Does Foreign Aid Play a Role in the Maintenance of Economic Growth?

A Non-Linear Analysis.

Nermeen Harb [a,b1], Stephen G. Hall[a]

[a] Department of Economics, University of Leicester, UK

[b] Department of Economics, Zagazig University, Egypt

Abstract

Should donors keep scaling up foreign aid or should they be more cautious because of the recipient country's limited absorptive capacity? This paper investigates the non-linearity hypothesis between foreign aid and economic growth for 25 developing countries during the period from 1984 to 2008. By using state space system equations, we provide a new insight to estimating the Panel Smooth Transition Regression Model (PSTR). This method identifies the estimated coefficients at each point of time and determines endogenously an appropriate threshold level. For upper middle countries, we recognise the positive impact of aid flows on economic growth but with diminishing returns while lower middle and least developed countries support the big push concept.

Keywords: foreign aid; economic growth; non-linear; PSTR model.

JEL Codes: C24, C32.

[1] Correspondence to: Nermeen Harb, Department of Economics, University of Leicester, Brookfield, Teaching Centre, Leicester, London road, LE2 1RQ and Zagazig University, Egypt.
Email: nh246@le.ac.uk

1. Introduction

According to the OECD, official development assistance is considered to be a type of government aid which is designed mainly to enhance the welfare and economic development of developing countries. In 2010, official development assistance reached its peak of 134.77 USD billion; this was the highest amount of foreign aid since the 1970s. However, the Development Assistance Committee (DAC) reports the declining amount of foreign aid directed to poor countries. Nowadays, high aid inflows are investigated carefully since foreign aid is considered to be a crucial source of economic growth (OECD, 2015)[2]. Furthermore, it accounts for more than two thirds of external finance directed to the Least Developed Countries (hereinafter referred to as LDCs).

Many concerns are raised around the effectiveness of high aid inflows. Some researchers find that aid flows always promote economic growth. For instance, Hansen and Tarp (2001), Moreira (2005) and Gyimah-Brompeng et al., (2012) investigate the relationship between foreign aid and the growth in real GDP per capita. They argue that foreign aid enhances economic growth while its impact varies between countries due to different conditions. Additionally, they emphasize that the effectiveness of foreign aid is not conditional on a good policy environment. Their empirical analyses confirm that, through investment, foreign aid enhances the rates of economic growth. On the other hand, a World Bank research study asserts that aid is only effective in a good policy environment (Burnside and Dollar, 1997, 2000). However, other studies (e.g., Hansen and Tarp, (2000, 2001); Lensink and White, 2001; Easterly, 2003; Karras, 2006) claim that their results are fragile and restricted only to the sample and the chosen time period.

A third group of researchers (e.g. Svensson, 2000; Economides et al., 2008; Djankov et al., 2008; and Feeny and De Silva 2012) argue that aid has a detrimental impact on economic growth. They relate foreign aid's poor macroeconomic impact on economic growth to the prevalence of corruption and various types of rent seeking activities. Hence it motivates self-interested people towards extracting resources for their personal gains and stops productive work. In the same vein, Remmer (2004) and Moyo (2009) provide evidence that countries, which are highly dependent on foreign aid, are more likely to expand their government size.

[2] http://www.oecd.org/newsroom/development-aid-stable-in-2014-but-flows-to-poorest-countries-still-falling.htm

Further rent-seeking impact arises if the size of the aid recipient country's public sector is large and is accompanied by a considerable amount of aid. Other evidence (e.g. Alesina and Dollar, 2000; Alesina and Weder, 2002)[3] supports the idea that high aid inflows raise the corruption levels.

Another line of research confirms the positive impact of foreign aid on economic growth but with diminishing returns. This is because foreign aid improves economic growth up to a certain point but, once it passes the threshold level, its impact starts to decline (e.g. Mosley, P et al., 1987; Hadjimichael et al., 1995; Durbarry et al., 1998; Hansen and Tarp, 2000, 2001; Lensink and White, 2001; Clemens et al., 2012; and Wagner, 2014). They highlight the presence of a robust non-linear relationship through employing an aid-squared term which, when they are both included, eliminates the aid-policy interaction term.

In this context, two viewpoints are raised: namely, the big push concept and absorptive capacity constraints. The big push adopts the idea of scaling up foreign aid in order to reduce poverty rate by half. However, there exists a suspicion as to whether or not the full amount of aid will be absorbed effectively. Many scholars argue that most developing countries have many obstacles for growth such as, human and physical constraints, macroeconomic constraints and institutional constraints (Feeny and De Silva, 2012). Although we can conclude that, in some circumstances, it is important to scale up foreign aid to enhance economic growth rates, donors should be sensible with regard to the amount of aid directed to LDCs since they should consider their limited absorptive capacity. Therefore, recent studies have started to take into account the non-linearity hypothesis between foreign aid and economic growth. However, these studies employ a quadratic or interaction term to capture the diminishing returns to aid. On the contrary, we argue that this approach imposes only a specific form of non-linearity (inverted U-shape) and may not capture the possibility of multiple threshold levels.

This study contributes to the literature in several ways. Firstly, we introduce a new insight on estimating the PSTR model. We have defined this model in the form of state space system in order to identify the behaviour of the state variables at each point of time during the employed period of time. This is new to the economic literature. Additionally, it allows us to

[3] They claim that foreign aid programmes are misdirected, as they could not provide any evidence that low corrupt governments receive higher amount of aid. They demonstrate that foreign aid directed to developing countries is highly determined by a political and strategic consideration.

identify endogenously a precise and significant threshold variable[4]. Secondly, we improve our model in such a way that we allow our explanatory variables to vary according to the estimated threshold level of foreign aid. Thirdly, we examine the multiple threshold levels of foreign aid for all three groups of countries. Fourthly, we estimate the threshold level of foreign aid for 25 developing countries during the period from 1984 to 2008. Furthermore, we estimate the threshold level of foreign aid for three groups of countries according to their income level (upper middle, lower middle and LDCs). This is because we believe that pooling all countries together may have its own caveats since the countries have various characteristics and are at different stages of development. Fifthly, some previous studies assert that foreign aid works effectively only in a good policy environment and these do not consider corruption as one of its determinants. Therefore, we employ the interaction term between the level of corruption and foreign aid as one of our explanatory variables in order to capture whether or not the levels of corruption matter in providing recipient countries with effective foreign aid.

Thus, this paper aims to answer the following questions: 1) Should foreign aid be open-ended? 2) Does foreign aid follow big push or absorptive capacity concept? 3) Is the threshold level of foreign aid similar across all developing countries? 4) How do aid recipient countries' levels of corruption affect the aid allocation process?

The remainder of the paper is organised as follows. In the following second section, we discuss the specifications of both the panel smooth transition regression approach and the state space model. In particular, we display how we specify the PSTR model in state space system equations and we raise the endogeneity issue. The third section is given over to analysing the results of various estimated threshold models of foreign aid and discussing their influence. The last section presents the conclusion.

[4] Previous studies employ quadratic term to determine the non-linearity between foreign aid and economic growth. However, the quadratic term imposes a priori constraint where the impact of foreign on economic growth increase and decrease monotonically with respect to foreign aid.

2. Methodology

Although various threshold models have been employed previously, the threshold level has been determined exogenously. These approaches suffer from an arbitrary selection of the threshold levels and the number of regimes. In this study, we introduce an econometric technique which varies from the existing ones. Accordingly, we will define a model (PSTR) model in the form of state space system equations. Contrary to other threshold methods, our model determines the threshold level of foreign aid endogenously and examines its impact on economic growth both above and below the threshold level. Additionally, our model sets the speed of transition between regimes. We have developed our model in such a way that it allows the parameters of our explanatory variables to react to the changes in the foreign aid threshold level. Consequently, we assign two coefficients for each explanatory variable (i.e. time varying effects of the explanatory variables) in order to capture their impact both above and below the threshold level. Lastly, this model gives us the opportunity to examine the presence of multiple threshold levels of foreign aid.

2.1 Panel smooth transition regression approach

The PSTR model is a fixed effect model with exogenous regressors. It can be defined as a nonlinear homogenous panel model. Furthermore, we can generalize it as a linear heterogenous panel model with different coefficients across individuals and across time. Heterogeneity is allowed by supposing that coefficients are a continuous function of an observable variable through a bounded function of this variable. This is called the transition function which oscillates between a limited number of regimes (Gonzalez et al., 2005).

The simple PSTR model with two extreme regimes is defined as:

$$y_{it} = \mu_i + \beta_0' x_{it} + \beta_1' x_{it}\, g(q_{it}; \gamma, c) + u_{it} \qquad (1)$$

For $i = 1,\ldots,N$, and $t = 1,\ldots,T$, where N and T indicate the cross section and time dimensions of panel data respectively. The dependent variable, y_{it}, is a scalar representation of annual growth rate of GDP per capita for 25 developing countries. μ_i is a fixed individual effect; x_{it} is a dimensional vector of time varying exogenous variables; and, lastly, u_{it} represents the error term.

