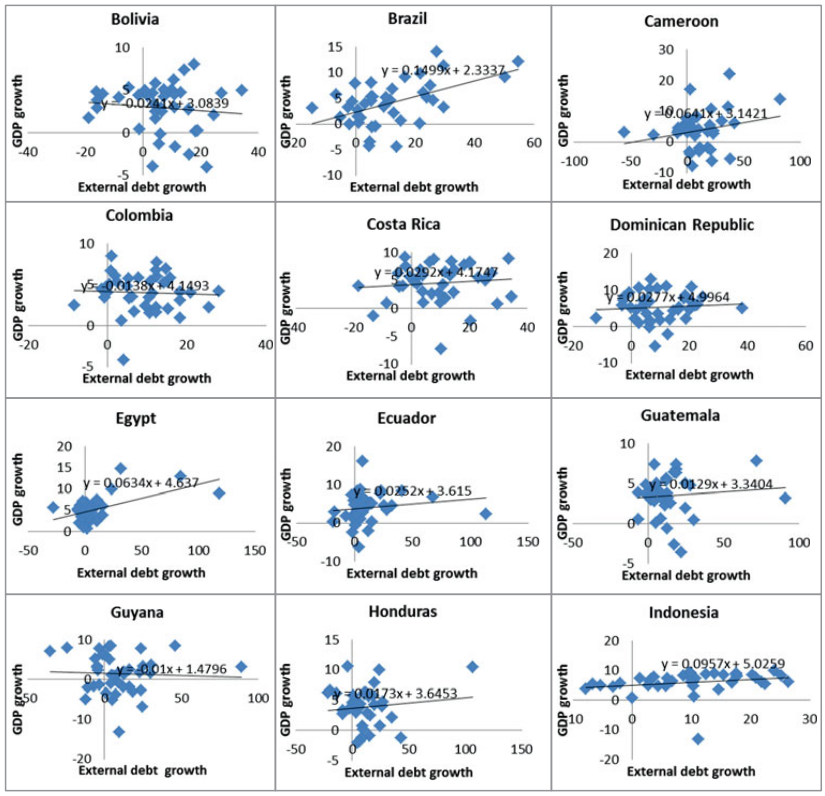
The p-value of 0.543 reported by Sargan test in the investment model could not reject the null hypothesis, suggesting that a valid specification without an over-identifying problem exists in the estimated model. Meanwhile, it is noted that the external debt and

[13] This paper also conducted a preliminary descriptive analysis on the impact of external government debt on investment. The result is shown in Appendix 4.

debt service payment are not significant in contributing to a movement in investment rate for the overall sample and the non-HIPC group, while the openness is found to contribute positively and significantly (at 5 percent significance level) to the investment rate[14].

4.4. Discussion

Figure 1 illustrates curves on external debt growth and GDP growth on the analyzed countries. This would provide a snapshot of which countries have benefited from new external debt as well as countries that hold too much of external debts. Furthermore, it also provides robust evidence on the non-existence of Debt-Laffer curve. A downward-sloping curve is shown for Bolivia, Colombia, Guyana, Lesotho, Mali, Papua New Guinea, Swaziland, Tunisia, Uruguay and Zambia implies that the external debt has impeded the economics growth through the inefficient use of external debt to investment.



[14] This paper also runs a robustness check with the bias-corrected least-squares dummy variable estimators which hold with a small number of cross-sectional units in panel data. By adapting Kiviet and Bun's (2001) bootstrap procedure to estimate the asymptotic variance-covariance matrix, Bruno (2005) has extended Bun and Kiviet (2003) to accommodate the unbalanced panel. The results reveal consistent results with the estimated GMM-system to provide robust evidence of negative effect of external debt on economic growth. Results are attached in Appendix 2.

