# Too Much Debt and Budget Deficit on Fiscal Sustainability: Do Institutions Matter?

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***Abstract***: The current study estimates threshold levels of the public debt-to-gross domestic product (GDP) ratio and the budget deficit for 106 developing and 36 developed countries from 1996 to 2018. A PCA-based fiscal sustainability indicator is also constructed and a dynamic panel threshold regression is employed. The main findings reveal a threshold effect in the public debt-to-GDP ratio and budget deficit-fiscal sustainability nexus. The public debt-to-GDP ratio and budget deficit are beneficial in maintaining fiscal sustainability at lower or upper threshold levels in different institutional indicators. The highest threshold level of the public debt-to-GDP ratio was 59.56% for developed countries and 64.87% for developing countries. The highest threshold level of budget deficit-to-GDP ratio was 0.41% for developed countries and 3.34% for developing countries. Three institutional indicators contribute significantly to the threshold estimation: regulatory quality, the rule of law and control of corruption. Policymakers are advised to maintain certain threshold points to ensure a fiscally sustainable level. The quality of law enforcement and control of corruption should also be improved.

Keywords: Fiscal sustainability indicator, public debt, budget deficit, institutions, dynamic panel threshold
JEL classification: E02, E26, E62, H62, H63

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* The current study is supported by research grant from Universitas Sebelas Maret under contract No. 254/UN27.22/PT.01.03/2022.

Article Info: *Received* 19 June 2022; *Revised* 22 November 2022; *Accepted* 8 December 2022
https://doi.org/10.22452/MJES.vol59no2.5

## 1. Introduction

Fiscal sustainability issues bring challenges to policymakers in both developed and developing countries. Owing to the sovereign debt crisis in 2009, policymakers must assess fiscal sustainability indicators and maintain a certain level of public debt-to-gross domestic product (GDP) ratio (Akram & Rath, 2020; Caselli & Wingender, 2021; Lau & Lee, 2018). The accumulation of a significant public debt-to-GDP ratio suppresses the economy through several channels, including higher long-term interest rates, higher taxation, stronger uncertainty and vulnerability to crises (Baharumshah et al., 2017; DiPeitro & Anoruo, 2012). Scholars also reveal that a certain level of public debt significantly impacts fiscal sustainability (Baharumshah et al., 2017; Tran, 2018).

There is no single best definition or assessment for fiscal sustainability. Fiscal sustainability is characterised by the European Commission (2017, p. 1) as 'public finance sustainability is the ability of a government to sustain its current spending, tax and other policies in the long-run without threatening the government's solvency or without defaulting on some of the government's liabilities of promised expenditure'.

Krejdl (2006) provided another definition, suggesting that fiscal sustainability underlines long-term fiscal policy without resulting in enormous debt accumulation. The primary gap and recursive algorithm indicators are employed to assess fiscal sustainability (Asava-vallobh et al., 2018; Cruz-Rodriguez, 2014; Lau & Lee, 2021; Nxumalo & Hlophe, 2018; Uryszek, 2016). These two indicators highlight the significance of the public debt-to-GDP ratio in determining fiscal sustainability. The International Monetary Fund (IMF) reports in the *World Economic Outlook* that the lack of overall government debt-to-GDP ratio of developed countries, such as Japan, the United States and several European countries, has soared to more than 100% in recent decades. A high level of government expenditure suggests a high level of public debt accumulation and budget deficit. Certain levels of public debt and the budget deficit can contribute significantly to fiscal sustainability.

The current study notes that a fiscally sustainable level delivers some advantages, such as maintaining sustainable economic growth and destabilising high debt accumulation (Akram & Rath, 2020), thereby maintaining a country's macroeconomic stability and financial capacity (Dornean & Oanea, 2015). Therefore, the government should have no incentive to default on its debt (Chen, 2014) or maintain the future of primary surplus, and the debt growth to be lower than the interest rate (Chalk & Hemming, 2000). A fiscally unsustainable level can result in some disadvantages, including low economic growth, a high budget deficit and the default of public debt (Berrittella & Zhang, 2015), and budget (tax) burden (Balassone & Franco, 2000). Therefore, the government should trim the deficit level when it exceeds a certain level (Baharumshah et al., 2017).

Many previous studies discuss public debt level, but Apergis (1998) and Bajo-Rubio et al. (2006) emphasised the budget deficit level, which significantly impacts the economy through several channels such as domestic interest rate, investment, trade deficit and public finance. Although there have been many empirical studies on public debt and budget deficit, only a handful estimate the impact of threshold levels of public debt-to-GDP ratio and budget deficit on fiscal sustainability. Thus, the current

study estimates threshold levels of public debt-to-GDP ratio and budget deficit on fiscal sustainability by considering institutional indicators. Policymakers use a threshold approach in determining a certain level of public debt-to-GDP ratio and budget deficit. The impacts of more precise findings regarding threshold levels of public debt-to-GDP ratio and the budget deficit can benefit policymakers in ensuring a fiscally sustainable level.

The threshold level of public debt can be defined as an increment in the debt-to-GDP ratio, which signifies the level of well-being and consumption and impacts wealth distribution (Aiyagari & McGrattan, 1998; Barro, 1979). Increasing the budget deficit-to-GDP ratio implies issuing interest-bearing debt, debt accumulation and inflation (Buiter, 1983). Specifically, Tran (2018) evaluated the threshold effect of the public debt-to-GDP ratio for assessing fiscal sustainability in 14 emerging economies from 1999 to 2016. The author highlights several findings, including that Latin-American economies have higher debt stocks and a faster debt growth rate. The debt threshold for Latin-American countries (around 35% of GDP) is much smaller than that of other countries (40% to 55% of GDP) and the entire sample (38.0% to 59% of GDP). This finding does not highlight the significance of institutional indicators. Another empirical study published by Ali and Ahmed (2017) evaluates public debt accumulation in 17 MENA countries between 1996 and 2015 by considering institutional indicators. The finding reveals that poor governance leads to an increase in the public debt-to-GDP ratio. Moreover, Bajo-Rubio et al. (2006) found that approximately 5.30% threshold effect of the budget deficit-to-GDP ratio has consequences on the non-linearity of fiscal policy in Spain from 1964 to 2003 and 1982:1–2004:1.

This study contributes to the literature on constructing new fiscal sustainability indicators by incorporating shadow economy using principal component analysis (PCA). The new indicator can be considered a PCA-based fiscal sustainability indicator; PCA has been elaborated on by Jollife (2002). Schneider and Williams (2013) proposed the definition of the shadow economy as the market-based production of goods and services, whether legal or illegal, that escapes detection in the official estimates of GDP. The shadow economy can affect the level of fiscal policy for both the government revenue and expenditure (Arrazola, et al., 2011). Yereli et al. (2007) argued that a larger shadow economy leads to lower tax revenue and greater public expenditure. Consequently, a country that experiences a high-size shadow economy may not obtain sufficient funds to pay the existing public debt (González-Fernández & González-Velasco, 2014). Medina and Schneider (2018) assessed the size of the shadow economy for 158 countries from 1991 to 2015 using multiple indicators multiple causes (MIMIC). The current study selects the size of the shadow economy assessed by Medina and Schneider (2018) to construct a PCA-based fiscal sustainability indicator.