The transition function, g (q_{it}; γ, c), is defined as a continuous function of an observable variable, q_{it}[5] , which is bounded between 0 and 1. These two values are correlated with the regression coefficients β_0 and $\beta_0 + \beta_1$; however, γ, locates the smoothness of transitions between regimes and c indicates the threshold parameter. q_{it} is the threshold variable which is net official development assistance as a percentage of GDP. According to Gonzalez et al., (2005), Granger and Teräsvirta (1993), the general form of logistic transition function is defined as follows:

$$G(q_{it}; \gamma, c) = \left(1 + exp\left(-\gamma \prod_{j=1}^{m} (q_{it} - c_j)\right)\right)^{-1} \quad \text{with } \gamma > 0 \text{ and } c_1 \leq c_2 \leq \ldots \leq m \qquad (2)$$

$c = (c_1, \ldots\ldots, c_m)'$ is an m-dimensional vector of location parameters, while γ > 0 and $c_1 \leq c_2 \leq \ldots \leq$ m represent the imposed restriction. In the case of *m*=1, the model displays that two extreme regimes are correlated with low and high values of q_{it}. If $\gamma \rightarrow \infty$, the logistic transition function, becomes an indicator function I[A], this take value 1 when A occurs or 0 otherwise.

For *m* =2, the transition function f (q_{it}; γ, *c*) has a value of 1 at both low and high values of q_{it} and attains its minimum value at $\frac{(c_1+c_2)}{2}$. In this state, if $\gamma \rightarrow \infty$, the model is a three-regime threshold model. Lastly, for any value of m if $\gamma \rightarrow 0$, the transition functions reduce to the linear panel regression model with fixed effects. According to Gonzalez et al., (2005) building a PSTR model is based on three main stages: namely, specification; estimation, and evaluation stage[6].

2.2 State space model

State space models are useful in explaining the dynamic system; this involves the unobserved state variable. State space models are based on two sets of equations: namely, measurement equations (signal or observation equation) and transition equations (state equation).

a) Measurement equation: it characterizes the relationship between observed variables (data) and unobserved state variables.

[5] Threshold variable is individual specific and time varying.

[6] For more details, see, GONZÁLEZ, A., TERÄSVIRTA, T. and DIJK, D.V., 2005. Panel smooth transition regression models, Working Paper Series in Economics and Finance No. 604.

b) Transition equation is an equation which exhibits the dynamics of unobserved state variable (Kim and Nelson, 1999). The state variable and the unknown parameter have to be estimated from the data by using maximum likelihood which can be obtained using the Kalman filter.

A general state space model can be defined as follows:

Measurement equation: $Y_t = F_t D_t + i_t + \varepsilon_t$ E $(\varepsilon_t) = 0$, Var $(\varepsilon_t) = V_t$ (3)

Transition equation: $D_t = K_t D_{t-1} + p_t + e_t$ E $(e_t) = 0$, Var $(e_t) = Z_t$ (4)

Where Y_t is a vector of variables observed at time t with dimensions $(n \times 1)$, D_t displays state vector of unobserved variables with dimensions $(m \times 1)$, F_t is a matrix which links the observed vector Y_t and the unobserved D_t with dimensions $(n \times m)$, i_T is an $(n \times 1)$ while, ε_t is a vector of serially uncorrelated disturbances $\varepsilon_t \sim N(0, V_t)$. According to the transition equation, K_t is an $(m \times m)$ matrix, p_t is an $(m \times 1)$ vector and e_t represents serially uncorrelated disturbances $e_t \sim N(0, Z_t)$.

Other assumptions should be made in order to complete the state space model specification. 1) D_0 has mean d_0 and covariance matrix P_0. 2) The disturbance ε_t and e_t are not correlated with each other neither at any period of time nor with the initial state. Therefore,

$$\forall(s,t) \qquad E(\varepsilon_t . e_s') = 0 \qquad (5)$$

$$\forall t \qquad E(\varepsilon_t . D_0') = 0 \qquad (6)$$

According to Mergner (2009), a state space model offers a high degree of flexibility because it permits time varying coefficients and missing observations. Along the same lines, Basdevant (2003) emphasize the state space model's ability to offer a simple representation of complex problems. It evaluates the relative features of various approaches and, therefore, it can be considered to be an encompassing approach.

2.3 Define PSTR model in state space form

By using a state space model, we contribute to the literature by estimating the threshold level of foreign aid for a panel group of developing countries. A simple representation of the PSTR model in the form of state space system is as follows:

Measurement equation:

$y_{it}= \beta_{0t}+\beta_{1t}aid_{it}+\beta_{2t}inf_{it}+\beta_{3t}inv_{it}+\beta_{4t}gfce_{it}+\beta_{5t}aid*corr_{it}+\beta_{6t}corr_{it}+\beta_{7t}M2_{it}+\varepsilon_{it}$ (7)

Transition equation:

$\beta_{0t} = \pi_0$ (8)

$\beta_{1t} = \pi_1 G(q_{it}, \gamma, C) + \pi_2[1- G(q_{it}, \gamma, C)]$ (9)

$G(q_{it}, \gamma, C) = \frac{1}{(1+\exp(-\gamma(q_{it}-c)))}$ where $\gamma > 0$ (10)

$\beta_{2t}= \pi_3, \quad \beta_{3t}= \pi_4, \quad \beta_{4t}= \pi_5, \quad \beta_{5t}= \pi_6, \ \beta_{6t}= \pi_7 , \ \beta_{7t}= \pi_8$ (11)

Where y_{it} represents the annual growth rate of GDP per capita and β_{0t} displays the fixed country effect. While both π_1, π_2 show the impact of foreign aid on economic growth above and below the threshold level respectively. On the other hand, G (q_{it}, γ, C) represents the transitional function since q_{it} displays the threshold variable of foreign aid and γ determines the smoothness of transition between regimes. However, C expresses the threshold value. Whereas the transition function takes the value of zero if $q_{it} < c$ and one if $q_{it} \geq c$. Furthermore, $\beta_{2t}, \beta_{3t}, \beta_{4t}, \beta_{5t}, \ \beta_{6t}$ and β_{7t} display respectively the impacts of inflation, investment, government expenditure, the interaction term between aid and corruption, corruption and M2 on economic growth.

The state space model is flexible since it allows us to estimate a threshold level of foreign aid with time varying exogenous variables. Thereby, we can recognize their impacts on economic growth with respect to the estimated threshold level of foreign aid. Therefore, the state space model can be defined as follows:

Measurement equation:

$y_{it} = \beta_{0t} + \beta_{1t}aid_{it}+\beta_{2t}inf_{it}+\beta_{3t}inv_{it}+\beta_{4t}gfce_{it}+\beta_{5t}M2_{it}+ \varepsilon_{it}$ (12)

Transition equation:

$\beta_{0t} = \pi_0$ (13)

$\beta_{1t} = \pi_1 G(q_{it}, \gamma, C) + \pi_2[1- G(q_{it}, \gamma, C)]$ (14)

$\beta_{2t}= \pi_3 G(q_{it}, \gamma, C) + \pi_4[1- G(q_{it}, \gamma, C)]$ (15)

$\beta_{3t}= \pi_5 G\ (q_{it}, \gamma, C) + \pi_6[1- G\ (q_{it}, \gamma, C)]$ (16)

$\beta_{4t}= \pi_7 G\ (q_{it}, \gamma, C) + \pi_8[1- G\ (q_{it}, \gamma, C)]$ (17)

$\beta_{5t}= \pi_9 G\ (q_{it}, \gamma, C) + \pi_{10}[1- G\ (q_{it}, \gamma, C)]$ (18)

$G\ (q_{it}, \gamma, C) = \frac{1}{(1+\exp(-\gamma(q_{it}-c)))} \quad \gamma > 0$ (19)

In this case, π_3, π_5, π_7, π_9 display respectively the impacts of inflation, investment, government expenditure and M2 on economic growth above the threshold level of foreign aid. On the one hand, π_4, π_6, π_8 and π_{10}represent respectively how inflation, investment, government expenditure and M2 affect the rate of economic growth below the threshold level of foreign aid. On the other hand, the transition function is similar across all state equations.

Lastly, in order to examine the existence of multiple threshold levels of foreign aid and since we have only one threshold variable, we expect to have three regime threshold models. Therefore, a multiple (3-regime) threshold model is defined as follows:

Measurement Equation:

$y_{it} = \beta_{0t} + \beta_{1t} aid_{it} + \beta_{2t} inf_{it} + \beta_{3t} inv_{it} + \beta_{4t} gfce_{it} + \beta_{5t} M2_{it} + \varepsilon_{it}$ (20)

State Equation:

$\beta_{0t} = \pi_0$ (21)

$\beta_{1t} = [\pi_2[1- G_1\ (q_{it}, \gamma_1, C_1)] + \pi_1 G_1\ (q_{it}, \gamma_1, C_1)]\ (1-G_2(q_{it}, \gamma_2, C_2)\ ) + \pi_3 G_1(q_{it}, \gamma_1, C_1)\ G_2(q_{it}, \gamma_2, C_2)$ (22)[7]

$G\ (q_{it}, \gamma_1, C_1) = \frac{1}{(1+\exp(-\gamma_1(q_{it}-c_1)))} \quad \gamma > 0$ (22.a)

$G\ (q_{it}, \gamma_2, C_2) = \frac{1}{(1+\exp(-\gamma_2(q_{it}-c_2)))} \quad \gamma > 0$ (22.b)

[7] However, a four regime threshold models is anticipated if we have two different threshold variables (q_{1it}, q_{2it}). So, in case of four regime model (i.e. two different threshold variables), state equation (14) will be represented as follows:
β_{1t} =[$\pi_2(1- G_1\ (q_{1it},\ \gamma_1,\ C_1)) + \pi_1 G_1\ (q_{1it},\ \gamma_1,\ C_1)]\ (1-G_2(q_{2it}, \gamma_2, C_2)\ )$ +[$\pi_3(1 - G_1\ (q_{1it}, \gamma_1, C_1)) + \pi_4 G_1\ (q_{1it}, \gamma_1, C_1)]G_2(q_{2it}, \gamma_2, C_2)$. Thus, we can realise a 4-regime model change smoothly from π_2 to π_1 to π_3 to π_4.

