Estimating Fiscal Reaction Functions for Developing and Developed Countries: A Dynamic Panel Threshold Analysis

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Abstract

Using a dynamic threshold regression method to estimate fiscal reaction functions, this paper examines the response of the primary surplus, government expenditure, and government revenue to the public debt for a large sample of countries over the period 2000 – 2018. Our empirical results lend a strong evidence for the dynamic threshold specification. Governments implement a sustainable fiscal policy until reaching the threshold level, but beyond this level the primary balance does not react to changes in public debt in developing countries. On the other hand, for developed countries, primary balance gives a negative (positive) response to an increase in the public debt when the debt is lower (higher) than the threshold level. Moreover, it seems that the primary balance is countercyclical. Besides the primary surplus, investigating the response of government expenditure and revenue provides valuable insights on the fiscal policy. Finally, dividing our sample as pre- and post-crisis periods we uncover some important changes in the fiscal policy after the last global financial crisis.

Keywords: *dynamic threshold, reaction function, fiscal policy, sustainability, panel*

JEL Classification: E62, H60, H62

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Introduction

The last global financial crisis has taught many important lessons on macroeconomic policy. There is no doubt that one of them is fiscal policy matters. Before the crisis there is a widespread consensus among scholars that monetary

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policy is perfectly capable of dealing with economic shocks or contractions. However, it becomes apparent that conventional monetary policy is not adequate when the policy interest rate is already very low, even hitting the zero lower bound in some countries. Thus, two options are available for governments tointervene in the economy. The first one consists of new or unconventional monetary policy measures, including forward guidance and quantitative easing. The second one is to implement the expansionary fiscal policy, such as increasing the government spending, cutting taxes or a combination of the two. Governments jointly implemented expansionary monetary and fiscal policies to alleviate the impact of the crisis on the output and employment.

Not surprisingly the expansionary fiscal policies resulted in unprecedented budget deficits and eventually public debts in many countries. Of course this increase does not arise only from the expansionary policies but also a decline in the output. This sharp increase in public debt ratios trigerred doubts and concerns on the sustainability of public debt, particularly in some countries with high debt ratios even before the crisis. When public finances are already in a weak or fragile condition, governments inevitably face an unpleasant dilemma. They need to implement the austerity measures to ensure the sustainability of public debt at a time in which the economy experiences a contraction or stagnation. Even though, some studies, such as Bertola and Drazen (1993) and Alesina and Ardagna (2009), suggest that fiscal consolidations would have expansionary or non-Keynesian effects under specific conditions, this does not necessarily imply that every fiscal consolidation will end up increasing the economic activity.

Following Bohn (1998) there is a large literature estimating fiscal reaction functions to investigate the stance of fiscal policy (among others, Gali and Perotti, 2003; Turan and Telatar, 2013; Egert, 2014; Berti et al., 2016; Bökemeier and Stoian, 2018). Early studies, like Gali and Perotti (2003), assume a linear relationship. However, as highlighted in the literature the response of budget balance to public debt does not need to be monotonic or linear (Bohn, 1998; Mendoza and Ostry, 2008). For example, a government would more strongly react to debt when the debt level is high or vice versa. Thus, more recent studies largely focus on the non-linear relationship between the budget balance and public debt (Ghosh et al., 2013; Fournier and Fall, 2017; Icaza, 2018).

Interestingly, except a small number of studies such as Burger et al. (2011), de Mello (2008), Turan and Telatar (2013), Small et al. (2020), and Tetik et al. (2022), the literature extensively estimates the fiscal reaction functions to analyze the sustainability and cyclicality of fiscal policy for developed or advanced countries. However, it is not straightforward to generalize the findings obtained

for developed countries to developing ones. The difference between developed and developing countries regarding the reaction of fiscal policy to public debt and the cycle might be explained by many economic, financial, and institutional factors (Kaminsky et al., 2004; Mendoza and Ostry, 2008; Frankel et al., 2013). For example, it would be more challenging to obtain funds from financial markets, especially during contractions or crises for developing countries. Similarly, sustainability issues would be more easily triggered and damaging, indicating a lower debt intolerance level in developing countries (Reinhart et al., 2003). Therefore, more interesting is to estimate the fiscal reaction functions for both developing and developed countries and then make a comparative analysis, as in Mendoza and Ostry (2008).