This study seeks to explore a gap in the existing literature by estimating the threshold levels of public debt-to-GDP ratio and budget deficit on fiscal sustainability. The gaps in the literature are drawn in several ways. First, the current study constructs a PCA-based fiscal sustainability indicator. In assessing fiscal sustainability, much previous literature has not used an indicator that includes multiple dimensions to provide a better analysis. The size of the shadow economy is one of the dimensions

for constructing fiscal sustainability indicators. The current study's findings can benefit policymakers in reducing the size of the shadow economy to ensure a fiscally sustainable level. Second, the current study estimates the threshold levels of public debt-to-GDP ratio and budget deficit by determining the quality of institutions, indicating a lack of fiscal literature that can be used to observe the contribution of institutions to fiscal sustainability in a comprehensive framework (Canh, 2018). The institutional indicators are employed according to Ali and Ahmed (2017) and Cooray et al. (2017). Third, the current study selects sufficiently large-scale data to provide robust findings from 106 developing and 36 developed countries with significant public debt-to-GDP ratios in the recent decade. The sample is divided into two groups of countries to demonstrate the appropriate threshold levels between the groups.

The current study uses the dynamic panel threshold regression proposed by Kremer et al. (2013). Hansen's (1999) static panel threshold specification has been extended by Kremer et al. (2013). The dynamic panel threshold method has not been widely used in fiscal sustainability analysis. The method can provide more information and reduce multicollinearity, such as controlling cross-section heterogeneity; hence, the dynamic panel threshold is preferable to the static panel threshold. With this analysis, policymakers can take advantage of maintaining the threshold levels of public debt-to-GDP ratio and budget deficit on fiscal sustainability by enhancing the quality of institutions.

Previous literature has also emphasised the linkage between institutions and fiscal sustainability (Ali & Ahmed, 2017; Bergman et al., 2016; Cooray et al., 2017). Bergman et al. (2016) examined whether national fiscal rules promote sustainable public finances or must be supported by good governance to be effective. They argued that the effect of fiscal rules is smaller when government efficiency increases, indicating that fiscal rules and efficiency are institutional substitutes for promoting fiscal sustainability. Additionally, Cooray et al. (2017) estimated the relationship between corruption, shadow economy and public debt. Their main findings reported that (a) a 1-unit increase in the corruption index of International Transparency leads to a 0.13% increase in the debt-to-GDP ratio; (b) a 1-unit increase in the Kaufmann corruption index leads to a 0.11% increase in the debt-to-GDP ratio. The level of corruption can correct the benefits of public debt on fiscal policy (Halkos, et al., 2020).

The main findings regarding the threshold level of the public debt-to-GDP ratio on PCA-based fiscal sustainability indicators can be illustrated in several ways. First, by considering the regulatory quality, the highest threshold point ($\hat{\lambda}$) of the public debt-to-GDP ratio for developed countries is approximately 59.56%. Moreover, the developing countries faced the highest threshold point ($\hat{\lambda}$) of 64.87%. Second, the findings for developed countries reveal that the highest threshold level of budget deficit-to-GDP ratio is approximately 0.41% under regulatory quality. On the other hand, the highest threshold point of the budget deficit-to-GDP ratio for developing countries is approximately 3.34%.

This paper is organised as follows: the first section covers the introduction, section 2 reviews previous empirical studies and section 3 delves into data and methodology. The empirical findings are presented and discussed in section 4. Section 5 presents the conclusion and policy implications.

## 2. Review of Related Literature

### *2.1 Fiscal Sustainability Indicators and Intertemporal Budget Constraints*

Fiscal sustainability can be assessed using the concept of intertemporal budget constraint (IBC). This concept analyses public debt and primary balance (Akram & Rath, 2020; Magazzino et al., 2019; Paniagua et al., 2017). The IBC is formulated to explain the linkage between public debt ($B_t$) and primary deficit ($G_t - T_t$ or $E_t - R_t$) as $B_t = (G_t - T_t) + (1 + r_t)B_{t-1}$ or $B_t = (E_t - R_t) + (1 + r_t)B_{t-1}$. G or E denotes government expenditure excluding interest payment, while $B_{t-1}$ equals previous public debt. Thus, the IBC (current public debt) is determined by the primary deficit plus previous public debt multiplied by the interest payment ($r_t$).

The IBC can be derived to construct the primary gap indicator employed by Uryszek (2016) and Nxumalo and Hlophe (2018), resulting in the following:

$$d + (r - \theta)b_0$$

The primary gap equation illustrates that the primary gap indicator is determined by the primary deficit-to-GDP ratio (d) plus the difference between the real interest rate (r) and real growth rate (θ) multiplied by the current public debt-to-GDP ratio ($b_0$). In particular, it depicts the short-run primary gap indicator. A higher value (positive) of the primary gap indicator denotes a fiscally unsustainable level, while a lower value (negative) indicates a fiscally sustainable level.

Cruz-Rodriguez (2014), Asava-vallobh et al. (2018) and Lau and Lee (2021) noted that the IBC can also be used to formulate recursive algorithm as follows:

$$FSI_t = (\beta_t - \lambda_t) = \left[ \frac{1 + r_t}{1 + g_t} - \frac{ps - ps^*}{d_{t-1} - d^*} \right]$$

The recursive algorithm equation expresses that the fiscal sustainability indicator (FSI) can be determined by the policy reaction parameter ($\beta_t - \lambda_t$). The recursive algorithm can be assessed by real interest rate (r) and real growth rate (g) minus the difference between ps and ps* and by the difference between $d_{t-1}$ and d*. ps is current primary surplus-to-GDP ratio, while ps* is targeted primary surplus-to-GDP ratio. $d_{t-1}$ equals previous public debt-to-GDP ratio, while d* denotes targeted public debt-to-GDP ratio. A higher value (≥1) of the recursive algorithm indicates a fiscally unsustainable level, while a lower value (<1) denotes a fiscally sustainable level.

### *2.2 Optimal Levels of Public Debt and Budget Deficit*

Panel threshold regression has been applied to fiscal sustainability in previous studies. The static panel threshold regression to examine public debt-to-GDP has been employed for 14 emerging economies from 1999 to 2016 (Tran, 2018). Tran's findings showed that Latin-American economies receive a negative impact from higher debt stocks and faster debt growth rates, while Brazil and Venezuela are countries with a significant risk level of public debt. The debt threshold for Latin-American countries is approximately 35% of GDP. The current study estimates the threshold levels of public debt-to-GDP ratio and budget deficit using a larger sample size of 106 developing

countries and 36 developed countries from 1996 to 2018. Furthermore, the current study uses dynamic instead of static panel threshold regression with three FSIs: the primary gap, recursive algorithm and PCA-based FSI. The PCA-based fiscal sustainability indicator provides a more precise estimation than Tran's (2018).