$\beta_{2t}= \pi_4$, $\beta_{3t}= \pi_5$, $\beta_{4t}= \pi_6$, $\beta_{5t}= \pi_7$ (23)

Where both G_1 (q_{it}, γ_1, C_1) and G_2 (q_{it}, γ_2,C_2) represent the first and second transitional functions. Accordingly, C_1 and C_2 are defined as the first and the second threshold values of foreign aid whereas $c_1 \leq c_2 \leq \ldots \leq$ m and $\gamma > 0$ display the imposed restrictions. The coefficients change smoothly from π_2 to π_1 to π_3, where π_2 displays the impact of foreign aid on economic growth, when $q_{it} < C_1$, π_1 shows the effect wherever $C_2 > q_{it} \geq C_1$ and π_3 occur when $q_{it} \geq C_2$.

2.4 Endogeneity Problem

Recent empirical literature argues the presence of a spurious correlation between foreign aid and the economic growth nexus. Since foreign aid is not allocated arbitrarily to countries, it is likely to be specified to countries which used either its past inflows efficiently or suffered from natural disasters (Kalyvitis et al., 2012). The common solution to the endogeneity problem is to employ instruments and to apply 2sls estimation just as in linear regression. For instance, Aurangzeb and Stengos (2010) and Kalyvitis et al., (2012) propose the use of an instrumental variable as a measure for aid. They suggest that the choice of an instrumental variable relates directly to the level of donors instead of the recipient countries (e.g. size of the donor and the recipient countries and the interaction between country size and the colonial link).

In contrast, Kourtellos et al., (2007) believe that instrumental variables are ineffective along the aid-growth nexus. This is because it is difficult to find an instrumental variable which is not associated with any other omitted variable. Along the same lines, Fenny and McGillivray (2010) suggest that it is inessential to instrument foreign aid. They state that, even if foreign aid has been allocated according to the current level of growth, aid cannot be endogenous because there is no immediate recognition of the impact of aid on economic growth.

One weakness, which applies to all threshold models, is dealing with the endogeneity problem. Hansen (1999) is the pioneer who introduces the PTR model which determines the threshold level endogenously; however, the threshold variable is assumed to be exogenous. Caner and Hansen (2004) develop a model with endogenous variables but with an exogenous threshold variable. They employ a 2sls estimator for the threshold parameter and a GMM estimator of the slope parameter. Afterwards, Gonzalez et al., (2005) introduce a panel smooth transition regression approach, which is a generalization of Hansen's PTR model; they introduce only the smooth transition between regimes. Kourtellos et al. (2007) argue that there is no current

solution to estimating a threshold model where both slope and threshold variable are endogenous. However, Fouquau et al., (2008) and Lee and Chiu (2011, 2013) employ the PSTR model with IV estimation. They assume that the estimators are convergent; on the other hand, there is no formal proof of this.

However, Yu (2013) provide evidence that 2sls is inconsistent in dealing with the endogeneity problem in threshold regression. On the other hand, due to the non-stationary discontinuity structure of the threshold regression, Yu and Phillips (2014) argue that the threshold effect can be examined even in the presence of endogeneity and the absence of instrumentation. However, if the instrumental variable is available, it improves only the efficiency and raises the convergence rate of the threshold parameter and related coefficients.

According to the foregoing discussion, we can conclude that it is difficult to control endogeneity in the aid-economic growth relationship. Although some recent studies (e.g. Kourtellos et al., 2007) use sample splitting models or threshold models, they are incapable of tackling endogeneity. Lastly, Yu and Phillips (2014) introduce the Integrated Difference Kernel Estimator (IDKE), which may be useful for future research in producing a consistent estimator even if the threshold variable is endogenous.

3. Data

The empirical analysis is based on panel data for 25 developing countries; this covers the period from 1984 to 2008[8]. We selected the countries[9] according to the availability of a balanced panel data set[10]. Other than as specified, we obtained data from the World development indicators (World Bank. The dependant variable is defined as annual growth rate of GDP per capita (y_{it}). Following Kalyvitis et al., 2012 and Aurangzeb and Stengos (2010) we employ a set of various explanatory variables which reflect economic policies[11]. For instance, we employ

[8] Most of previous studies average their dataset over 4 or 5 years so as to avoid the variations in annual growth rates. I am in favour to employ annual observations; thus, it enables us to capture the maximum variations in the employed dataset. Furthermore, if foreign aid depends on current level of growth, foreign aid cannot be endogenous because we cannot promptly observe its impact on economic growth.

[9] List of Countries employed according to the world bank classification:
Upper middle countries: Algeria, Botswana, China, Colombia, Costa Rica, Gabon and Tunisia.
Lower Middle Countries: Cameroon, Cote d'lvoire, Egypt, Ghana, India, Indonesia, Morocco, Nigeria, Pakistan and Sudan.
Low and Least countries: Bangladesh, Ethiopia, Malawi, Mali, Niger, Sierra Leona, Togo and Uganda.

[10] Due to the limited availability of a balanced panel dataset, the data is restricted only till 2008. The countries are selected according to the availability of a balanced panel data set.

[11] Aid and long-run growth relationship is complicated; they both affect growth and highly intertwined and the ways aid affect growth depend on deep determinants of productivity (See Dalgaard et. al., 2004, p.197).

the general government final consumption expenditure (percentage of GDP), inflation measured by annual growth rate of consumer price index and M2 percentage of GDP employed as a measure of financial development. Furthermore, we include gross fixed capital formation (percentage of GDP) as a measure for investment. Our main threshold variable is foreign aid measured by Net Official Development Assistance[12] (net ODA percentage of GDP).

Lastly, some of the economic literature argues that aid can work only in a good policy environment. For example, Burnside and Dollar (2000) create a policy index comprising inflation, budget surplus and trade openness; Kalyvitis et al., (2012) and Gyimah-Brempong at al., (2012) employs institutional quality; and Lensink and White (2001) include index of civil liberties and political rights. However, corruption is not included as one of the policy variables. It is considered to be a potential hazard to foreign investment from different aspects. Therefore, we employ both the corruption index and its interaction term with foreign aid as one of the explanatory variables[13]. We obtain data about corruption from the International Country Risk Guide (ICRG) data[14]. However, the data is limited only to the period from 1984 to 2008 and, thereby, our data set is restricted to this period of time. According to the ICRG data, corruption index scales range from 0 to 6. A score of 6 displays a very low level of corruption while a score of 0 indicates a high level of corruption. For robustness checks, another variable of institutional quality is considered (i.e. level of democracy)[15] ; we obtained it from the Quality of Government basic dataset, version Jan 2016, University of Gothenburg. Its scale starts from 0 to 10; 0 points out the least democracy while 10 represents a high level of democracy.

4. Empirical Results

4.1 Estimate threshold level for all developing countries

In this section, by using a new estimation technique, we investigate whether aid flows follow either absorptive capacity or the big push concept for developing countries. Additionally, we employ the interaction term between aid and corruption in order to determine whether the

[12] The significance of foreign aid is expected to be quite low as the employed variable (net official development assistance) is a mixed bag of various types of foreign aid and not all types of foreign aid have direct impact on economic growth, (Wagner 2014).

[13] Some of the previous studies (e.g. De la Croix and Delavallade, 2013), employ control of corruption index created by the World Bank to determine the relationship between foreign aid and corruption.

[14] The ICRG index, Freedom House and the Quality of Government Institute index is more convenient to use in this case; this is because the data is available annually for the whole period under study. However, other institutional quality indexes are available only every two successive years between 1996 and 2000, for instance, the World Bank Governance Index.

[15] Consistent with previous studies (e.g. Svensson, 1999) we employ level of democracy as another source of institutional quality.

effectiveness of foreign aid is conditional upon the recipient country's level of corruption. Table (1) illustrates respectively the main statistics of net ODA as a percentage of GDP for all developing countries, upper middle, lower middle and LDCs countries. It is plain that, compared to other groups of countries, LDCs receive a significant amount of foreign aid.

Table (1): Summary statistics for net ODA as % of GDP

	All developing countries	Upper middle	Lower middle	Low and least
Mean	6.155802	1.232633	3.407554	13.89889
Median	2.770677	0.555437	2.003853	13.69470
Maximum	39.78162	8.577450	19.16267	39.78162
Minimum	-0.174570	-0.174570	0.051344	1.700356
Std. Dev.	7.238783	1.614403	3.436669	7.496185
Observations	625	175	250	200

According to the methodological framework, the growth rate of GDP per capita is considered to be a function of ODA percentage of GDP, inflation, investment, government expenditure, interaction term and M2 percentage of GDP. We define the PSTR model in the form of state space equations in order to examine the presence of a nonlinear relationship between foreign aid and economic growth. Firstly, we examine the non-linearity hypothesis between foreign aid and economic growth for all developing countries included in our sample. Table (2) reveals that the threshold level of foreign aid is 12.24% of GDP and is significant at the 10% significance level; furthermore, the smoothness of transition between regimes is high. Consistent with Gomanee et al., 2003; Aurangzeb and Stengos, 2010; Kalyvitis et al., 2012 and Gyimah-Brempong et al., 2012, our results confirm that foreign aid exhibits a significant positive impact on economic growth above the threshold level (π_1) while the impact is negative and insignificant below this level (π_2). All our control variables have the expected sign, while only investment and government expenditure have a significant impact on economic growth at the 5% significance level.