Estimating the fiscal policy reaction functions, this study examines the response of primary balance, government expenditure and government revenue to the public debt and hence contributes to the existing literature in some important dimensions. First, unlike most previous studies generally focus on developed countries such as Golinelli and Momigliano (2009), Berti et al. (2016), Everaert and Jansen (2018), Icaza (2018), we estimate fiscal reaction functions for a large sample of countries, precisely 95 countries, then make a distinction between developed and developing ones. Second and more importantly, to the best of our knowledge, this is the first study employing the dynamic panel threshold regression method developed by Kremer et al. (2013) in this context. Properly tackling the endogeneity and autocorrelation issues, this method enables us to test the existence of a threshold or non-nonlinear effect in the response of fiscal policy to public debt in a dynamic setting. Since the presence of an inertia is very likely in this subject, using a dynamic approach would be crucial. Third, in the literature only a few studies pay attention to the government expenditure and revenue as a proxy for fiscal stance in estimating the fiscal reaction functions (Reicher, 2013; Egert, 2014; Small et al., 2020). To provide more insights on the fiscal policy, we include the government expenditure and revenue as the dependent variables in the fiscal reaction functions. Fourth, to test whether the fiscal policy has changed after the global financal crisis we divide our sample as pre- and post- crisis periods. Our empirical results lend a strong evidence for the importance of dynamic threshold specification and also distinguishing between the reactions of government expenditure and revenue. Finally, our results indicate that the last global crisis has some long lasting effects on the fiscal policy.

This paper is structured as follows. We review the literature in section 1, explain our method and data in section 2, present and discuss the empirical results in section 3, and conclude in the final section.

1. Literature Review

An increasing number of studies estimate the fiscal reaction functions to analyze the fiscal policy, summarized in Table 1. In a broader sense, sustainability refers to the notion that government debt is expected to remain constant or non-increasing. This implies that growth rate should be higher than or at least equal to interest rate. In essence, government intertemporal budget constraint makes it clear that the sustainability requires the discounted negative value of future primary surpluses be equal to the value of initial or inherited debt. In other words, if the inital debt has a positive value then the government should give primary surplus in the future. Many studies, including Hamilton and Flavin (1986), Hakkio and Rush (1991), and Trehan and Walsh (1991), investigate the sustainability focusing on time series properties, such as stationarity or cointegration, of relevant fiscal variables.

T a b l e 1

A Summary of the Selected Studies

Study	Sample/Period	Meth.	Main Findings
Gali and Perotti (2003)	11 EMU, 3 European countries, 5 OECD countries	IV fixed effects	The coefficient on the debt is negative in EMU and EU but almost zero in OECD countries. Structural balance gives a negative response to an increase in debt in EMU and EU. Fiscal policy is pro-cyclical in pre-Maastricht period and more countercyclical in post-Maastricht period.
Mendoza and Ostry (2008)	34 emerging market (EM) and 22 industrial countries (IC), 1990 – 2005, 1970 – 2005 respectively	Panel models	A positive relationship exists between primary balance and public debt in both group of countries. Different results obtained for high and low debt countries. The coefficient on the output gap is higher in IC than EM countries.
Staehr (2008)	12 Eurozone and 10 Central and Eastern European (CEE) countries, 1995 – 2005	GMM, OLS	Budget balance does not give a significant response to changes in debt. Expenditure is countercyclical while revenue is procyclical (a-cyclical) in Eurozone (CEE) countries. Fiscal balance is more countercyclical in CEE countries than Eurozone countries.
Golinelli and Momigliano (2009)	Euro Area, 1994 – 2008	System GMM	The coefficient on the debt is positive. When primary balance (cyclically adjusted primary balance) is used as the dependent variable, some evidence reported for procylical (acyclical) policy. Modelling choices and data span significantly affect the results.
Balassone et al. (2010)	14 European countries 1970 – 2007	Fixed effects and causality	The coefficient on the debt is negative. A cyclical asymmetry in the fiscal policy is found.
Afonso and Jalles (2011)	OECD countries 1970 – 2010	Pooled OLS, IV-FE, GMM, MG and AMG	The response of primary balance to debt is positive. Primary balance is countercyclical.
Lukkezen and Rojas-Romagosa (2012)	US, UK, Netherlands, and Belgium, Spain, Ireland and Portugal. Data period changes by country.	OLS	For the US, the UK, the Netherlands (NL), and Belgium (BE) the coefficient on debt is positive and significant while it insignificant for Spain, Ireland and Portugal. Evidence exists for non-linear effects. The coefficient on the output gap is positive.