In addition to using static and dynamic panel threshold regression, the threshold level of public debt can also be estimated using other methods. Previous studies have applied different methods to examine public debt thresholds, such as dynamic macroeconomic of optimal public debt structure in developing countries (Ansah & Qureshi, 2013), linear and non-linear models under growth-maximising of public debt in developed countries (Checherita-Westphal et al., 2014) and non-linearity of optimal public debt in Sub-Saharan African countries (Megersa, 2015). Ansah and Qureshi (2013) argued that sealing debt fixing (debt relief) increases the debtor country's significant investment, a higher investment increases the capacity to pay a future debt and funding public investment through borrowing produces the highest debt-GDP ratio. The subsequent findings published by Checherita-Westphal et al. (2014) showed that the target debt level for 47 countries between 1960 and 2010 (15% lower than the OECD estimate for the growth-maximising debt ratio) of GDP for the common target is around 50%. Furthermore, the debt sustainability threshold should be lower for developing countries than developed ones (Megersa, 2015). The threshold levels of public debt in certain countries have been examined by previous literature, such as Adamo et al. (2004), who examined the optimal issue of public debt in Italy. Yuan-Hong and Chiung-Ju (2015) estimated the optimal level of public debt in Taiwan, and Omotosho et al. (2016) employed the non-linearity threshold model of optimal public debt in Nigeria. Finally, Nakajima and Takahashi (2017) determined the optimal level of public debt in Japan.

The current study estimates the public debt and budget deficit thresholds. Previous empirical studies by for example, Bajo-Rubio et al. (2006) have estimated the long-run sustainability of Spain's budget deficits and non-linear fiscal policy from 1964 to 2003 and 1982: 1−2004: 1. Their findings show that the budget deficit should not exceed 5.30%. The current study seeks to extend the previous study by using dynamic panel threshold estimation of the public debt-to-GDP ratio and budget deficit and incorporating the institutions' roles. The institutional indicators are collected from the Worldwide Governance Indicators (WGI); hence, the current study provides new evidence on the threshold levels of public debt-to-GDP ratio and the budget deficit for fiscal sustainability in developed and developing countries.

### *2.3 Institutions and Fiscal Sustainability*

Institutions can be defined as the rules in a society or, more officially, the humanly devised challenges that influence social interaction (North, 1990). A thorough examination of the relationship between institutions and fiscal sustainability is frequently overlooked (Canh, 2018). It is premised on the disparities in the quality of institutions across many countries. When a country has a lower level of institutional quality, it can be challenging to boost its fiscal sustainability. Many countries have urged more focus on developing and implementing better fiscal rules and institutions in the aftermath of the financial crisis (Bergman et al., 2016).

Ali and Ahmed (2017) employed the system generalised methods of moments (GMM) to investigate the effect of institutional quality on public debt under intertemporal budget constraints in 17 MENA countries from 1996 to 2015. Their institutional indicators are obtained from the *Worldwide Governance Indicators* (WGI), which include control of corruption, government effectiveness, voice and accountability, political stability and absence of violence, regulatory quality, and the rule of law. They found that poor governance leads to a higher public debt-to-GDP ratio; political stability and absence of violence, regulatory quality and the rule of law all exert significant and negative effects on the public debt-to-GDP ratio. In contrast, other governance indicators significantly and positively affect the debt/GDP ratios.

Other studies discuss corruption extensively because it significantly impacts the economy. Cooray et al. (2017) reported a significant relationship between the corruption index and fiscal sustainability. The higher the corruption index, the greater the increase in the public debt-to-GDP ratio, implying that each country should reduce corruption levels to decrease public debt-to-GDP ratio accumulation. This finding inspires the current study's objective to contribute more perspectives on fiscal sustainability.

## 3. Data and Methodology

### *3.1 Data*

The current study selects a large panel of data from 106 developing and 36 developed countries from 1996 to 2018. These countries are set as samples because they have a record of increasing the public debt-to-GDP ratio based on the publications of the IMF and the World Bank. The sample period of 22 years is averaged over 5-year periods. The purpose of averaging the sample period is that the dynamic panel data requires many cross-section units (N) and a small number of periods (T), indicating that the average process can reduce the many instruments problem. The sample period of 1996–2018 is applied in dynamic panel threshold regression analysis by considering the publication period of the institutional indicators in the WGI.

The data of two existing fiscal sustainability indicators, namely the primary gap and recursive algorithm, are collected from the International Monetary Fund (IMF) and the World Bank. The data includes the public debt-to-GDP ratio, primary balance, economic growth and real interest rate. The primary gap indicator was calculated according to the empirical studies of Uryszek (2016) and Nxumalo and Hlophe (2018). Two conditions indicate the value of the primary gap. First, the fiscal sustainability level can be achieved when the indicator value is negative. Second, fiscal unsustainability level occurs when the indicator value is positive. Moreover, the recursive algorithm indicator was measured based on the empirical studies of Asava-vallobh et al. (2018), Croce and Juan-Ramón's (2003), and Lau and Lee (2021). The recursive algorithm value is interpreted as follows: fiscal sustainability level occurs when the value of the indicator is less than one ($<1$), while the fiscal unsustainability level is obtained when the value of the indicator exceeds or is equal to one ($\geq 1$).

Data on the public debt-to-GDP ratio, budget deficit and macroeconomic data are obtained from the IMF and World Bank. The current study sets three institutional

indicators following the literature on regulatory quality (RQ), the rule of law (RL) and control of corruption (CC). The corruption perception index (CPI) is published by Transparency International.

### *3.2 Principal Component Analysis*

Principal component analysis (PCA) provides a comprehensive assessment to construct new FSIs using multiple dimensions. The new indicator is called a PCA-based FSI, which can reduce the dimensionality of a data set consisting of many interrelated variables (Jollife, 2002). Nizam et al. (2020) argued that a multidimensional approach can improve the comparability of analysis and explain the relative rankings of a variable in several countries. Additionally, PCA can be formulated using two stages following Nagar and Basu (2002) and Nizam et al. (2020). Nagar and Basu (2002) examined the human development index of 174 countries, while Nizam et al. (2020) assemble the financial inclusion index of 63 countries.