End of Figure 1

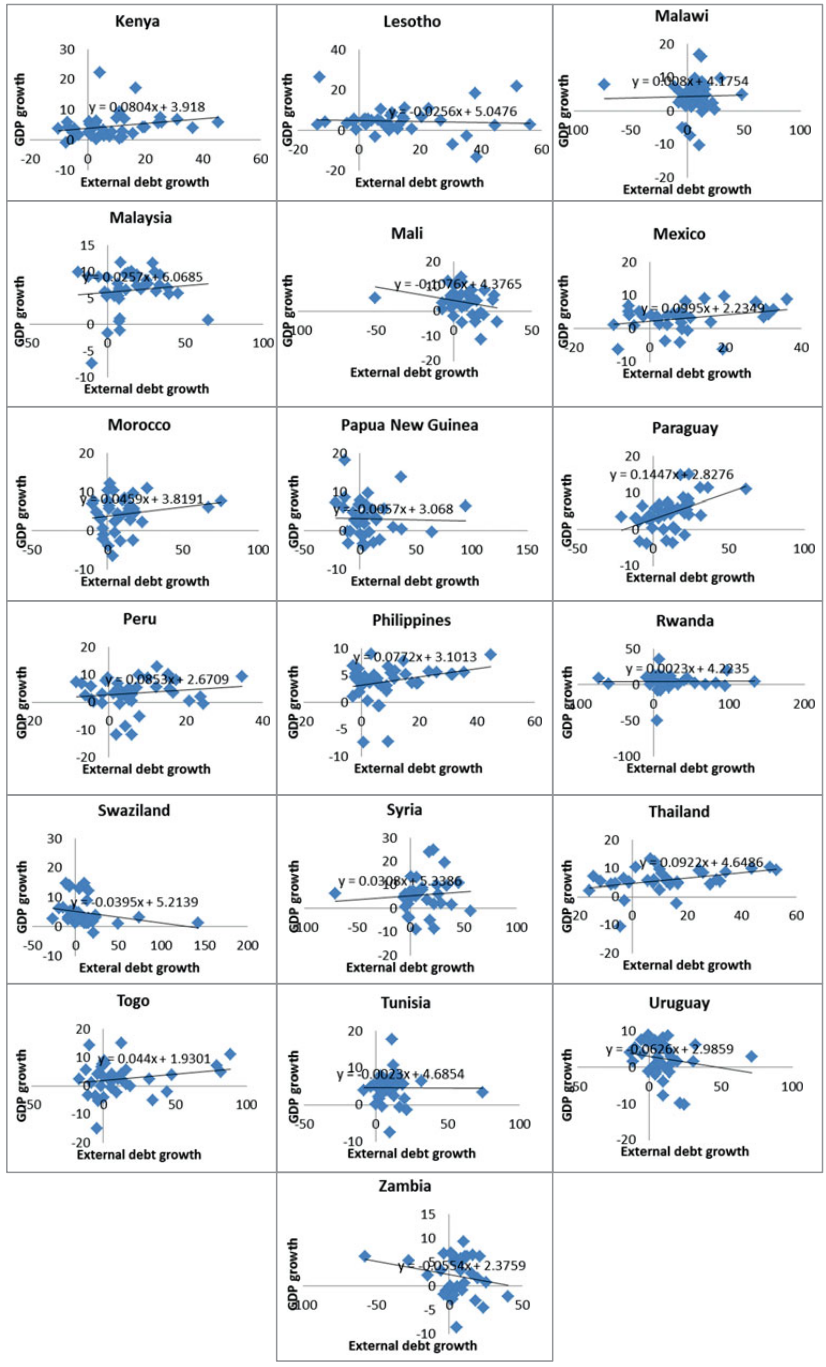


Fig. 1. Country debt-growth nexus curve

In addition, the downward-sloping curve applies only to the second (bad) section of the Debt- Laffer curve which indicates negative relationship between the stock of external indebtedness and expected of repayment (which represent by the GDP growth rate). Thus, implies no evidence of debt-Laffer curve relationship exists, which reflects that the negative relationship of debt with economic growth is robust.

Furthermore, among the countries that have downward-sloping debt curve, Bolivia, Guyana, Swaziland, Uruguay and Zambia have the potential of being in the debt overhang situation. This situation is explained by a positive growth in debt service and negative growth in investment apart by a negative relationship between the stocks of external indebtedness and expected of repayment as shown in Table 6.

Table 6. The impact of external debt to investment

Countries	Average growth rate of total debt service	Average growth rate of investment	Level of indebtedness	Level of income
Bolivia			Moderate indebtedness	Lower middle income
1970–1979	31.91	6.38		
1980–1989	20.32	–3.10		
1990–1999	1.37	10.56		
2000–2009	3.14	2.64		
Colombia			Moderate indebtedness	Lower middle income
1970–1979	10.95	3.61		
1980–1989	15.59	3.20		
1990–1999	7.81	1.44		
2000–2009	6.82	9.68		
Guyana			Severe indebtedness	Lower middle income
1970–1979	38.86	5.61		
1980–1989	1.51	–5.58		
1990–1999	–6.90	6.77		
2000–2009	–9.71	3.51		
Lesotho			Less indebtedness	Low income
1970–1979	32.20	22.81		
1980–1989	22.68	6.39		
1990–1999	9.93	3.21		
2000–2009	5.02	0.75		
Mali			Less indebtedness	Low income
1970–1979	5.52	0.00		