Ghosh et al. (2013)	23 advanced countries 1970 – 2007	Panel models with fixed effects	Strong evidence for fiscal fatigue hypothesis, the coefficients on lagged debt and cubic functional forms are negative and significant while squared lagged debt with a positive coefficient. The coefficient on the output gap has a positive sign, indicating a countercyclical policy.
Reicher (2013)	20 industrialized countries The data starts in various years end in 2007	OLS	A positive response of primary surplus to increases in debt is reported. Primary surplus positively reacts to the output in almost all countries. Tax revenues (government purchases) are procyclical (acyclical).
Zdravkovic et al. (2013)	21 CESEE countries, 1995 – 2012	Fixed effect, pooled, and GMM.	A non-linear relationship, fiscal fatigue, is detected. Both lagged debt and output gap are positively associated with primary balance.
Weichenrieder and Zimmer (2014)	17 Euro-area countries, 1970 – 2011	Panel models	A positive response of the primary surplus to increases in debt. The coefficient on the output deviation is positive.
Egert (2014)	OECD countries, 1970 – 2008	Least Square Dummy Variable and GMM	Fiscal balances respond positively to increases in debt. Evidence presented for asymmetric and non-linear effects. Differences detected when disaggregated revenue and spending data are used. Total and primary balances are countercyclical.
Berti et al. (2016)	13 European Union countries, 12 Central and Eastern European (CEE) countries, 1950 – 2013, Mid 1990s – 2013, respectively.	Cointegration for 13 countries and Panel models (GMM, Pooled OLS and Fixed Effects) for CEE Countries	Fiscal policy positively reacts to increasing debt ratio in the most countries. Some countries have a potential risk of experiencing fiscal fatigue. The coefficient on the output gap is statistically insignificant for CEE countries.
Baldi and Staehr (2016)	European Union, 2000 – 2014	Two-stage instrumental variables with fixed effects	A significant and positive response of primary budget to debt is found for full sample but not Euro area and CEE countries. However, fiscal policy has reacted to debt stock more strongly after the last global crisis. Primary balance is countercyclical in full sample and Euro are but a-cyclical in Central and Eastern European countries.
Checherita-Westphal and Žďárek (2017)	Euro area countries, 1970 – 2013	IV, Fixed effect, GMM	Primary balance positively reacts to increases in debt. The output gap (growth rate) coefficient is insignificant (significant). No evidence for nonlinear fiscal fatigue hypothesis.
Fournier and Fall (2017)	31 oecd countries 1985 – 2013	Panel models	Primary balance rises in a response to increases in debt. However, fiscal fatigue is detected at high debt ratios. Fiscal policy is countercyclical.
Everaert and Jansen (2018)	21 OECD countries 1970 – 2014	Fixed effect, Prais- Winsten Generalized Least Square, Mean Group	The response of debt is hetereogenous across countries and fiscal fatigue is a result of imposing homegenity. Fiscal policy is countercyclical. However, evidence exists for asymmetric cyclical behavior.
Icaza (2018)	Eurozone, 1980 – 2013	OLS and GMM	No clear-cut evidence for fiscal fatigue. Primary balance significantly reacts to only negative output gap.
Bökemeier and Stoian (2018)	10 CEE countries 1998 – 2015	IV and Limited Information Maximum Likelihood	Primary surplus is positively associated with increases in debt. There is no robust evidence for fiscal fatigue hypothesis. Primary surplus does not react to the cycle.
Small et al. (2020)	53 developing countries 1990 – 2017	GMM	The response of primary balance and tax revenue to increases in debt is positive while that of primary expenditure is negative. Fiscal policy, in terms of primary balance and tax revenue, is countercyclical. Nonlinear effects are reported. There is a difference between low and high middle-income countries regarding their fiscal response to debt.

Source: Compiled by authors.

However, in a seminal contribution to the literature Bohn (1998) criticizes these approaches and suggests a more simple but intuitive model-based sustainability test. Under some assumptions, Bohn (1998) demonstrates that the sufficient condition for public debt sustainability is the positive response of primary surplus to increases in public debt, both as a share of GDP. This approach has some well-known advantages over conventional sustainability tests based on the univarite time series properties of the variables such as it does not require any knowledge on the discount factor, distribution and maturity of debt structure or debt management policies (Mendoza and Ostry, 2008; Mahdavi, 2014).

On the other hand, more recent studies, such as Daniel and Shiamptanis (2013) and Weichenrieder and Zimmer (2014), argue that a mere positive response of primary surplus to debt might not be sufficient if primary surplus has an upper bound. This is related to fiscal limit concept defined as the maximum primary surplus a government would afford due to economic and political considerations in Leeper (2013). In an important contribution to the literature, Ghosh et al. (2013) highlight the idea that at sufficiently high level of public debt, it is impossible to increase the primary surplus any more. In other words, there exists a limit, i.e. GDP, which primary surplus could not exceed. This implies that after a high level of public debt fiscal policy could not keep up with increasing interest payments and eventually exhibits fiscal fatigue. This approach suggests that the sustainability requries the response of primary surplus to debt ratio be sufficiently strong, i.e. more than interest growth differential. Thus, fiscal fatigue approach predicts a non-linear relationship, differing from the one already discussed in Bohn (1998), between primary surplus and public debt. For example, for a cubic specification, there exists no or slightly negative relationship between these two variables at low levels of debt, as debt increases this relationship turns to positive, and finally the response of primary surplus weakens and even decreases after reaching a high level of debt.