The two PCA stages applied in the current study can be explained as follows (Nagar & Basu, 2002; Nizam et al., 2020). The first stage illustrates multiple dimensions of the PCA-based fiscal sustainability indicator. The dimensions cover the primary gap indicator (PG), recursive algorithm indicator (RA), and size of the shadow economy (SE). SE is obtained from multiple indicators, multiple causes (MIMIC) models proposed by Medina and Schneider (2018). The second stage is the formulation of the PCA-based FSI index. Therefore, the indicator can be written as follows:

$$NFSSE = \frac{\sum_{j=1}^{p} \lambda_j P_{ki}}{\sum_{j-1}^{p} \lambda_j} \tag{1}$$

where NFSSE is the PCA-based FSI. The eigenvalue of *j-th* is indicated by $\lambda_j$ ($j$ = 1,……$p$). P describes a matrix with dimension p.

PCA-based fiscal sustainability indicators can be formulated as follows:

$$NFSSE = \frac{1}{2}\left[ \frac{\sqrt{pg_k^2 + ra_k^2 + se_k^2}}{\sqrt{n}} + \left( 1 - \frac{\sqrt{(z - pg_k)^2 + (z - ra_k)^2 + (z - se_k)^2}}{\sqrt{n}} \right) \right] \tag{2}$$

where $z$ denotes the weighted value which is determined intrinsically. NFSSE explains that a fiscally sustainable level is achieved when the indicator's value is negative (–), while a fiscally unsustainable level occurs when the indicator value is positive (+).

### *3.3 The Econometric Method*

In the literature, intertemporal budget constraint (IBC) is the fundamental approach to constructing fiscal sustainability indicators, such as the PG and RA. The IBC describes the public debt-to-GDP ratio as one of the key variables (Akram & Rath, 2020; Stoian & Campeanu, 2010). Therefore, the current study applies two existing fiscal sustainability indicators from the IBC.

Previous studies have developed empirical models for the public debt threshold (Tran, 2018), budget deficit threshold (Bajo-Rubio et al., 2006), and the relationship between institutional quality and fiscal sustainability (Ali & Ahmed, 2017). The current study proposes the following equations to examine the threshold level of the public debt-to-GDP ratio by considering institutions for both developed and developing countries, resulting:

$$FSI_{(publicdebt)it} = \alpha_0 + \beta_1 GGGD_{it} + \beta_2 INITIAL_{it} + \beta_3 INS_{it} + \beta_4 Z_{it} + \varepsilon_{it} \quad (3)$$

where FSI comprises the PG, RA and PCA-based fiscal sustainability indicator. GGGD indicates a country-level general government gross (public) debt-to-GDP ratio. GGGD serves as a threshold variable of the public debt-to-GDP ratio. INITIAL denotes initial fiscal sustainability. INS is an institutional indicator covering regulatory quality (RQ), the rule of law (RL) and control of corruption (CC). Z represents the vector of control variables, namely: economic growth (EG), inflation rate (INF), unemployment rate (UE) and CPI. ε expresses error term, while *i* = 1,.....N represents the country and *t* = 1,.....N is the time. GGGD is presented in percentage, while the institutions' indicators are assessed in a range of approximately −2.5 (weak) to 2.5 (strong). The CPI is calculated as an index ranging from 0 (the highest level of corruption) to 100 (the lowest level of corruption).

The threshold level of the budget deficit-to-GDP ratio is estimated in Equation (4):

$$FSI_{(budgetdeficit)it} = \alpha_0 + \beta_1 BDR_{it} + \beta_2 INITIAL_{it} + \beta_3 INS_{it} + \beta_4 Z_{it} + \varepsilon_{it} \quad (4)$$

where FSI is the three fiscal sustainability indicators, while BDR equals the budget deficit-to-GDP ratio. BDR becomes a threshold variable of the budget deficit-to-GDP ratio. INITIAL refers to initial fiscal sustainability. INS indicates institutional indicators covering RQ, RL, and CC. Z represents the vector of control variables, namely: EG, inflation rate (INF), unemployment rate (UE) and CPI. ε expresses error term, while *i* = 1,.....N represents the country and *t* = 1,.....N is the time. The BDR is presented in percentage.

Equations (3) and (4) are estimated using dynamic panel threshold regression introduced by Kremer et al. (2013) to characterise the non-linear relationship between the public debt-to-GDP ratio and budget deficit on fiscal sustainability indicators, which consist of two existing indicators and PCA-based indicator. Their dynamic threshold regression is developed from static panel threshold regression introduced by Hansen (1999) and cross-sectional instrumental variable (IV) threshold regression proposed by Caner and Hansen (2004) to solve endogeneity estimation. Therefore, the dynamic panel threshold regression is written in Equation (5) regarding the public debt-to-GDP ratio as follows:

$$FSI_{(publicdebt)it} = \mu_i + \beta_1 GGGD_{it} I(GGGD_{it} \le \lambda) + \delta_1 I(GGGD_{it} \le \lambda) + \beta_2 GGGD_{it} I(GGGD_{it} > \lambda) + \varphi_1 INITIAL_{it} + \varphi_2 INS_{it} + \varphi_3 Z_{it} + \theta_t + \varepsilon_{it} \quad (5)$$

Equation (6) describes the dynamic panel threshold of the budget deficit-to-GDP ratio as follows:

$$FSI_{(budgetdeficit)it} = \mu_i + \beta_1 BDR_{it} I(BDR_{it} \le \lambda) + \delta_1 I(BDR_{it} \le \lambda) + \beta_2 BDR_{it} I(BDR_{it} > \lambda) + \varphi_1 INITIAL_{it} + \varphi_2 INS_{it} + \varphi_3 Z_{it} + \theta_t + \varepsilon_{it} \quad (6)$$

where $\mu_i$ is a country-specific fixed effect, while $\theta_t$ equals the time-fixed effect. $\lambda$ denotes the unknown threshold parameter. $Z$ symbolises control variables, which include EG, inflation and unemployment rate and CPI. $\varphi_3$ is the parameter of control variables, $\delta$ illustrates the parameter of the low or high regime, *I(.)* is an indicator function of the low or high regime and $\varepsilon$ represents the error term. The initial fiscal sustainability is considered an endogenous variable in the equations.

Equation (7) formulates the threshold estimation of the public debt-to-GDP ratio as follows:

$$FSI_{(publicdebt)it} = \begin{cases} \beta_0^1 + \beta_1^1 GGGD_{it} + \beta_2^1 INITIAL_{it} + \beta_3^1 INS_{it} + \beta_4^1 Z_{it} + \varepsilon_{it}, & GGGD_{it} \le \lambda \\ \beta_0^2 + \beta_1^2 GGGD_{it} + \beta_2^2 INITIAL_{it} + \beta_3^2 INS_{it} + \beta_4^2 Z_{it} + \varepsilon_{it}, & GGGD_{it} > \lambda \end{cases} \quad (7)$$

Moreover, Equation (8) shows the threshold estimation of the budget deficit-to-GDP ratio, resulting in the following:

$$FSI_{(budgetdeficit)it} = \begin{cases} \beta_0^1 + \beta_1^1 BDR_{it} + \beta_2^1 INITIAL_{it} + \beta_3^1 INS_{it} + \beta_4^1 Z_{it} + \varepsilon_{it}, & BDR_{it} \le \lambda \\ \beta_0^2 + \beta_1^2 BDR_{it} + \beta_2^2 INITIAL_{it} + \beta_3^2 INS_{it} + \beta_4^2 Z_{it} + \varepsilon_{it}, & BDR_{it} > \lambda \end{cases} \quad (8)$$

where $\beta_1^1$ equals the parameter for countries with a low regime, and $\beta_1^2$ expresses the parameter for countries with a high regime.