Table (2): Estimate threshold of foreign aid for all developing countries

Variable	π_2	π_1	Transition Variables	
			C	Exp (γ)
Aid	-0.020324 0.8632)	0.838861 (0.0322)**	12.2439* (0.071)	10.8157
Inflation	-0.027097 (0.4144)			
Investment	0.200503 (0.0495)**			
Government expenditure	-0.325594 (0.0422)**			
M2	-0.049650 (0.4683)			

Notes: Dependent Variable is real GDP per capita growth. Values in parentheses represent p-value. *, **, *** display the significance levels at 10%, 5% and 1% respectively. Meanwhile, π_1 and π_2 represent the impact of foreign aid above and below the estimated threshold level. The significance of the threshold calculated by the likelihood ratio test of Hansen (1999) approach.

The literature provides ambiguous evidence regarding the non-linear relationship between aid flows and economic growth. Furthermore, there are mixed results about the threshold level of foreign aid. This may relate to the heterogeneity of aid; various characteristics for each developing country; and different income and financial development levels. Consistently, our estimated threshold level for all developing countries (12.24% of GDP) is considered to be high when compared with the average levels of foreign aid received by both upper middle and lower middle countries. Additionally, some of the previous studies (e.g. Hansen and Tarp, 2000, 2001; Guillaumont, P. and Guillaumont, J.; 2007b) suggest that the effectiveness of foreign aid threshold levels vary among aid recipient countries. Thus, in order to examine a more homogenous set of aid inflows, we classify our sample into 3 groups of (upper middle, lower middle and low and least) developed countries according to the World Bank classification.

4.2 Estimate threshold level for various income level countries

In this context, we estimate the threshold level of foreign aid for three different groups of countries according to their income levels. Our explanatory variables involve both the corruption index and the interaction term between foreign aid and corruption. According to the reported results in Table (3), we realise the insignificant impact of the interaction term for all three groups of countries. In turn, this means that corruption does not play a significant role in allocating foreign aid to developing countries. Furthermore, there is no clear nonlinear impact on lower middle countries since foreign aid displays an insignificant impact during both

regimes. On the other hand, for LDCs, it is obvious that aid flows follow the big push concept. This is because we can realise the presence of a threshold level of foreign aid (11.38% of GDP) above which it exhibits a significant positive impact on economic growth level (π_1). On the other hand, below the threshold level, its behaviour changes to have an insignificant negative impact. Due to the insignificant impact of both the corruption index and the interaction term (aid*corr), we omit both variables from our analysis. These may be responsible for the vague impact of foreign aid on economic growth. Our results are in line with some previous studies (e.g. Easterly et al., 2003; Rajan and Subramanian, 2008; Wagner, 2014) which provide little evidence about the effectiveness of institutional quality between foreign aid and the economic growth nexus.

Therefore, Table (4) represents the estimated results for all three groups of countries excluding the interaction term[16]. For the upper middle countries, we find a threshold level of foreign aid (1.22% of GDP); this is consistent with our data while the smoothness of transition between regimes is considerably high. Additionally, our results confirm that foreign aid is only effective below the threshold level (π_2). However, above this level (π_1), it changes to have an insignificant impact. This means simply that, after a certain threshold level, foreign aid loses its significant impact (displaying a diminishing marginal return) and, thus, a high level of foreign aid cannot be employed effectively. Although foreign aid displays different behaviours during both regimes, our estimated threshold level is unsuitable because it is insignificant at all levels. Additionally, all our economic policy variables, namely, inflation, investment and government expenditures have the expected sign and are, also, significant with the exception of M2 which has an insignificant negative impact on economic growth.

On the other hand, both lower middle[17] and LDCs countries' results support the big push concept. We find that threshold levels for both groups of countries are 4.33% and 11.385% of GDP respectively and are significant at the 1% significance level. Also, we realise that foreign aid enhances rates of economic growth beyond the threshold level (π_1) while, below this level, it changes to have a negative insignificant impact. Furthermore, both investment and government expenditures have the expected signs and display significant impact at various

[16] Adding human capital to the model, does not change the benchmark results regarding the effect of foreign aid. In other words, no significant difference has been realized in determining the threshold level and the impact of foreign aid on economic growth.

[17] For lower middle countries, Egypt is considered to be an outlier in our sample. Among all the countries, it records the highest score in the top 10 ODA recipients by 2013 and is considered to be one of the largest recipients of aid since 1970's. Therefore, we omit it from our sample because, whenever it is included, we fail to recognize the impact of foreign aid on economic growth.

significance levels. While both inflation and M2 have their anticipated sign, they are no longer significant. Additionally, there is a smoothness of transition between regimes and, when compared to LDCs countries, this is considerably higher for lower middle countries. Indeed, various groups of countries have different threshold levels and may follow diverse concepts. Consequently, our results confirm the idea that pooling different groups of countries with various income levels leads to biased results[18].

Table (3): Estimate threshold level of foreign aid for different income level developing countries

Variable	π_2	π_1	Transition Variables	
			C	Exp (γ)
A) Upper Middle Income countries				
Aid	2.221649 (0.0716)*	2.498169 (0.3389)	1.19975	17.34482
Inflation	-0.10726 (0.0238)**			
Investment	0.49185 (0.0002)***			
Government expenditure	-0.46549 (0.0001)***			
Aid*corr	-0.4179 (0.1416)			
corruption	-0.5949 (0.2226)			
M2	-0.06103 (0.1482)			
B) Lower Middle Income countries				
Aid	-0.1907 (0.6238)	0.8388 (0.2618)	4.5595** (0.05)	0.983060
Inflation	-0.01902 (0.7080)			
Investment	0.09055 (0.3168)			
Government expenditure	-0.10743 (0.2675)			
Aid*Corr	0.04905 (0.7025)			
corruption	-0.8890 (0.3174)			
M2	-0.0227 (0.7052)			

[18] This is in line with Hansen and Tarp's (2000, 2001) and Guillaumont, P. and Guillaumont, J.'s (2007.b) studies which confirm the effectiveness of foreign aid. However, they indicate that some countries are less in need of foreign aid. Furthermore, they criticize the estimation of a threshold level of foreign aid for a large group of various income level countries.

c) Low and Least developed countries

Aid	0.22866 (0.1929)	1.17336 (0.0000)***	11.38522*** (0.0000)	6.710653
Inflation	-0.0048 (0.7412)			
Investment	0.3203 (0.0221)**			
Government expenditure	-0.41585 (0.0939)*			
Aid*corr	-0.0657 (0.3386)			
corruption	0.8705 (0.1604)			
M2	0.02542 (0.4745)			

Notes: Dependant Variable is real GDP per capita growth. Values in parentheses represent p-values. *, **, *** display the significance levels at 10%, 5% and 1% respectively. π_1 and π_2 represent the impact of foreign aid above and below the estimated threshold level. The significance of the threshold is calculated by the likelihood ratio test of the Hansen (1999) approach.

Table (4): Estimates of the threshold level of foreign aid omitting the interaction term.

Variable	π_2	π_1	Transition Variables	
			C	Exp (γ)
A) Upper Middle Income countries				
Aid	0.4913 (0.0947)*	0.4134 (0.8333)	1.221345	18.87879
Inflation	-0.1151 (0.0049)***			
Investment	0.4169 (0.0003)***			
Government expenditure	-0.4037 (0.0003)***			
M2	-0.0355 (0.2472)			
B) Lower Middle Income countries				
Aid	-0.105155 (0.2525)	0.83563 (0.0382)**	4.3337*** (0.000)	13.21608
Inflation	-0.03001 (0.3103)			
Investment	0.1216 (0.0614)*			
Government expenditure	-0.17113 (0.0479)**			
M2	-0.02789 (0.5403)			
c) Low and Least developed countries				

Aid	0.09507 (0.5668)	1.14157 (0.0000)***	11.38522*** (0.000)	6.710653
Inflation	-0.0049 (0.6825)			
Investment	0.3697 (0.0074)***			
Government expenditure	-0.48357 (0.0404)**			
M2	0.02548 (0.5021)			

Notes: Dependant Variable is real GDP per capita growth. Values in parentheses represent p-values. *, **, *** display the significance levels at 10%, 5% and 1% respectively. π_1 and π_2 represent the impact of foreign aid above and below the estimated threshold level. The significance of the threshold is calculated by the likelihood ratio test of the Hansen (1999) approach.

4.3 Time varying effects of explanatory variables

We developed our model in such a way that we allowed the parameters on our explanatory variables to vary with respect to the changes in the estimated threshold level. Therefore, we provide each explanatory variable with two coefficients in order to distinguish their impact during both regimes. Table (5) display the results of the estimated equations (12 - 19); it provides the changes in the parameters of each explanatory variable according to the threshold level of foreign aid. Similarly, with our baseline results, foreign aid in upper middle countries exhibits a significant positive impact on economic growth below the threshold level; however, the estimated threshold level is insignificant. We recognise consistently that investment enhances the rate of economic growth below the threshold level; however, beyond that level, the impact is insignificant. Similarly, both government expenditure and inflation exhibit a detrimental effect on economic growth below threshold level while, above the threshold level, there is an insignificant impact.