Some studies lend empirical evidence for fiscal fatigue hypothesis (Ghosh et al., 2013; Berti et al., 2016; Fournier and Fall, 2017; Zdravkovic et al., 2013). However, some other studies, such as Checherita-Westphal and Ždárek (2017), Evearet and Jansen (2018), Icaza (2018), and Bökemeier and Stoian (2018), present the evidence against this hypothesis and empirically cast doubts on its validity. Furthermore, contrary to fiscal fatigue hypothesis, Bohn (1998) reports that the response of primary balance to debt-GDP ratio is stronger when the debt is higher in the US.

Other than the quadratic or cubic functional forms, another way of detecting the non-linearity is to use the spline and threshold regressions (Mendoza and Ostry, 2008; Small et al., 2020). This approach makes a distinction between low

and high debt ratios. This stems from the idea that the reponse of budget balance to debt is not monotonic and is likely to vary by debt level. Some studies report evidence for a non-linear relationship between budget balance and public debt (Mendoza and Ostry, 2008; Egert, 2014; Small et al., 2020; Lukkezen and Rojas-Romagosa, 2012). Additionally, Lukkezen and Rojas-Romagosa (2012) conclude that the primary balance in the US gives a positive response to debt when the debt is above historical means while the opposite is valid for Spain and Portugal.

Although the main focus of this study is to investigate the response of primary balance, government expenditure and revenue to the public debt, fiscal reaction functions are very helpful in explaining the cyclical reaction of fiscal policy. Therefore, we briefly discuss this issue as well. Motivated by tax smoothing model of Barro (1979), Bohn (1998) also expilicitly pays attention to the temporary or cyclical fluctuations in government expenditures and output, called the expenditure and output gaps in the literature. In this context, a variable representing the economic cycle, such as growth rate or output gap, is incorporated to the fiscal reaction functions, following Bohn (1998) and Gali and Perotti (2003). Estimating fiscal reaction functions, many studies suggest that fiscal policy is countercyclical in European and OECD countries (Afonso and Jalles 2011; Egert, 2014; Fournier and Fall, 2017; Everaert and Jansen, 2018; Baldi and Stachr, 2016). However, some studies, such as Golinelli and Momigliano (2009), Berti et al. (2016), Checherita-Westphal and Ždárek (2017), Bökemeier and Stoian (2018), report a pro-cylical policy or an insignificant response of fiscal policy to the cycle. Moreover, Mendoza and Ostry (2008) find that fiscal policy gives a stronger response to the cycle in industrial countries rather than in emerging market countries. On the other hand, Staehr (2008) suggests that fiscal balance is more countercyclical in CEE countries than Eurozone countries.

As highlighted by Golinelli and Momigliano (2009) in a comprehensive study, the use of different time periods, model specifications, selected variables, country samples and econometric estimation methods lead to different even conflicting results. However, we should keep in mind that this issue is not limited to only this subject in economics.

2. Method and Data

Within the scope of our study, that is to estimate fiscal reaction functions for 95 countries in total, consists of 64 developing and 31 developed ones, over the period 2000 – 2018, we build up 3 threshold models which vary with regard to the dependent variables.[1] The data availability dictates our sample countries and

[1] List of countries is available from the authors upon request.

periods. The regarding models analyze the response of the primary surplus, government expenditure, and government revenue to the public debt. Following the literature other than the growth rate (gr), we include the current account balance (cab) and inflation rate as controls in our specifications. Each 3 models are estimated for developed and developing economies in addition to all sample. Furthermore, we also derive estimations based on a periodical classification considering pre- and post- crisis era. In this framework, the definition of the set of variables in question and data sources are outlined in Table 2.

T a b l e 2

The Overview of Data

Series	Definition	Source
Pbalance	General government primary net lending/borrowing (percent of GDP)	IMF World Economic Outlook Databases (2019)
Gexpenditure	General government total expenditure (percent of GDP)	IMF World Economic Outlook Databases (2019)
Grevenue	General government revenue (percent of GDP)	IMF World Economic Outlook Databases (2019)
Gdebt	General government gross debt (percent of GDP)	IMF World Economic Outlook Databases (2019)
Cab	Current account balance (percent of GDP)	IMF World Economic Outlook Databases (2019)
Gr	Gross domestic product, constant prices (percent change)	IMF World Economic Outlook Databases (2019)
Inflation	Inflation, average consumer prices (index)	IMF World Economic Outlook Databases (2019)

Source: Compiled by the authors.

Hansen (1999) developed a non-dynamic threshold model, that splits the regression into regimes. This static model enables the distinction of the impact below and above the estimated threshold levels. However, this procedure could not take into account the potential endogeneity problem between dependent and independent variables. On the other hand, Caner and Hansen (2004) proposed a model that extends the model of Hansen (1999) model by means of instrumental variable approach for cross sectional data eliminating the endogeneity bias. Considering the methodological priorities of dynamic panel threshold model in that it attaches panel approach to the instrumental and cross sectional model of Caner and Hansen (2004), we employ Kremer et al. (2013) approach to examine the nonlinear influences in the estimation of fiscal reaction function in the following form:

$$y_{it} = \mu_i + \beta_1' q_{it} I\left(q_{it} \le \gamma\right) + \delta_1 I\left(q_{it} \le \gamma\right) + \beta_2' q_{it} I\left(q_{it} > \gamma\right) + \phi x_{it} + \varepsilon_{it} \qquad (1)$$

In equation (1), $i = 1,\ldots, N$ denotes countries while $t = 1,\ldots, T$ represents the time dimension. y_{it} is the dependent variable which is determined as *pbalance, gexpenditure, and grevenue*, respectively in the framework of specified 3 models.