In particular, Hansen (2000) and Caner and Hansen (2004) have developed the following formula to determine the critical value of the 95% confidence interval of the threshold value:

$\Gamma = \{\lambda: LR(\lambda) \le C(\alpha)\}$

where $C(\alpha)$ denotes 95% of the asymptotic distribution of the likelihood ratio $LR(\lambda)$. The threshold value is expressed by $\hat{\lambda}$, and the slope coefficients can be estimated using the GMM. Additionally, the research uses lags of the dependent variable as an instrument, following Arellano and Bover (1995).

## 4. Empirical Results

### *4.1 Descriptive Statistics*

Table 1 shows that the PCA-based FSI benefits developed countries by ensuring a fiscally sustainable level. The PCA-based FSI provides a lower value than the PG and RA. The PG and RA are two existing fiscal sustainability indicators; however, the two indicators cannot better assess fiscal sustainability by considering multiple dimensions. Hence, the current study constructs the PCA-based fiscal sustainability indicator.

The mean values of the public debt-to-GDP ratio and budget deficit are 58.78% and −2.58%, respectively; policymakers should focus on reducing the size of the SE to maintain fiscal sustainability. Furthermore, the highest public debt-to-GDP ratio is approximately 183.18%, and the budget deficit is around −6.02%. The quality of institutions brings a positive signal for developed countries, indicating that developed countries can stimulate higher quality for institutions, such as RQ, the RL and CC. Furthermore, the mean values of EG, inflation rate and unemployment rate are 3.27%, 3.26% and 7.96%, respectively. The macroeconomic data explain that the unemployment rate is around twice the EG and inflation rate. Moreover, the EG is slightly higher than the inflation rate.

**Table 1**. Descriptive statistics for developed countries

| Variables | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| PG | 35.42 | 68.26 | -116.35 | 216.00 |
| RA | 9.78 | 6.21 | 2.46 | 22.47 |
| PCA-FSI | -0.14 | 0.74 | -1.58 | 2.44 |
| GGGD (%) | 58.78 | 34.38 | 6.75 | 183.18 |
| BDR (%) | -2.58 | 1.36 | -0.70 | -6.02 |
| RQ (-2.5 – 2.5) | 1.11 | 0.46 | -0.06 | 2.04 |
| RL (-2.5 – 2.5) | 1.10 | 0.59 | -0.19 | 2.03 |
| CC (-2.5 – 2.5) | 1.08 | 0.74 | -0.31 | 2.42 |
| CPI (0-100) | 66.61 | 19.05 | 33.02 | 93.40 |
| EG (%) | 3.27 | 1.13 | 1.57 | 5.88 |
| INF (%) | 3.26 | 4.95 | 0.19 | 31.22 |
| UE (%) | 7.96 | 3.29 | 3.19 | 16.24 |

*Notes*: The countries are 36 developed countries. PG is primary gap indicator, while RA is recursive algorithm indicator. PCA-FSI is fiscal sustainability indicator by incorporating shadow economy which is assessed using principal component analysis. GGGD equals public debt-to-GDP ratio and BDR denotes budget deficit-to-GDP ratio. RQ, RL and CC are regulatory quality, rule of law, and control of corruption, respectively. CPI, EG, INF and UE represent corruption perception index, economic growth, inflation rate, and unemployment rate, respectively.

*Sources*: IMF, the World Bank, WGI and TI.

**Table 2**. Descriptive statistics for developing countries

| Variables | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| PG | 64.09 | 59.34 | 0.42 | 348.63 |
| RA | 12.90 | 15.57 | -37.39 | 109.93 |
| PCA-FSI | 0.05 | 0.82 | -2.05 | 3.96 |
| GGGD (%) | 53.32 | 29.95 | 0.97 | 202.22 |
| BDR (%) | -3.13 | 1.45 | -0.12 | -8.09 |
| RQ (-2.5 – 2.5) | -0.20 | 0.67 | -2.23 | 2.17 |
| RL (-2.5 – 2.5) | -0.27 | 0.67 | -2.28 | 1.83 |
| CC (-2.5 – 2.5) | -0.25 | 0.69 | -1.73 | 2.21 |
| CPI (0-100) | 33.25 | 12.67 | 13.43 | 79.27 |
| EG (%) | 4.62 | 1.35 | 1.50 | 9.55 |
| INF (%) | 6.63 | 5.90 | 0.34 | 37.11 |
| UE (%) | 8.33 | 6.40 | 0.80 | 35.19 |

*Notes*: The countries are 106 developing countries. PG is primary gap indicator, while RA is recursive algorithm indicator. PCA-FSI is fiscal sustainability indicator by incorporating shadow economy which is assessed using principal component analysis. GGGD equals public debt-to-GDP ratio and BDR denotes budget deficit-to-GDP ratio. RQ, RL and CC are regulatory quality, rule of law, and control of corruption, respectively. CPI, EG, INF, and UE represent corruption perception index, economic growth, inflation rate, and unemployment rate, respectively.

*Sources*: IMF, the World Bank, WGI and TI.

Table 2 shows the descriptive statistics of developing countries. PCA-based FSI significantly contributes to maintaining a fiscally sustainable level, showing that the value of the PCA-based FSI is lower than that of the PG and RA indicators. The mean values of the public debt-to-GDP ratio and budget deficit are 53.32% and −3.13%, respectively. Additionally, the highest public debt-to-GDP ratio and budget deficit are 202.22% and −8.09%, respectively, indicating that developing countries receive the risk of high levels of public debt accumulation and budget deficit. The lower level of institutional quality indicates that developing countries may face the risks of poor institutions. It is worth noting that the mean values of EG, inflation rate and unemployment rate are 4.62%, 6.63% and 8.33%, respectively. The inflation rate is higher than EG. The unemployment rate should also be suppressed to a certain (lower) level to encourage EG and achieve fiscally sustainable levels. Simply put, developing countries should enhance EG to ensure a fiscally sustainable level.

### *4.2 Optimal Level of the Public Debt*

The current study estimates the threshold level of public debt-to-GDP ratio on fiscal sustainability under three institutional indicators for 106 developing and 36 developed countries. Table 3 shows that the threshold point ($\hat{\lambda}$) of the public debt-to-GDP ratio in developed countries is approximately 51.23% and slightly higher at 61.35% for developing countries. This result indicates that developed countries manage a lower public debt-to-GDP ratio threshold to ensure fiscal sustainability. Moreover, developing countries should focus more on controlling the higher level of public debt-to-GDP ratio. Additionally, the three institutional indicators contribute significantly to the threshold estimation of fiscal sustainability.