In contrast, for lower middle countries, most of our explanatory variables are insignificant during both regimes. Perhaps, they are not sensitive enough to the changes in foreign aid. Only foreign aid coefficient is marginally significant above the threshold level. In addition, the coefficient of the estimated threshold level of aid is significant. For LDCs, we observe that only investment and government expenditure have a significant impact below the threshold level of foreign aid. We can say that the amounts of aid below this threshold level are not enough to ameliorate the rates of economic growth; however, investment can promote economic growth. On the other hand, due to the lack of experienced labour and staff, foreign aid is not employed efficiently. Consequently, a significant amount of investment is required to raise the human capital constraint which, in turn in the long run, fosters economic growth.

Consistent with Feeny and De Silva's (2012) findings, additional flows of foreign aid are handicapped due to the shortage of skilled staff. Consequently, more foreign aid should be directed to skill development programmes.

Table (5): Estimate the threshold level of foreign aid with time varying effects of explanatory variables.

Variable	π_2	π_1	Transition Variables	
			C	Exp (γ)
A) Upper Middle Income countries				
Aid	0.4906 (0.0968)*	0.6009 (0.9859)	1.221346	18.878791
Inflation	-0.1062 (0.068)*	-0.3087 (0.7682)		
Investment	0.3951 (0.0212)**	0.3452 (0.9269)		
Government expenditure	-0.3829 (0.0015)***	-1.3986 (0.7406)		
M2	-0.03137 (0.5547)	-0.2330 (0.9653)		
B) Lower Middle Income countries				
Aid	-0.1022 (0.3353)	0.7838 (0.0956)*	3.8542*** (0.000)	8.7268
Inflation	-0.02959 (0.5949)	-0.0854 (0.5823)		
Investment	0.1032 (0.2663)	0.29004 (0.438)		
Government expenditure	-0.1606 (0.1258)	-0.5550 (0.4771)		
M2	-0.02167 (0.7158)	-0.06613 (0.8765)		
c) Low and Least developed countries				
Aid	0.02118 (0.9232)	1.18932 (0.6398)	9.78821** (0.05)	-0.29451
Inflation	-0.01457 (0.4244)	-0.1016 (0.8702)		
Investment	0.3671 (0.0186)**	-2.9006 (0.6009)		
Government expenditure	-0.56285 (0.0967)*	1.7185 (0.8012)		
M2	0.0117 (0.8100)	3.6268 (0.5701)		

Notes: Dependant Variable is real GDP per capita growth. Values in parentheses represent p-values. *, **, *** display the significance levels at 10%, 5% and 1% respectively. π_1 and π_2 represent the impact of foreign aid above and below the estimated threshold level. The significance of the threshold is calculated by the likelihood ratio test of the Hansen (1999) approach.

4.4 Estimate multiple threshold level of foreign aid

Lastly, we wanted to examine the multiple regime threshold models and, thus, we developed our model to explore the possibility of another threshold level of aid for all groups of countries[19]. For upper middle countries, we are looking for a lower threshold level below which it exhibits a detrimental impact on economic growth. In contrast, for lower middle and LDCs, we examine the presence of a higher threshold level of foreign aid above which it may harm rates of economic growth.

While attempting to estimate another threshold level of foreign aid for upper middle countries, it is apparent from Table (6) that we fail to provide any suitable threshold level. Further foreign aid coefficients display insignificant impacts during all regimes. Similarly, our results provide little evidence of the existence of a higher threshold level of foreign aid for both lower middle and LDCs countries. This is because only one threshold level of foreign aid, (i.e. 4.33% and 11.33% of GDP for lower middle and LDCs countries respectively) proved to be significant at the 1% significance level. Although foreign aid to LDCs countries displays different behaviours during all regimes, we cannot find a higher suitable threshold level. Hence our estimated level (27.737% of GDP) is no longer significant at all levels. Moreover, we recognise that there is a smooth transition between all regimes (first π_2 to second π_1 to third π_3). However, the speed of transition from second π_1 to third regime π_3 is slow when compared to the speed of transition from the first π_2 to second regime π_1 which seems to be relatively high.

Together, the results provide important insights that pooling a heterogenous group of countries may lead to misleading results. This is because we observe that the threshold level varies between various groups of income level countries. Interestingly, we argue that both lower middle and LDCs countries are in need of more aid inflows; nevertheless, donors should be cautious in providing high aid inflows specifically to LDCs countries. Consistent with our data, we can see that, in 1994, Malawi hits the peak (39.78% of GDP) while, its growth rate of GDP was -10.24%. Also, the foreign assistance received by Sierra Leona accounted for 30.017% of GDP whereas the growth rate of GDP was -1.947%. In addition, we observe that most of the LDCs, included in our sample, are located in Africa. However, the highest aid inflows are directed towards African countries. Consequently, we may conclude that policy makers should examine and regulate the rules which control the allocation of aid inflows to recipient countries.

[19] Similarly, some of the previous studies (e.g. Guillaumont, P. and Guillaumont, J.; 2007b) suggest the presence of two threshold levels of foreign aid (i.e. there exists a minimum threshold level of foreign aid that follows the big push concept and a higher threshold level which supports the absorptive capacity concept).

Table (6): Estimate a multiple threshold model

Variable	π_2	π_1	π_3	Transition Variables	
				C	Exp (γ)
A) Upper Middle Income countries					
Aid	0.08575 (0.9781)	-0.41259 (0.9894)	0.3659 (0.9904)	C_1 =0.3887 C_2=1.3948	γ_1 =-0.0617 γ_2 =-0.0609
Inflation	-0.1254 (0.0151)**				
Investment	0.39053 (0.0281)**				
Government expenditure	-0.4641 (0.0005)***				
M2	-0.03943 (0.4607)				
B) Lower Middle Income countries					
Aid	-0.14206 (0.1277)	0.6892 (0.1982)	0.09714 (0.7286)	C_1=4.3334*** (0.000) C_2=9.5115	γ_1 =13.2161 γ_2 =-15.1875
Inflation	-0.02824 (0.3347)				
Investment	0.12131 (0.0964)*				
Government expenditure	-0.17745 (0.0419)**				
M2	-0.02868 (0.5650)				
c) Low and Least developed countries					
Aid	0.10996 (0.2864)	0.51096 (0.0007)***	-0.20933 (0.3485)	$c_1 = 11.337^{***}$ (0.000) $c_2 = 27.737$	$\gamma_1 = 8.1384$ $\gamma_2 = 0.6824$
Inflation	-0.00494 (0.5559)				
Investment	0.36852 (0.0027)***				
Government expenditure	-0.4721 (0.0247)**				
M2	0.01595 (0.6494)				

Notes: Dependent Variable is real GDP per capita growth Values in parentheses represent p-values. *, **, *** display the significance levels at 10%, 5% and 1% respectively. Meanwhile,π_2 represent the impact of foreign aid below C_1, π_1 shows the effect wherever $C_2 > q_{it} \geq C_1$ and π_3 occur when $q_{it} \geq C_2$. The significance of the threshold is calculated by the likelihood ratio test of the Hansen (1999) approach.

4.5 Robustness analysis

In this section, we present the robustness checks of the main results displayed in section 4.2. Section 4.5.1 illustrates results with another institutional quality variable (democracy). In section 4.5.2, we employ the institutional quality variables (corruption and democracy) as alternative threshold variables and, furthermore, we split our sample with respect to their respective corruption and democracy levels. Finally, in section 4.5.3, we address the issue of endogeneity.

4.5.1 Another measure of institutional quality

In order to detect whether or not institutional quality impacts on the effectiveness of aid in developing countries, we considered another measure of institutional quality (democracy). Correspondingly with our main results presented in Table (3), our results, presented in Table (7), show no evidence that institutional quality may promote the effectiveness of aid for all three groups of countries. Similar to our baseline results for both democracy and the interaction term, institutional quality has no significant impact on economic growth. In addition, our estimated threshold levels and aid coefficients are comparable to those given in Table (3) with only inconsiderable change in their magnitude.

Table 7: Threshold Variable: Foreign Aid, (control democracy).

Variable	π_2	π_1	Transition Variables	
			C	Exp (γ)
A) Upper Middle Income countries				
Aid	1.3207 (0.2693)	1.25575 (0.3223)	1.168022	12.86232
Inflation	-0.12966 (0.0009)***			
Investment	0.38713 (0.0003)***			
Government expenditure	-0.44911 (0.0009)***			
Aid*democ	-0.1274 (0.3519)			
Democracy	0.33378 (0.5316)			
M2	-0.03771 (0.2403)			
B) Lower Middle Income countries				

Aid	-0.02484 (0.9248)	0.8738 (0.0489)**	4.0969*** (0.000)	25.28143
Inflation	-0.03357 (0.2958)			
Investment	0.16695 (0.1048)			
Government expenditure	-0.17733 (0.1383)			
Aid*democ	-0.0207 (0.6106)			
Democracy	0.05348 (0.8570)			
M2	-0.2115 (0.7258)			
c) Low and Least developed countries				
Aid	0.00753 (0.9716)	1.05687 (0.0002)***	11.635*** (0.000)	5.98785
Inflation	-0.005729 (0.7057)			
Investment	0.37028 (0.0070)***			
Government expenditure	-0.42967 (0.0678)*			
Aid*democ	0.00929 (0.6379)			
Democracy	-0.0807 (0.6805)			
M2	0.01607 (0.6770)			

Notes: Dependant Variable is real GDP per capita growth. Values in parentheses represent p-values. *, **, *** display the significance levels at 10%, 5% and 1% respectively. π_1 and π_2 represent the impact of foreign aid above and below the estimated threshold level. The significance of the threshold is calculated by the likelihood ratio test of the Hansen (1999) approach.