μ_i denotes the individual fixed effects that are eliminated with forward orthogonal transformation as proposed by Kremer et al. (2013). x_{it} is the vector of regime-independent exogeneous variables, that are *gr, inflation, and cab* and the endogeneous variables which is taken as the lagged values of the dependent variable following Kremer et al. (2013). The vector of explanatory regressors is divided into a subset x_{1it} of exogenous variables uncorrelated with ε_{it}, and a subset of endogeneous variables x_{2it}, correlated with ε_{it}. $I(.)$ is the indicator function that specifies the regimes. q_{it} represents both the threshold variable and regime dependent regressor, *gdebt*, that splits the sample into two regimes, below and above the unknown level of the threshold parameter, γ β_1 and β_2 indicate the regime-dependent slope coefficients while δ_1 represents the fixed regime coefficient. ε_{it} is the error term that is independently and identically distributed.

As the first part of the methodology to reach the dynamic panel threshold regression in (1), the model removes the individual effects via forward orthogonal transformation suggested by Arellano and Bover (1995) and thereby the serial correlation of the transformed errors is avoided. Afterwards, the procedure follows three steps briefly including, i) the estimation of the reduced form regression of the endogeneous variables as a function of instruments, that are the lags of dependent variable in accordance with Caner and Hansen (2004), ii) the determination of threshold parameter by following Hansen (1999) and Caner and Hansen (2004), iii) the estimation of the slope coefficients via Generalized Method of Moments (GMM) procedure. Prior to the presentation of empirical results in the following part, the descriptive statistics of the series are presented in Table 3.

T a b l e 3

Descriptive Statistics

	Full Sample		**Developing countries**		**Developed Countries**	
Series	*Mean*	*Standard deviation*	*Mean*	*Standard deviation*	*Mean*	*Standard deviation*
Pbalance	0.121	5.679	0.243	6.430	-0.134	3.662
Gexpenditure	31.216	12.142	25.826	9.994	42.344	7.863
Grevenue	29.788	12.676	24.475	11.001	40.757	8.006
Gdebt	50.956	34.536	45.194	28.211	62.852	42.479
Cab	2.893	41.648	4.051	50.542	0.504	5.915
Gr	3.825	3.954	4.607	4.083	2.211	3.106
Inflation	5.743	8.305	7.571	9.515	1.971	1.839

Source: Compiled by the authors.

3. Empirical Results and Discussion

Column 1 in Table 4 indicates that the coefficient on the public debt is insignificant both below and above the threshold (33.70 percent) value, suggesting the absence of a threshold effect for full sample. On the other hand, the primary

surplus positively reacts to the growth rate, implying a countercyclical fiscal policy, consistent with some previous results such as Everaert and Jansen (2018) and Small et al. (2020). Moreover, primary balance gives a positive reponse to an increase in the current account balance, supporting the argument that an increase in current account is associated with an improvement in the budget balance (Magazzino, 2020; Marinheiro, 2008). We also find that inflation rate leads to an increase in the primary balance, indicating a restraining role of fiscal policy for the aggregate demand to combat the inflation rate.

T a b l e 4

Fiscal Policy Reaction Functions (Dep. Var.: Primary balance)

	Full sample	**Developing countries**	**Developed countries**
Threshold Estimate (%)	% 33.69	38.54	81.60
Impact of public debt			
Regime 1: $\hat{\beta}_1$	–0.0039 (0.032)	0.48270*** (0.111)	–0.0895*** (0.015)
Regime 2: $\hat{\beta}_2$	–0.0041 (0.005)	–0.0019 (0.006)	0.0307*** (0.011)
Impact of covariates			
Endgn	–0.0084 (0.015)	0.0431 (0.017)	–0.1901** (0.088)
Gr	0.2228*** (0.036)	0.1391*** (0.041)	0.3841*** (0.046)
Cab	0.0554* (0.030)	0.0612** (0.026)	0.2182** (0.046)
Inflation	0.0291* (0.016)	0.0196 (0.015)	0.1239 (0.088)
$\hat{\delta}$	1.3890 (0.997)	1.6992 (1.361)	9.269*** (1.409)
Observations	1 900	1 280	620
Number of countries	95	64	31

Notes: i) *,** and *** indicate the significance at 10%, 5% and 1% level, respectively. ii) Either regime contains at least 5% of all observations in accordance with Hansen (1999). iii) Feasible inflation thresholds are valid for the estimations, thus between %95 confidence intervals. iv) Standard errors are given in parentheses. v) The variable *endgn* denotes the endogeneous variable specified as the lagged of the dependent variable following Kremer et al. (2013).