End of Table 6

Countries	Average growth rate of total debt service	Average growth rate of investment	Level of indebtedness	Level of income
1980–1989	–1.10	0.56		
1990–1999	2.89	0.45		
2000–2009	–0.13	0.00		
Papua New Guinea			Moderate indebtedness	Low income
1970–1979	18.34	1.71		
1980–1989	14.76	3.79		
1990–1999	–6.03	–2.95		
2000–2009	18.17	6.89		
Swaziland			Less indebtedness	Low income
1970–1979	14.07	15.47		
1980–1989	8.04	11.62		
1990–1999	1.04	–2.51		
2000–2009	7.51	–3.50		
Tunisia			Moderate indebtedness	Lower middle income
1970–1979	20.68	9.54		
1980–1989	7.70	0.81		
1990–1999	0.83	5.71		
2000–2009	2.40	3.80		
Uruguay			Severe indebtedness	Upper middle income
1970–1979	18.72	11.25		
1980–1989	10.70	–4.03		
1990–1999	4.49	6.72		
2000–2009	17.73	2.59		
Zambia			Severe indebtedness	Low income
1970–1979	30.26	–8.54		
1980–1989	4.70	–7.96		
1990–1999	62.25	17.40		
2000–2009	8.85	0.43		

5. Conclusion

The aim of this paper is to analyze the debt-growth nexus, particularly the debt-growth and the debt-investment relationship with reference to 31 developing countries in the sample. This paper also employed the recent technique of spatial econometrics to incorporate the 'neighbour' effect in the debt-growth model. Five main points may be summarized from the analysis. First, our paper reject the null hypothesis of there is no impact of external debt on growth. In addition, the accumulation of external debt is associated with a slowdown in the economies of the developing countries. Apart from this, we find evidence that the debt service ratio does not crowd out the investment rate in developing countries. Thus, there are convincing results to support the negative effect of external debt on economic growth but there is no evidence that debt service payment squeezes the investment rate. This could imply that the likelihood of a country being able to service its repayment (principal and interest payment) through investment is still high. In other words, the negative effect could be interpreted as a signal of the symptom of the debt-overhang problem. Third, and correspondingly, the insignificant effect of external debt on investment rate could raise the issue of whether the external borrowing has been efficiently allocated to investment. However, this issue should be analyzed in further detail and with due caution since it is important for policy formulation, mainly on the debt management issues. Despite the above findings, fiscal balance, government revenue, openness and domestic credits are found to have a positive effect on investment and, to a lesser extent, economic growth. Fourth, the analysis also shows that the role of spatial correlation is important and should be considered for any analysis in growth models. Although the inclusion of spatial autocorrelation does not significantly change the estimated coefficient for other variables, these findings have highlighted the important omission variable in the debt-growth model, thus increasing the accuracy of the estimated results. In addition there is evidence to support the existence of spillover growth among the neighbourhood countries. Fifth, there is no evidence that the debt-Laffer curve relationship exists in the debt growth model, which reflects that the negative relationship of debt with economic growth is robust.

The results have important implications for policy-makers who aspire to generate economic growth, particularly for most of the developing countries. It is a major challenge for governments to formulate a prudent debt management policy to control and maintain the level of indebtedness of their countries at a manageable level before it becomes too late and the country becomes involved in a debt overhang situation or, to a lesser extent, is in default. As external debt is important as a source of capital, the government could play an important role in utilizing the public debt to improve and provide an environment conducive to investment incentive. In return, a climate of investment growth will benefit a country through aggregate national growth. In other words, a well-built infrastructure for investment could help boost domestic investment as well as attract more foreign direct investment into the country. In addition, policy that could generate earnings, especially in foreign revenue, should be formulated wisely. Policies such as an export-led growth strategy could benefit a country, since countries use their foreign earnings to service the external debt. Besides that, a manageable debt level is important since this could affect a country's sovereign ratings and source of funding.

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APPENDIX 1

Country list

Region/countries	Level of indebtedness	Level of income
A) East Asia and Pacific		
Indonesia	Severe indebtedness	Lower middle income
Malaysia	Moderate indebtedness	Upper middle income
Papua New Guinea	Moderate indebtedness	Low income
Philippines	Moderate indebtedness	Lower middle income
Thailand	Less indebtedness	Lower middle income
B) Latin America and Caribbean		
Bolivia	Moderate indebtedness	Lower middle income
Brazil	Severe indebtedness	Lower middle income
Colombia	Moderate indebtedness	Lower middle income
Costa Rica	Less indebtedness	Upper middle income
Dominican Republic	Less indebtedness	Lower middle income
Ecuador	Severe indebtedness	Lower middle income
Guatemala	Less indebtedness	Lower middle income
Guyana	Severe indebtedness	Lower middle income
Honduras	Moderate indebtedness	Lower middle income
Paraguay	Moderate indebtedness	Lower middle income
Peru	Severe indebtedness	Lower middle income
Mexico	Less indebtedness	Upper middle income
Uruguay	Severe indebtedness	Upper middle income
C) Middle East and North Africa		
Egypt	Less indebtedness	Lower middle income
Morocco	Less indebtedness	Lower middle income
Syria	Severe indebtedness	Lower middle income
Tunisia	Moderate indebtedness	Lower middle income