The public debt threshold findings in Table 3 are significantly higher than those estimated by Tran (2018), which is around 35% of the GDP of Latin-American countries. Checherita-Westphal et al. (2014) found that the debt threshold for 47 countries is 50% of GDP. Additionally, the statistical significance of the two regime-dependent coefficients for developed countries are $\widehat{\beta}_1$ ($\widehat{\beta}_2$), which are in the low (high) level of public debt-to-GDP ratio regimes. The findings demonstrate that the public debt-to-GDP ratio is a negative and statistically significant determinant of the PG at the 5% and 1% levels, either below or above the threshold under RQ. The coefficient of $\widehat{\beta}_2$ is less than $\widehat{\beta}_1$, indicating that a higher public debt-to-GDP ratio has a lower impact on the PG than a lower public debt-to-GDP ratio. The findings also reveal the negative impact of a low (high) regime under the RL; however, in terms of corruption control, the coefficient of $\widehat{\beta}_2$ is significant at the 5% level and less than $\widehat{\beta}_1$. The differences in the regime intercepts ($\widehat{\delta}_1$) are negative and statistically significant at the 1% level under RQ and the RL, while statistically significant at the 5% level under the CC.

Conversely, developing countries experience a higher public debt-to-GDP ratio, approximately 61.35%, by considering RQ, the RL and CC. The confidence interval-heterogeneity corrected shows a small gap between the upper and lower limits for each threshold point under different institutions, indicating certainty in the threshold point. The differences in the regime intercepts ($\widehat{\delta}_1$) are negative and statistically significant at the 1% level under RQ, the RL and CC; however, the impact of the public debt-to-GDP

**Table 3**. Dynamic panel threshold analysis of public debt-to-GDP ratio (Dependent variable: primary gap)

| | Developed Countries | | | Developing Countries | | |
|---|---|---|---|---|---|---|
| | RQ | RL | CC | RQ | RL | CC |
| *Threshold estimates* | | | | | | |
| $\hat{\lambda}$ | 51.23 | 51.23 | 51.23 | 61.35 | 61.35 | 61.35 |
| 95% confidence interval | [30.14 – 66.28] | [34.16 – 61.19] | [33.41 – 61.55] | [61.08 – 66.52] | [58.48 – 66.52] | [61.08 – 66.52] |
| *Regime dependent Impact of public debt-to-GDP ratio* | | | | | | |
| $\widehat{\beta}_1$ | -39.60** | -40.07** | -25.54 | 6.18 | -5.99 | 1.14 |
| | (14.37) | (15.89) | (15.18) | (14.27) | (16.23) | (15.65) |
| $\widehat{\beta}_2$ | -72.15*** | -67.36*** | -45.55** | 29.96* | 10.90 | 25.98 |
| | (18.45) | (19.09) | (18.89) | (14.63) | (17.11) | (16.78) |
| *Regime independent Impact of covariates* | | | | | | |
| INITIAL PG | 0.45*** | 0.45*** | 0.46*** | 0.32*** | 0.33*** | 0.33*** |
| | (0.08) | (0.08) | (0.09) | (0.05) | (0.05) | (0.05) |
| CPI | -1.30*** | -1.28*** | -1.40*** | -0.20 | -0.19 | -0.19 |
| | (0.40) | (0.41) | (0.42) | (0.17) | (0.17) | (0.17) |
| EG | -13.14*** | -13.66*** | -11.59*** | -3.12*** | -3.12*** | -2.97*** |
| | (2.85) | (2.99) | (2.85) | (0.90) | (0.90) | (0.90) |
| INF | -0.57*** | -0.50*** | -0.40*** | -0.23 | -0.25 | -0.24 |
| | (0.12) | (0.14) | (0.13) | (0.17) | (0.17) | (0.17) |
| UE | 1.31 | 1.72 | 1.97 | -0.14 | -0.20 | -0.22 |
| | (1.79) | (1.82) | (1.86) | (1.05) | (1.05) | (1.06) |
| $\widehat{\delta}_2$ | -80.24*** | -79.48*** | -66.37** | -75.95*** | -73.95*** | -76.34*** |
| | (27.31) | (27.04) | (23.83) | (10.77) | (10.54) | (10.70) |
| Observations | 36 | 36 | 36 | 106 | 106 | 106 |
| N | 180 | 180 | 180 | 521 | 521 | 521 |

*Notes*: The sample period is 1996-2018 (5-year average). RQ is regulatory quality, while RL and CC are rule of law and control of corruption, respectively. INITIAL PG, CPI, EG, INF and UE denote initial primary gap indicator, corruption perception index, economic growth, inflation rate and unemployment rate, respectively. The standard errors are reported in parentheses. ***, ** and ** indicate significance at 1%, 5% and 10% levels, respectively.

ratio on fiscal sustainability indicators occurs in a regime of high level ($\widehat{\beta}_2$) under RQ at a 10% level of significance.

The explanatory variables deliver positive impacts to maintain fiscally sustainable levels in developed and developing countries. For example, the initial fiscal sustainability has a significant and positive effect on the PG indicator at the 1% level for RQ, the RL and CC for both developed and developing countries. EG significantly negatively affects the PG indicator at the 1% level for three institutional indicators, indicating that

higher EG leads to a lower value of the PG indicator. Hence, developed and developing countries can maintain fiscally sustainable levels; however, the CPI and inflation rate contribute significantly but negatively to fiscal sustainability for developed countries. Higher corruption control practices can contribute to achieving a fiscally sustainable level.

Table 4 describes the results of the dynamic panel threshold estimation of the public debt-to-GDP ratio on a RA indicator. The threshold points of the public debt-to-GDP ratio for developed and developing countries are approximately 20.34%–35.65% and 34.10%–38.27%, respectively. This finding is lower than the findings in Tables 3 and 5. Additionally, the independent variable does not provide evidence of a significant impact on the RA indicator.