4.5.2 Alternative Threshold Variables: Corruption and Democracy

Other studies (e.g Law et al., 2013; Law and Singh, 2014) criticise the strategy of employing the interaction term. They suggest that, for instance, the interaction term between foreign aid and institutional quality variables (corruption or democracy) propose a priori constraint in which the effect of foreign aid on economic growth increases monotonically with respect to the level of institutional quality. On the other hand, they claim that a specific level of institutional quality needs to be attained prior to distinguishing the impact of foreign aid on economic growth. Thereby, in this section, we employ both corruption and democracy as threshold variables to detect whether or not there exists a threshold level beyond or below which foreign aid has any significant impact on economic growth. Tables 8 and 9 illustrate the

results accomplished by using respectively both corruption and democracy as threshold variables[20]. Both Tables show no evidence of a suitable threshold level for both corruption and democracy. Additionally, and consistent with our previous results, foreign aid loses its significant impact on economic growth during both regimes and with respect to the changes of both institutional quality variables.

Finally, we split our sample into two groups with respect to the average level of both corruption and democracy. Results reported in Table 10 shows evidence of non-linearity between foreign aid and economic growth for both high and low corrupted countries. However, the estimated threshold level of foreign aid for high corrupted countries is 9.5% of GDP beyond which it enhances the rate of economic growth. The estimated threshold level is close to our baseline finding and, hence, most of high corrupted countries belong to the LDCs group. A lower threshold level of foreign aid (3.44% of GDP) is realized for low corrupted countries. Similarly, Alesina and Weder (1999) and Alesina and Dollar (2000) cannot provide any evidence that low corrupted countries receive high amounts of aid. In the same vein, Table 11 displays the impact of foreign aid on economic growth for the most and least democratic countries. According to our estimated results, we find a threshold level of foreign aid (7.97% of GDP) for most democratic countries, below which it has an insignificant negative impact on economic growth, while above that level it fosters economic growth. On the other hand, with respect to the least democratic countries, we cannot find a suitable threshold level of foreign aid. Similarly, foreign aid is no longer significant during both regimes. This result is consistent with previous studies' (i.e. Isham et al, 1997; Svensson, 1999) findings which suggest that, when measured by civil liberties and political rights, foreign aid displays a higher impact in the most democratic countries.

[20] We employed the non-linearity specification test to test the no-linearity hypothesis for both corruption and democracy levels. The results are not reported for brevity (results are available upon request). However, it suggests the non-linearity of corruption for all groups of countries at the 5% significance level. With respect to democracy, we fail to reject the non-linearity hypothesis only for lower middle income countries, while it is rejected for both Upper middle and LDCs countries at 1% and 10% significance level respectively.

Table 8: Threshold Variable: Corruption

Variable	π_2	π_1	Transition Variables	
			C	Exp (γ)
A) Upper Middle Income countries				
Aid	0.45395 (0.1134)	10.4643 (0.3863)	1.46302	11.103889
Inflation	-0.13218 (0.0011)***			
Investment	0.38397 (0.0007)***			
Government expenditure	-0.481565 (0.0000)***			
M2	-0.03276 (0.2360)			
B) Lower Middle Income countries				
Aid	-0.122448 (0.2193)	0.101978 (0.5115)	0.51372	14.49295
Inflation	-0.033046 (0.2255)			
Investment	0.14212 (0.0289)**			
Government expenditure	-0.166233 (0.1779)			
M2	-0.02759 (0.4989)			
c) Low and Least developed countries				
Aid	0.01535 (0.9403)	32.78 (0.9985)	2.63218 (0.9869)	1.297057
Inflation	-0.002589 (0.8496)			
Investment	0.366231 (0.0170)**			
Government expenditure	-0.2503 0.384			
M2	0.00223 (0.9556)			

Notes: Dependant Variable is real GDP per capita growth. Values in parentheses represent p-values. *, **, *** display the significance levels at 10%, 5% and 1% respectively. π_1 and π_2 represent the impact of foreign aid above and below the estimated threshold level. The significance of the threshold is calculated by the likelihood ratio test of the Hansen (1999) approach.

Table 9: Threshold Variable: Democracy[21]

Variable	π_2	π_1	Transition Variables	
			C	Exp (γ)
A) Upper Middle Income countries				
Aid	0.1598 (0.15987)	7.33769 (0.6303)	1.08472 (0.2781)	1.71225
Inflation	-0.14399 (0.0012)***			
Investment	0.37650 (0.0014)***			
Government expenditure	-0.4965 (0.0000)***			
M2	-0.04324 (0.2055)			
c) Low and Least developed countries				
Aid	-0.0676 (0.6235)	0.605685 (0.3038)	1.430074 (0.3529)	0.257422
Inflation	-0.0089 (0.4873)			
Investment	0.39104 (0.0020)***			
Government expenditure	-0.4516 (0.0814)*			
M2	0.00996 (0.7962)			

Notes: Dependant Variable is real GDP per capita growth. Values in parentheses represent p-values. *, **, *** display the significance levels at 10%, 5% and 1% respectively. π_1 and π_2 represent the impact of foreign aid above and below the estimated threshold level. The significance of the threshold is calculated by the likelihood ratio test of the Hansen (1999) approach.

[21] The linearity test reject the non-linearity hypothesis of democracy among lower income countries, therefore results for lower middle income countries are not reported.

Table 10: Split sample according to corruption level

	High corrupted countries		Low corrupted countries	
Variable	π_2	π_1	π_2	π_1
Aid	0.055304 (0.7588)	0.664944 (0.0043)***	-0.148832 (0.3408)	0.568228 (0.0226)**
Inflation	-0.01183 (0.3849)		-0.03469 (0.2490)	
Investment	0.30919 (0.1841)		0.13446 (0.0966)*	
Government expenditures	-0.23114 (0.4747)		-0.37983 (0.0089)***	
M2	0.01379 (0.8466)		-0.009265 (0.8014)	
Threshold (c)	9.52435 (0.0405)**		3.4411 (0.000)***	
Slope {exp(γ)}	5.02162		0.9337	

Dependant variable: is real GDP per capita growth. Values in parentheses represent p-values. *, **, *** display the significance levels at 10%, 5% and 1% respectively. π_1 and π_2 represent the impact of foreign aid above and below the estimated threshold level. c is the threshold level of foreign aid.

Table 11: Split sample according to democracy level

	Most Democratic		Least Democratic	
Variable	π_2	π_1	π_2	π_1
Aid	-0.1728 (0.1674)	1.8823 (0.0906)*	-0.0671 (0.7371)	0.13137 (0.8183)
Inflation	-0.017396 (0.6370)		-0.025116 (0.7545)	
Investment	0.1534 (0.2157)		0.34186 (0.5420)	
Government expenditures	-0.33208 (0.0129)**		-0.48571 (0.1803)	
M2	0.02257 (0.5186)		-0.0314 (0.4792)	
Threshold (c)	7.9721 (0.0107)**		5.53102	
Slope: Exp(γ)	-0.0976		16.74105	

Dependant variable: is real GDP per capita growth. Values in parentheses represent p-values. *, **, *** display the significance levels at 10%, 5% and 1% respectively. π_1 and π_2 represent the impact of foreign aid above and below the estimated threshold level. c is the threshold level of foreign aid.

4.5.3 Foreign Aid Endogeneity

In an attempt to control the endogeneity problem, we perform the following steps:

1) Net official development assistance is regressed on higher lags plus all exogenous regressors; then, we predict the values for net ODA.
2) We follow the benchmark estimation procedure (equations 7-11); however, we employ the fitted values of net ODA as % of GDP (Foda refers to the fitted values of Net Official Development Assistance), as a threshold variable and, also, as a slope parameter.

Table (12) shows the estimated threshold level of foreign aid for all groups of developing countries as corrected for endogeneity. Consistent with our benchmark results, we underline the nonlinearity hypothesis between foreign aid and economic growth. Furthermore, we emphasize that various income level countries are in need of different levels of foreign aid. For instance, both lower middle and LDCs follow their push idea, while we cannot observe a suitable threshold level of foreign aid for the upper middle countries. Accordingly, foreign aid has an insignificant impact on economic growth during low and high regimes. Comparing these results with the benchmark model, we see only a negligible change in the coefficients. Additionally, the estimated threshold levels of foreign aid are almost the same. Lastly, we employ Hausman's (1978)[22] test and our results show no evidence of endogeneity in our estimation method. Since the coefficients on the residuals are not statistically significant from zero, we reject the hypothesis that FODA is endogenous[23]. Figure (1) shows the estimated transition function for our baseline model and the corrected one for endogeneity; it provides an interpretation of the model's characteristics. Similar to Gonzalez et al's (2005) and Omay and Khan's (2010) findings and, the regime change in our model looks to be discontinuous. However, this is not a problem with the smooth transition regression model since its main aim is to place a slow transition between regimes. Both studies recognize a high speed of transition

[22] The main idea behind the Hausman test is to estimate the reduced form of FODA by regressing it on all exogenous variables and lagged values of ODA as instruments then obtain the residuals. Afterwards, we add the residuals to the structural equation and test for the significance of the residuals. For more details about testing for endogeneity see Wooldridge (2012), p527.