Source: Authors' estimation.

Having examined the impact of public debt on the primary surplus for full sample, we now turn to make a distinction between the developing and developed countries. In other words, we test whether the effects of public debt on the primary balance vary by development level. When the public debt is below the thresold level (38.5 percent), the coefficient on the primary balance is positive and significant, implying the sustainability of public debt for developing countries (column 2 in Table 4). However, there is no significant effect of public debt on the primary balance when the public debt is higher than the estimated threshold level. This indicates that governments implement a sustainable fiscal policy until reaching the threshold level, but beyond this level primary balance does not react to changes in public debt, supporting the arguments of fiscal fatigue hypothesis put forward in some studies, such as Ghosh et al. (2013) and Berti et al. (2016). Since sustainability matters more when the public debt is higher, in our

opinion, these results strongly indicate a need to change in the fiscal policy for developing countries.

For developed countries, we obtain very different results. Estimated threshold level (81.60 percent) is higher, as expected. Besides other factors, developing countries could more easily access to financial funds and borrow. It seems that primary balance gives a negative (positive) response to an increase in the public debt when the debt is lower (higher) than the threshold level. Unlike the predictions of fiscal fatigue hypothesis, a positive coefficient on the public debt suggests that the sustainability condition is met in developed countries when the public debt exceeds the threshold, in line with the idea of Bohn (1998). Our results for developed countries are similar to that of other studies (see, among others, Mendoza and Ostry, 2008; Egert, 2014; Lukkezen and Rojas-Romagosa, 2012; Icaza, 2018; Bökemeier and Stoian, 2018). Therefore, it is possible to interpret our empirical results as lending evidence for fiscal fatigue hypothesis for developing but not developed countries despite documenting the non-monotonic relationship in both groups of countries. Although our main interest is to uncover the relationship between the primary balance and public debt, note that fiscal policy seems to be countercyclical both in developed and developing countries, consistent with the results reported in many studies such as Afonso and Jalles (2011), Egert (2014), Checherita-Westphal and Ždárek (2017), Fournier and Fall (2017), and Small et al. (2020).

To gain additional insights, we also investigate the response of government expenditure and revenues to the public debt and report the results in Tables 5 and 6 respectively. When the public debt is lower than the threshold (53.5 percent) an increase in the public debt positively and significantly affects the government expenditure for full sample. However, when the public debt is beyond the threshold, then its impact becomes insignificant. For developing countries, when the public debt is lower (higher) than the threshold level (50.81 percent), we find that government expenditures increase (decrease) as a response to a rise in the public debt. This clearly indicates a non-monotonic impact of public debt on the government expenditures. Interestingly, government expenditures increase when the public debt is both lower and higher than the threshold (81.50 percent) for developed countries. Unlike the case for developing countries, it seems that when public debt increases governments in developed countries do not take steps to cut the expenditures. Nonetheless, the coefficient on the public debt becomes smaller beyond the threshold. We also should note that an increase in the growth rate is associated with a decline in government expenditure. This points to the implementation of a countercyclical policy regarding the government expenditure in all specifications, supporting the evidence presented in Staehr (2008).

T a b l e 5

Fiscal Policy Reaction Functions (Dep. Var.: Gov. expenditure)

	Full sample	**Developing countries**	**Developed countries**
Threshold Estimate (%)	% 53.08	50.81	73.61
Impact of public debt			
Regime 1: $\hat{\beta}_1$	0.0336** (0.014)	0.0333** (0.016)	0.0778*** (0.013)
Regime 2: $\hat{\beta}_2$	0.0007 (0.008)	–0.0207** (0.010)	0.0339*** (0.011)
Impact of covariates			
Endgn	0.0351*** (0.006)	0.0500*** (0.009)	–0.0161** (0.006)
Gr	–0.2099*** (0.033)	–0.1143*** (0.041)	–0.4915*** (0.058)
Cab	0.0501** (0.022)	–0.0292 (0.022)	–0.1578** (0.097)
Inflation	–0.059*** (0012)	–0.0584*** (0.011)	–0.2139*** (0.041)
$\hat{\delta}$	–0.1731 (0.863)	–0.8463 (1.009))	–4.6504*** (1.085)
Observations	1 900	1 280	620
Number of countries	95	64	31

Notes: See the notes in Table 4.

Source: Authors' estimation.