End of Appendix 1

Region/countries	Level of indebtedness	Level of income
D) Sub Saharan Africa		
Cameroon	Moderate indebtedness	Low income
Kenya	Moderate indebtedness	Low income
Lesotho	Less indebtedness	Low income
Malawi	Severe indebtedness	Low income
Mali	Less indebtedness	Low income
Rwanda	Severe indebtedness	Lower middle income
Swaziland	Less indebtedness	Low income
Togo	Severe indebtedness	Low income
Zambia	Severe indebtedness	Low income

Notes: The income and level of indebtedness is based on World Bank classification.
Source: http://csirwebistad.org/pdf/classi.pdf

APPENDIX 2

Impact of external debt on growth (1996–2005)

	Bias-Corrected LSDV			Bias-Corrected LSDV	
Growth model	Non-HIPC	Overall	Investment model	Non-HIPC	Overall
Initial income$_{(t-1)}$	–28.228	–24.41	Investment rate $_{(t-1)}$	0.733	0.713
	(4.892)*	(4.632)*		(0.041)*	(0.048)*
External debt	–4.206	–5.840	Debt service	0.039	0.016
	(1.767)*	(1.786)*		(0.105)	(0.094)
Debt Service	–0.265	–0.088	External debt	–1.937	–1.958
	(0.142)**	(0.098)		(1.107)**	(1.224)
Secondary education	0.418	0.423	GDP growth rate	0.417	0.305
	(0.263)	(0.224)*		(0.057)*	(0.048)*
Gross investment	0.177	0.117	Aid	–0.182	0.095
	(0.089)**	(0.139)		(0.357)	(0.066)
Fiscal balance	0.070	0.422	Secondary education	–0.187	–0.049
	(0.080)	(0.223)**		(0.180)	(0.182)
Openness	0.029	0.020	Domestic credit	0.015	–0.000
	(0.030)	(0.270)		(0.021)	(0.000)
Term of trade	–0.000	–0.000	Openness	0.005	0.006
	(0.000)	(0.000)		(0.025)	(0.022)
Population growth	–3.674	–0.594	Government revenue	0.002	0.001
	(1.326)*	(0.303)**		(0.004)	(0.004)
Observations	22	31	Observations	22	18

Notes: * and ** denotes significant at 5 and 10 percent significance level respectively. Numbers in parenthesis represent the t-statistics. The initial income, investment rate and external debt are expressed in natural logarithm. The standard errors are computed based on the bootstrap variance-covariance matrix

APPENDIX 3

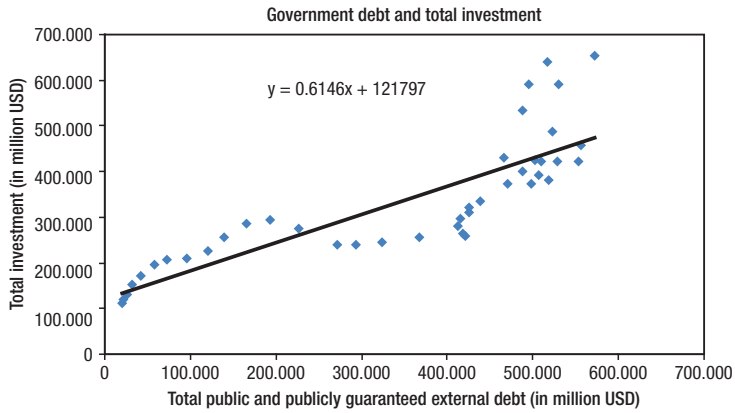
Diagnostic test on spatial correlation on the debt-growth model

	Rejection of the null of no spatial correlation
Moran's I test	1995, 2001, 2004
LR test	1974, 1976, 1977, 1979, 1985, 1986, 1991, 1993, 1998, 1999, 2001, 2004
Wald test	1970, 1973, 1974, 1976, 1977, 1979, 1980, 1982, 1985, 1986, 1988, 1991,1993, 1995, 1996, 1998, 1999, 2001, 2004, 2005
LM error test (SAR)	1970, 1971, 1974, 1975, 1976, 1977, 1979, 1980, 1985, 1986, 1988, 1991,1992, 1993, 1994, 1997, 1998, 1999, 2000, 2004, 2005
LM error test (SEM)	1976

Source: Daud and Podivinsky (2011)

APPENDIX 4

The government external debt and investment



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