[23] 2sls is more convenient in this case because it is difficult to split the instrumented foreign aid within the construction of GMM. Therefore, our estimation is limited to a less efficient but consistent estimator, (Baum et al., 2013).

69.05 and 118.77 respectively, while our parameter estimate for the corrected endogeneity model[24] are (exp {4.504 and 7.657}) respectively for lower middle and LDCs countries.

Table (12): Estimate the threshold level of foreign aid corrected for endogeneity

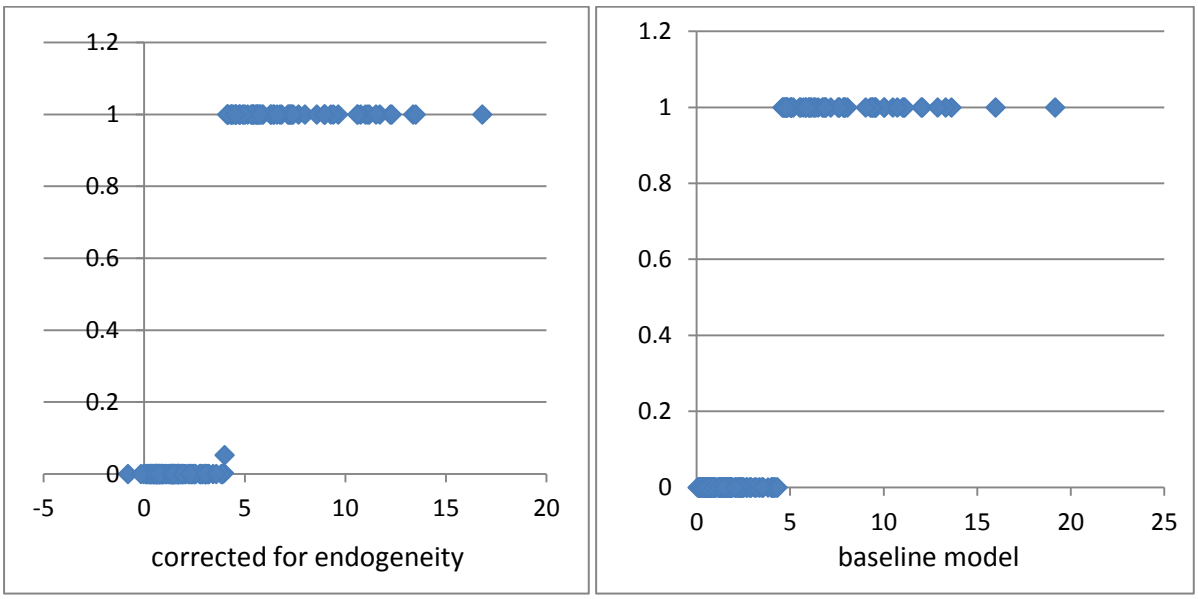
Variable	π_2	π_1	Transition Variables	
			C	Exp (γ)
A) Upper Middle Income countries:				
Faid	0.306551 (0.5047)	0.45175 (0.7893)	1.04778	7.1415
Inflation	-0.124482 (0.0169)**			
Investment	0.47922 (0.0002)***			
Government expenditure	-0.41993 (0.0001)***			
M2	-0.03792 (0.2261)			
B) Lower Middle Income countries:				
Faid	-0.0585 (0.7061)	0.90604 (0.0128)**	4.031562** (0.05)	4.50355
Inflation	-0.033257 (0.1542)			
Investment	0.13907 (0.1025)			
Government expenditure	-0.1575 (0.1365)			
M2	-0.03727 (0.5052)			
c) Low and Least developed countries:				
Faid	0.00494 (0.5352)	0.71155 (0.0478)**	6.016707** (0.038)	7.657241
Inflation	0.00836 (0.7598)			
Investment	0.30785 (0.1565)			
Government expenditure	-0.24742 (0.4097)			
M2	0.01756 (0.7575)			

Notes: Dependent Variable is real GDP per capita growth. Values in parentheses represent p-value. *, **, *** display the significance levels at 10%, 5% and 1% respectively. Foda refers to the fitted values of Net Official Development Assistance. Meanwhile, π_1 and π_2 represent the impact of foreign aid above and below the estimated threshold level. The significance of the threshold is calculated by the likelihood ratio test of the Hansen (1999) approach.

[24] Similarly, the speed of transition between regimes (γ) for the baseline model is high.

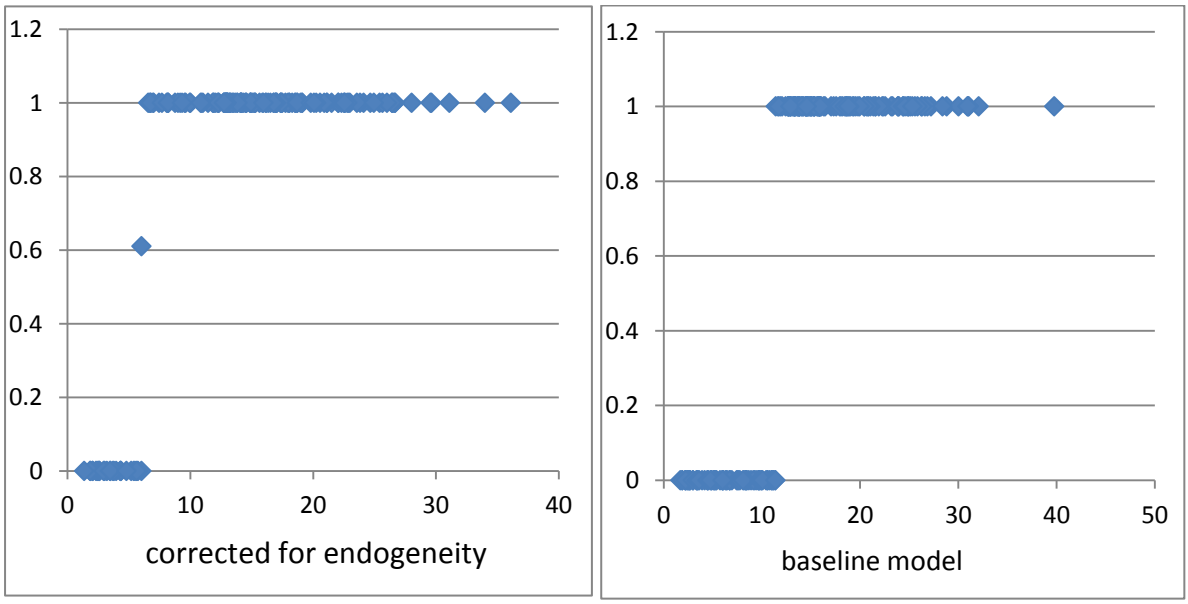
Figure (1): The Estimated Transition function

Lower Middle Income countries.



*x– axis represent the transition variable,while y–axis display the transition function g (q_{it}; γ,c)

Low and Least developed countries



*x– axis represent the transition variable,while y–axis display the transition function g (q_{it}; γ,c)

5. Conclusion

One of the most persistent issues in development economics is the debate about the relationship between foreign aid and economic growth. We may relate this discrepancy to the heterogeneity of aid and each recipient country's various characteristics. Also, the developing countries' limited absorptive capacity has been largely ignored. Moreover, due to employing inappropriate methods, previous empirical studies fail to provide a clear and precise estimate of the threshold level of aid.

Therefore, this paper aims to reinvestigate the nonlinear hypothesis between foreign aid and economic growth for 25 developing countries during the period from 1984 to 2008. We propose a new estimation method for the PSTR model, developed by Gonzalez et al., (2005), since we define the PSTR model in the form of state space equations. This method allows us to identify the state variable's behaviour at each point of time. Additionally, it estimates endogenously a precise and significant threshold level of aid. We have developed the model in two ways: firstly, we introduce the time varying effects of the explanatory variables and, secondly, we have extended the model to detect the possibility of multiple threshold levels of foreign aid.

In this study, we examine the role of income level in assessing the non-linear relationship between foreign aid and economic growth. Hence, we split our sample into three groups based on their income level according to the World Bank classifications. This is because we believe that, since countries vary from different perspectives, pooling various groups of countries may lead to either insignificant or biased results. Additionally, we employ the interaction term between aid and corruption level in order to detect whether or not the effectiveness of aid is conditional upon the recipient country's level of corruption.

In this context, our analysis confirms for both lower middle and LDCs countries the presence of one threshold level of foreign aid 4.3% and 11.38% of GDP respectively whereas, beyond that level, foreign aid has a positive effect on economic growth. However, we cannot find a precise threshold level of foreign aid for upper middle countries. Therefore, we can observe that it is misleading to estimate a threshold level for all developing countries collectively. In the same vein, we recognise the insignificant impact of aid conditional upon

the level of corruption. In turn, this means that the effectiveness of foreign aid is not restricted to recipient country's level of corruption. On the other hand, we recognize that the threshold level of foreign aid for high corrupted countries (9.5% of GDP) exceeds the low corrupted countries (3.44% of GDP). Additionally, we cannot provide any evidence to support a further threshold level of foreign aid for all three groups of countries. However, because we observe that foreign aid has is no longer effective during the third regime, we consider that donors and international organizations should implement some precautionary policies towards assigning high aid flows to LDCs.