Column 1 in Table 6 indicates that an increase in public debt up to threhsold level (55.23 percent) leads to a decline in the government revenue for full sample. However, after this level, the impact of public debt on the government revenue becomes insignificant. Similarly, an increase in the public debt above the threshold (50.02 percent) leads to a decline in the government revenue for developing countries. In a sense, this finding supports the implications of fiscal fatigue hypothesis and might be arising from the possible harmful effects of high public debt on economic decisions other than the growth effects we already control. We think that the negative revenue effects of public debt would be more pronuanced in developing countries due to many reasons, for instance structural problems. On the other hand, it seems that when the public debt is above the threshold (58.30 percent), an increase in the public debt leads an increase in the government revenue for developed countries. This indicates that governments in developed countries take a corrective action when the debt exceeds the threshold. Moreover, the government revenue could be the driving factor for the sustainability result obtained using primary balance as a proxy for fiscal stance in developed countries above. A higher coefficient on the public debt and a lower threshold level when we employ the government revenue instead of government expenditure as the dependent variable reinforce this interpretation. More importantly, as for cyclicality of government revenue, we detect an important difference between developed and developing countries. Government revenue displays a procyclical (acyclial) behaviour in developed (developing) countries, a similar result reported for industrialized countries regarding the tax revenues by Reicher (2013).

T a b l e 6

Fiscal Policy Reaction Functions (Dep. Var.: Government revenue)

	Full sample	**Developing countries**	**Developed countries**
Threshold Estimate (%)	% 55.23	50.04	58.39
Impact of public debt			
Regime 1: $\hat{\beta}_1$	–0.048*** (0.012)	–0.0207 (0.051)	–0.0011 (0.005)
Regime 2: $\hat{\beta}_2$	–0.0091 (0008)	–0.0574*** (0.008)	0.0652*** (0.007)
Impact of covariates			
Endgn	0.0317*** (0.005)	0.0271*** (0.008)	0.0038 (0.009)
Gr	0.0465 (0.039)	0.0805 (0.053)	–0.0688** (0.031)
Cab	0.0361*** (0.009)	0.0358*** (0.009)	–0.024*** (0.025)
Inflation	–0.0281 (0.023)	–0.0143 (0.024)	–0.1169** (0.053)
$\hat{\delta}$	3.6914*** (0.936)	0.8097 (0.913)	6.0188*** (0.906)
Observations	1 900	1 280	620
Number of countries	95	64	31

Notes: See the notes in Table 4.

Source: Authors' estimation.

Finally, we also test whether there is a change in the response of the primary balance, government expenditure, and revenue to the public debt before and after the last global financial crisis, which largely started in 2008 in the US and deeply affected many countries around the world. Accordingly, we divide our sample as pre- and post-crisis periods, 2000 – 2008 and 2010 – 2018, respectively.[2]

In the pre-crisis period, when the public debt exceeds the estimated threshold level (30.80 percent), the primary balance declines as a response to an increase in the public debt, indicating the unsustainability of fiscal policy. In the post-crisis period, the primary balance gives a negative response to an increase in the public debt when the public debt is lower than the threshold level (58.8 percent). Despite some differences in the pre- and post-crisis periods, fiscal policy does not seem to be sustainable in either periods. More interesting is to note that in the pre-crisis (post-crisis) period the primary balance is acyclical (countercyclical).

In the pre-crisis period there is no relation between the public debt and government expenditure, column 2 in Table 7.

However, in the post-crisis period the government expenditure positively reacts to an increase in public debt when the public debt is lower than the threshold level (53.84 percent). Additionally, we don't detect a remarkable difference regarding the cyclical behaviour of government expenditure in the pre- and post-crisis periods.

[2] To avoid the structural break problem, we exclude 2009. Additionally, it is not clear whether 2009 should be included in the pre- or post-crises period.

In the pre-crisis period, an increase in public debt is associated with a rise (decline) in government revenue when the public debt is lower (higher) than the threshold level (53.34). Contrary to the pre-crisis period, an increase in public debt is associated with a decline (rise) in government revenue when the public debt is lower (higher) than the threshold level (69.03 percent). This explicitly demonstrates both the importance of threshold specification to capture the exact relationship and the existence of a striking difference between pre- and post-crisis periods. Another crucial difference between the two periods is the change in the cyclical behaviour of government revenue. In the pre- (post-) crisis period, government revenue is negatively (positively) associated with the growth rate, suggesting a procyclical (countercyclical) policy. Moreover, we think that this change probably drives the result regarding the cyclicality of primary balance discussed above.

Finally, we could not distinguish between developing and developed countries in pre- and post-crisis periods due to insufficient number of observations to carry out robust dynamic threshold estimations. Therefore, a caveat is in order when interpreting our results.