**Table 4**. Dynamic panel threshold analysis of public debt-to-GDP ratio (Dependent variable: recursive algorithm)

| | Developed countries | | | Developing countries | | |
|---|---|---|---|---|---|---|
| | RQ | RL | CC | RQ | RL | CC |
| *Threshold estimates* | | | | | | |
| $\hat{\lambda}$ | 35.65 | 20.34 | 20.34 | 34.10 | 38.27 | 35.87 |
| 95% confidence interval | [13.69 – 72.43] | [13.69 – 72.43] | [13.69 – 72.43] | [30.29 – 42.94] | [32.33 – 43.93] | [30.29 – 54.22] |
| *Regime dependent Impact of public debt-to-GDP ratio* | | | | | | |
| $\widehat{\beta}_1$ | 11.72*** | 5.06 | 5.99** | -5.53* | -9.15** | -7.10** |
| | (3.67) | (3.49) | (2.61) | (3.06) | (3.36) | (2.99) |
| $\widehat{\beta}_2$ | 3.56 | 4.90 | 7.12*** | -13.40*** | -17.32*** | -10.67*** |
| | (3.56) | (3.01) | (2.27) | (3.24) | (4.05) | (3.04) |
| *Regime independent Impact of covariates* | | | | | | |
| INITIAL RA | 0.53*** | 0.54*** | 0.54*** | 0.51*** | 0.50*** | 0.50*** |
| | (0.13) | (0.14) | (0.14) | (0.11) | (0.11) | (0.11) |
| CPI | -0.14* | -0.12* | -0.13* | -0.01 | -0.03 | -0.03 |
| | (0.08) | (0.07) | (0.07) | (0.04) | (0.04) | (0.04) |
| EG | -0.53 | -0.44 | -0.40 | 0.29 | 0.27 | 0.19 |
| | (0.78) | (0.83) | (0.74) | (0.24) | (0.23) | (0.22) |
| INF | -0.01 | -0.02 | -0.02 | 0.01 | -0.01 | -0.01 |
| | (0.03) | (0.03) | (0.03) | (0.03) | (0.03) | (0.02) |
| UE | -0.18 | -0.20 | -0.15 | -0.01 | 0.05 | 0.05 |
| | (0.33) | (0.32) | (0.31) | (0.15) | (0.15) | (0.15) |
| $\widehat{\delta}_1$ | -8.90* | -5.42 | -4.35* | 9.69*** | 9.94*** | 8.64*** |
| | (4.94) | (3.61) | (2.69) | (1.89) | (1.78) | (1.71) |
| Observations | 36 | 36 | 36 | 106 | 106 | 106 |
| N | 180 | 180 | 180 | 521 | 521 | 521 |

*Notes*: The sample period is 1996–2018 (5-year average). RQ is regulatory quality, while RL and CC are rule of law and control of corruption, respectively. INITIAL RA, CPI, EG, INF and UE denote initial recursive algorithm indicator, corruption perception index, economic growth, inflation rate and unemployment rate, respectively. The standard errors are reported in parentheses. ***, ** and ** indicate significance at 1%, 5% and 10% levels, respectively.

**Table 5**. Dynamic panel threshold analysis of public debt-to-GDP ratio (Dependent variable: PCA-FSI)

| | Developed countries | | | Developing countries | | |
|---|---|---|---|---|---|---|
| | RQ | RL | CC | RQ | RL | CC |
| *Threshold estimates* | | | | | | |
| $\hat{\lambda}$ | 59.56 | 53.13 | 53.13 | 64.87 | 56.07 | 53.13 |
| 95% confidence interval | [40.49 – 73.11] | [48.12 – 63.27] | [43.81 – 63.67] | [11.80 – 65.17] | [11.93 – 65.17] | [43.81 – 63.67] |
| *Regime dependent Impact of public debt-to-GDP ratio* | | | | | | |
| $\widehat{\beta}_1$ | -0.62*** | -0.58*** | -0.44*** | -0.06 | -0.16 | -0.44*** |
| | (0.10) | (0.10) | (0.09) | (0.07) | (0.08) | (0.09) |
| $\widehat{\beta}_2$ | -0.68*** | -0.67*** | -0.56*** | 0.11 | -0.33** | -0.56*** |
| | (0.18) | (0.14) | (0.13) | (0.12) | (0.12) | (0.13) |
| *Regime independent Impact of covariates* | | | | | | |
| INITIAL PCA-FSI | 0.55*** | 0.52*** | 0.51*** | 0.86*** | 0.88*** | 0.51*** |
| | (0.09) | (0.09) | (0.10) | (0.06) | (0.06) | (0.10) |
| CPI | 0.00 | 0.00 | 0.01 | -0.01 | -0.01 | 0.01 |
| | (0.01) | (0.01) | (0.00) | (0.01) | (0.00) | (0.00) |
| EG | -0.03 | -0.03 | -0.01 | -0.01 | -0.01 | -0.01 |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) |
| INF | -0.03*** | -0.01* | -0.01 | 0.01 | 0.01 | -0.01 |
| | (0.01) | (0.00) | (0.00) | (0.01) | (0.00) | (0.00) |
| UE | 0.01 | 0.02* | 0.03** | 0.01 | -0.01 | 0.03** |
| | (0.01) | (0.01) | (0.01) | (0.02) | (0.01) | (0.01) |
| $\widehat{\delta}_1$ | -0.38** | -0.48*** | -0.47*** | -0.29*** | -0.14* | -0.47*** |
| | (0.19) | (0.16) | (0.14) | (0.07) | (0.07) | (0.14) |
| Observations | 36 | 36 | 36 | 106 | 106 | 106 |
| N | 144 | 144 | 144 | 424 | 424 | 424 |

*Notes*: PCA-FSI is PCA-based fiscal sustainability indicator. The sample period is 1996–2015 (5-year average). RQ is regulatory quality, while RL and CC are rule of law and control of corruption, respectively. INITIAL PCA-FSI, CPI, EG, INF and UE denote initial PCA-based fiscal sustainability indicator, corruption perception index, economic growth, inflation rate and unemployment rate, respectively. The standard errors are reported in parentheses. ***, ** and ** indicate significance at 1%, 5% and 10% levels, respectively.

Table 5 shows the impact of the public debt-to-GDP ratio threshold on PCA-based fiscal sustainability indicators in both developed and developing countries. Under the RL and CC, the threshold point ($\hat{\lambda}$) of the public debt-to-GDP ratio for developed countries is approximately 53.13%. Moreover, considering RQ, the threshold point is slightly higher, up to 59.56%. Additionally, as a result of the public debt-to-GDP ratio on the PCA-based FSI, the coefficient of $\widehat{\beta}_1$ ($\widehat{\beta}_2$) in the low (high) level is negative and significant at 1%. Specifically, the coefficient of $\widehat{\beta}_2$ is less than $\widehat{\beta}_1$, which means that a higher public debt-to-GDP ratio has a lower impact on the PCA-based FSI than a lower one. The

differences in the regime intercepts ($\widehat{\delta_1}$) are negative and significant at the 1% level under the RL and CC and the 5% level under RQ.

The initial fiscal sustainability exerts a significant and positive impact on the PCA-based FSI at the 1% level for RQ, the RL and CC for both developed and developing countries. The findings also show that inflation and unemployment contribute significantly to the PCA-based FSI. A higher inflation rate leads to a lower value of the PCA-based FSI, which shows that developed countries can guarantee a fiscally sustainable level. A higher unemployment rate impacts a higher value of the PCA-based FSI.