In addition, policy makers should regulate the allocation process of foreign aid. They should work on how to raise the capacity for these countries and they should differentiate between the amount of aid required to reduce poverty and the levels of aid needed to accomplish high rates of economic growth. Although our results suggest that the donors should increase the amount of foreign aid directed to lower middle and LDCs countries, it raises another question, namely, which type of aid, grants or loans? Therefore, there exists an argument that aid recipient countries should consider grants as free resources of revenue while loans will raise the burden of repayments in the future. In turn, this will induce policy makers to employ funds wisely. This motivates us to evaluate the nonlinear relationship between loans, grant and economic growth as a further research avenue. Lastly, because it will help to assign an appropriate amount of foreign aid for aid recipient countries, it will be useful to create a more comprehensive index of the absorptive capacity for each individual country.

7. References

1. ALESINA, A. and DOLLAR, D., 2000. Who gives foreign aid to whom and why? Journal of economic growth, 5(1), pp. 33-63.
2. ALESINA, A. and WEDER, B., 2002. Do Corrupt Governments Receive Less Foreign Aid? American Economic Review, 92(4), pp. 1126-1137.
3. AURANGZEB, Z. and STENGOS, T., 2010. Foreign aid and Economic Growth in developing countries: Revisiting the Evidence by using a Threshold regression Approach. https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=CEA2010&paper_id=89
4. BASDEVANT, O.., April, 2003. On applications of state space modelling in macroeconomics. Discussion paper series, Reserve Bank of NEW ZEALAND. DP2003/02, pp.1-57.
5. BAUM, A., CHECHERITA-WESTPHAL, C. and ROTHER, P., 2013. 'Debt and growth: New evidence for the euro area', *Journal of International Money and Finance*, 32, pp. 809-821.
6. BURNSIDE, A.C. and DOLLAR, D., 1997. Aid, policies, and growth. World Bank policy research working paper, (569252).
7. BURNSIDE, C. and DOLLAR, D., 2000. Aid, Policies, and Growth. American Economic Review, pp. 847-868.
8. CANER, M. and HANSEN, B.E., 2004. Instrumental variable estimation of a threshold model. Econometric Theory, 20(05), pp. 813-843.
9. CLEMENS, M.A., RADELET, S., BHAVNANI, R.R. and BAZZI, S., 2012. Counting chickens when they hatch: Timing and the effects of aid on growth*. The Economic Journal, 122(561), pp. 590-617.
10. DALGAARD, C. J., HANSEN, H., & TARP, F. (2004). On the empirics of foreign aid and growth. The Economic Journal, 114 (496).
11. DE LA CROIX, D. and DELAVALLADE, C. (2013). Why corrupt governments may receive more foreign aid. Oxford Economic Papers, 66(1), pp. 51-66
12. DJANKOV, S., MONTALVO, J.G. and REYNAL-QUEROL, M., 2008. The curse of aid. Journal of Economic Growth, 13(3), pp. 169-194.

13. DURBARRY, R., GEMMELL, N. and GREENAWAY, D., 1998. New evidence on the impact of foreign aid on economic growth. Centre for Research in Economic Development and International Trade, University of Nottingham.
14. EASTERLY, W., 2003. Can foreign aid buy growth? The journal of economic perspectives, 17(3), pp. 23-48.
15. ECONOMIDES, G., KALYVITIS, S. and PHILIPPOPOULOS, A., 2008. Does foreign aid distort incentives and hurt growth? Theory and evidence from 75 aid-recipient countries. Public Choice, 134(3-4), pp. 463-488.
16. FEENY, S. and DE SILVA, A., 2012. Measuring absorptive capacity constraints to foreign aid. Economic Modelling, 29(3), pp. 725-733.
17. FEENY, S. and MCGILLIVRAY, M., 2010. Aid and growth in small island developing states. The Journal of Development Studies, 46(5), pp. 897-917.
18. FOUQUAU, J., HURLIN, C. and RABAUD, I., 2008. The Feldstein–Horioka puzzle: a panel smooth transition regression approach. Economic Modelling, 25(2), pp. 284-299.
19. GOMANEE, K., GIRMA, S. and MORRISSEY, O., 2003. Searching for aid threshold effects. CREDIT research paper, (03/15).
20. GONZÁLEZ, A., TERÄSVIRTA, T. and DIJK, D.V., 2005. Panel smooth transition regression models, Working Paper Series in Economics and Finance. No. 604.
21. GRANGER, C.W. and TERÄSVIRTA, T., 1993. Modelling Non-Linear Economic Relationships. Oxford: Oxford University Press.
22. GYIMAH-BREMPONG, K., RACINE, J.S. and GYAPONG, A., 2012. Aid and economic growth: Sensitivity analysis. Journal of International Development, 24(1), pp. 17-33.
23. HADJIMICHAEL, M. T.; GHURA, DHANESHWAR; MUHLEISEN, MARTIN; NORD, ROGER; UCER, E. MURAT, 1995. Sub-Saharan Africa: Growth, Savings, and Investment. *IMF Discussion paper*. No. 118, vii+79.
24. HANSEN, B.E., 1999. Threshold effects in non-dynamic panels: Estimation, testing, and inference. Journal of Econometrics, 93(2), pp. 345-368.
25. HANSEN, H. and TARP, F., 2001. Aid and growth regressions. Journal of Development Economics, 64(2), pp. 547-570.
26. HANSEN, H. and TARP, F., 2000. Aid effectiveness disputed. Foreign Aid and Development: Lessons Learnt and Directions for the Future, pp. 103-128.
27. HAUSMAN, J.A., 1978. Specification tests in econometrics. Econometrica: Journal of the Econometric Society, pp. 1251-1271.

28. ISHAM, J., KAUFMANN, D. and PRITCHETT, L.H., 1997. Civil liberties, democracy, and the performance of government projects. The World Bank Economic Review, 11(2), pp. 219-242.
29. KALYVITIS, S., STENGOS, T. and VLACHAKI, I., 2012. Are aid flows excessive or insufficient? Estimating the growth impact of aid in threshold regressions. Scottish Journal of Political Economy, 59(3), pp. 298-315.
30. KARRAS, G., 2006. Foreign aid and long-run economic growth: empirical evidence for a panel of developing countries. Journal of International Development, 18(1), pp. 15-28.
31. KIM, C. and NELSON, C.R., 1999. State-space models with regime switching: classical and Gibbs-sampling approaches with applications. MIT Press Books, 1.
32. KOURTELLOS, A., TAN, C.M. and ZHANG, X., 2007. Is the relationship between aid and economic growth nonlinear? Journal of Macroeconomics, 29(3), pp. 515-540.
33. LAW, S.H., AZMAN-SAINI, W. and IBRAHIM, M.H. (2013). Institutional quality thresholds and the finance–growth nexus. *Journal of Banking & Finance*, **37**(12), pp. 5373-5381.
34. LAW, S.H. and SINGH, N. (2014). Does too much finance harm economic growth? *Journal of Banking & Finance,* **41**, pp. 36-44.
35. LEE, C. and CHIU, Y., 2013. Modeling OECD energy demand: An international panel smooth transition error-correction model. International Review of Economics & Finance, 25, pp. 372-383.
36. LEE, C. and CHIU, Y., 2011. Electricity demand elasticities and temperature: Evidence from panel smooth transition regression with instrumental variable approach. Energy Economics, 33(5), pp. 896-902.
37. LENSINK, R. and WHITE, H., 2001. Are there negative returns to aid? Journal of development Studies, 37(6), pp. 42-65.
38. MERGNER, S., 2009. Linear Gaussian state space models and the Kalman filter. In: MERGNER, S Applications of state space models in finance. Germany: Universitätsverlag Göttingen. Pp. 17-40.
39. MOSLEY, P., HUDSON, J. and HORRELL, S., 1987. Aid, the public sector and the market in less developed countries. The Economic Journal, , pp. 616-641.
40. MOYO, D., 2009. *Dead aid: Why aid is not working and how there is a better way for Africa.* Macmillan.

41. OMAY, T. and OZNUR KAN, E., 2010. Re-examining the threshold effects in the inflation-growth nexus with cross-sectionally dependent non-linear Panel: Evidence from six industrialized economies. Economic Modelling, 27(5), pp. 996-1005.
42. REMMER, K.L., 2004. Does foreign aid promote the expansion of government? American Journal of Political Science, 48(1), pp. 77-92.
43. SVENSSON, J., 2000. Foreign aid and rent-seeking. Journal of International Economics, 51(2), pp. 437-461.
44. SVENSSON, J., 1999. Aid, growth and democracy. Economics & Politics, 11(3), pp. 275-297.
45. WAGNER, L., 2014. Identifying thresholds in aid effectiveness. Review of World Economics, 150(3), pp. 619-638.
46. WOOLDRIDGE, J. M., 2012. Instrumental Variable Estimation and Two Stage Least Squares. In: Wooldridge, Jeffrey M. Introductory Econometrics: A Modern Approach. 4th ed. Canada: Cengage Learning. 506-545.
47. YU, P., 2013. Inconsistency of 2SLS estimators in threshold regression with endogeneity. Economics Letters, 120(3), pp. 532-536.
48. YU, P. and PHILLIPS, P.C., 2014. Threshold regression with endogeneity, Cowles Foundation Discussion Paper No.1966.