T a b l e 7

Fiscal Policy Reaction Functions for the Pre- and Post-crisis Periods

	Pre-crisis (2000 – 2008)			**Post-Crisis (2010 – 2018)**		
	Dependent Variable					
	Prim. bal.	*Gov. exp.*	*Gov. rev.*	*Prim. bal.*	*Gov. exp.*	*Gov. rev.*
Threshold Estimate (%)	30.75	38.02	53.34	33.84	53.84	69.03
Impact of public debt						
Regime 1: $\hat{\beta}_1$	–0.0638	0.0543	0.0902*	–0.379***	0.068***	–0.097***
	(0.079)	(0.071)	(0.089)	(0.121)	(0.024)	(0.018)
Regime 2: $\hat{\beta}_2$	–0.054***	–0.004	–0.06***	0.0044	0.0283	0.0394**
	(0.013)	(0.007)	(0.014)	(0.013)	(0.024)	(0.019)
Impact of covariates						
Endgn	–0.0701**	0.0043	0.0428***	–0.049***	–0.026***	–0.0222***
	(0.035)	(0.006)	(0.006)	(0.016)	(0.006)	(0.005)
Gr	0.0514	–0.161***	–0.0980*	0.183***	–0.078***	0.1411***
	(0.063)	(0.047)	(0.060)	(0.057)	(0.058)	(0.052)
Cab	–0.0031	–0.0051	0.0037	0.3439***	–0.150***	0.1086***
	(0.041)	(0.015)	(0.019)	(0.039)	(0.041)	(0.022)
Inflation	0.0159	–0.0283*	–0.0021	0.0327	–0.135***	–0.0921***
	(0.026)	(0.019)	(0.019)	(0.026)	(0.029)	(0.034)
δ	0.0210	–1.3729	–1.4788	6.162***	0.2545	10.836***
	(0.024)	(1.467)	(1.775)	(1.365)	(1.799)	(1.993)
Obs.	855	855	855	855	855	855
Number of countries	95	95	95	95	95	95

Notes: See the notes in Table 4.

Source: Authors' estimation.

Conclusion

Using the dynamic threshold regression method developed by Kremer et al. (2013), this paper examines the response of the primary surplus, government expenditure and government revenue to public debt for a large sample of developing and developed countries. We find that the primary balance does not react to changes in the public debt for full sample. On the other hand, there exists some evidence for the threshold effect for developing and developed countries. Governments implement a sustainable fiscal policy until reaching the threshold level, but beyond this level primary balance does not react to changes in public debt, supporting the arguments of fiscal fatigue hypothesis in developing countries. For developed countries, it seems that primary balance gives a negative (positive) response to an increase in the public debt when the debt is lower (higher) than the threshold level. Unlike the predictions of fiscal fatigue hypothesis, a positive coefficient on the public debt suggests that the sustainability condition is met in developed countries when the public debt exceeds the threshold, lending evidence for the argument in Bohn (1998). Additionally, the primary balance seems to be countercyclical in full sample, developed, and developing countries.

To gain additional insights, we also investigate the reaction of the government expenditure and revenues. Our results indicate that unlike the case for developing countries, when the public debt increases governments in developed countries do not take steps to cut the expenditures. Moreover, we present a strong evidence for the countercyclical policy regarding the government expenditure in all specifications. Furthermore, an increase in the public debt above the threshold leads to a decline in the government revenue for developing countries. In a sense, this finding supports the implications of fiscal fatigue hypothesis. On the other hand, it seems that when the public debt is above the threshold, an increase in the public debt leads an increase in the government revenue for developed countries. More importantly, government revenue displays a procyclical (acyclial) behaviour in developed (developing) countries, an interesting result.

We also test whether there is a change in the repsonse of fiscal policy to the public debt in the pre- and post-crisis periods. Despite some differences, fiscal policy does not seem to be sustainable in either case. However, the primary balance has changed from acyclical in the pre-crisis period to countercyclical in the post-crisis period. We also report a significant change in the response of government revenue to the public debt and economic growth in pre- and post-crisis periods. Contrary to the pre-crisis period, an increase in public debt is associated with a decline (rise) in government revenue when the public debt is below (above) the threshold level in the post-crisis period. Additionally, in the

pre-crisis period government revenue is procyclical while it becomes counter-cyclical in the post-crisis period.

It is worth highlighting some points. First, it is important to focus on the threshold or non-linear effects in a dynamic setting when examining the relationship between the fiscal policy and public debt. Therefore, our results cast some doubts on the some previous results mainly rely on linear and even static specifications. Second, distinguishing between the developed and developing countries is crucial. For instance, we interpret our empirical results as lending evidence for fiscal fatigue hypothesis for developing but not developed countries despite documenting the non-monotonic relationship in both cases. Third, a change in fiscal policy would be helpful for developing countries to ensure the sustainability. Fourth, investigating the response of government expenditure and revenue provides additional and important insights to better grasp the dynamics of fiscal policy, such as the differences in the cyclical reponses of government revenue and expenditure. It seems that governments in developed countries should take necessary steps to change the procyclical behaviour of government revenue with respect to economic growth rate. Fifth, there are some changes in fiscal policy after the last global financial crisis but not in terms of sustainability.

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