Under RQ, the threshold point ($\hat{\lambda}$) of the public debt-to-GDP ratio for developing countries is approximately 64.87%; however, under the RL, the threshold point is approximately 56.07%. Additionally, under the CC, the threshold point of the public debt-to-GDP ratio is approximately 53.13%. The threshold point is in line with the findings of threshold points in developed countries by considering the RL and CC. The differences in the regime intercepts ($\widehat{\delta_1}$) are negative and significant at the 1% level under RQ and the 10% level under the RL; however, the finding provides limited empirical support to the significant contribution of macroeconomic data in the dynamic panel threshold regression of public debt-to-GDP ratio for developing countries.

### *4.3 Optimal Level of the Budget Deficit*

The current study uses dynamic panel threshold regression for developed and developing countries from 1996 to 2018 to estimate the threshold level of budget deficit-to-GDP ratio on fiscal sustainability by considering three institutional indicators. The findings show that developed countries have a threshold point ($\hat{\lambda}$) of the budget surplus-to-GDP ratio of approximately 0.64% under the RL and CC (Table 6); however, regarding RQ, developed countries face the lowest threshold point of the budget surplus-to-GDP ratio of 0.01%. This result suggests that policymakers can pay more attention to setting a lower budget deficit-to-GDP ratio or a slightly higher budget surplus-to-GDP ratio. Therefore, developed countries can design a policy on gaining a relatively high budget surplus-to-GDP ratio to support achieving a fiscally sustainable level.

The statistical significance of the two regime-dependent coefficients are $\widehat{\beta_1}$ ($\widehat{\beta_2}$) in the low (high) level of budget surplus-to-GDP ratio regimes. The findings show that the impact of the budget surplus-to-GDP ratio is negative and statistically significant on the PG at the 1% level below the threshold under RQ. The differences in the regime intercepts ($\widehat{\delta_1}$) are negative and statistically significant at the 1% level for RQ.

The findings also describe that initial fiscal sustainability has a positive and significant impact on the PG indicator at the 1% level under RQ, the RL and CC. The CPI has a negative and significant impact at the 1% level under RQ and the RL; however, in terms of CC, the initial fiscal sustainability has a negative and significant effect at the 5% level. The findings signal that a higher level of corruption index, a higher number of transactions free of bribery and lower corrupt practices, can support a fiscally sustainable level. EG and unemployment rate have a positive and significant impact, while the inflation rate has a negative and significant impact. EG has significant impact at the 5% level under RQ. According to the three institutional indicators, a higher unemployment rate can lead to financial unsustainability at the 5% level. Additionally, regarding RQ, a

**Table 6**. Dynamic panel threshold analysis of budget deficit-to-GDP Ratio (Dependent variable: primary gap)

| | Developed countries | | | Developing countries | | |
|---|---|---|---|---|---|---|
| | RQ | RL | CC | RQ | RL | CC |
| *Threshold estimates* | | | | | | |
| $\hat{\lambda}$ | 0.01[a] | 0.64[a] | 0.64[a] | 3.15 | 3.15 | 3.20 |
| 95% confidence interval | [-0.86 – 1.65] | [-0.86 – 3.26] | [-0.88 – 3.26] | [-3.78 – 4.05] | [-3.78 – 4.05] | [-3.78 – 4.05] |
| *Regime dependent Impact of budget deficit-to-GDP ratio* | | | | | | |
| $\widehat{\beta}_1$ | -129.88*** | -62.62 | -49.13 | -2.05* | -8.51 | -1.54 |
| | (29.86) | (33.23) | (31.11) | (11.50) | (13.09) | (11.62) |
| $\widehat{\beta}_2$ | -31.06 | -1.73 | -7.31 | 20.69 | 1.39 | 26.15 |
| | (27.13) | (32.77) | (32.32) | (12.93) | (5.25) | (13.89) |
| *Regime independent Impact of covariates* | | | | | | |
| INITIAL PG | 0.50*** | 0.47*** | 0.46*** | 0.39*** | 0.40*** | 0.39*** |
| | (0.09) | (0.09) | (0.09) | (0.05) | (0.05) | (0.05) |
| CPI | -1.81*** | -1.39*** | -1.38** | -0.10 | -0.10 | -0.11 |
| | (0.50) | (0.51) | (0.51) | (0.16) | (0.16) | (0.16) |
| EG | 68.26** | 24.63 | 26.01 | -1.89** | -1.88* | -1.85* |
| | (32.93) | (39.91) | (36.29) | (0.92) | (0.92) | (0.92) |
| IINF | -0.34*** | 0.10 | 0.07 | -0.37 | -0.38 | -0.35 |
| | (0.11) | (0.09) | (0.09) | (0.25) | (0.25) | (0.24) |
| UE | 3.99** | 4.64** | 4.72** | -0.55 | -0.60 | -0.56 |
| | (1.99) | (1.99) | (2.00) | (1.12) | (1.12) | (1.10) |
| $\widehat{\delta}_1$ | 115.61*** | 40.21 | 18.41 | -6.94 | -9.81 | -7.65 |
| | (31.56) | (25.34) | (21.91) | (8.16) | (8.53) | (8.41) |
| Observations | 36 | 36 | 36 | 106 | 106 | 106 |
| N | 180 | 180 | 180 | 521 | 521 | 521 |

*Notes*: The sample period is 1996–2018 (5-year average). RQ is regulatory quality, while RL and CC are rule of law and control of corruption, respectively. INITIAL PG, CPI, EG, INF, and UE denote initial primary gap indicator, corruption perception index, economic growth, inflation rate, and unemployment rate, respectively. The standard errors are reported in parentheses. ***, ** and ** indicate significance at 1%, 5% and 10% levels, respectively; [a] denotes threshold level of budget surplus-to-GDP ratio for developed countries.

higher inflation rate can provide an opportunity to maintain a fiscally sustainable level at the 1% level.

Developing countries experience a higher threshold point ($\hat{\lambda}$) of the budget deficit-to-GDP ratio, approximately 3.15% in RQ and the RL, and 3.20% for CC. The regime-dependent coefficients are $\widehat{\beta}_1$ ($\widehat{\beta}_2$) in the low (high) level of budget deficit-to-GDP ratio regimes. The findings indicate that the budget deficit-to-GDP ratio is negative and statistically significant on the PG indicator at the 10% level under RQ. The differences in the regime intercepts ($\widehat{\delta}_1$) are not significant. Other findings reveal that the initial fiscal

sustainability has positive and statistically significant impact on the PG indicator at the 1% level by considering RQ, the RL and CC. EG has a negative and significant impact at the 5% level under RQ and at the 10% level for the RL and CC. Thus, policymakers should encourage sustainable EG to ensure a fiscally sustainable level.

Table 7 explains the threshold level of the budget deficit-to-GDP ratio on RA indicator under three institutional indicators for both developed and developing countries. The table depicts that the threshold point ($\hat{\lambda}$) of the budget deficit-to-GDP ratio for developed countries is approximately 0.41% under RQ, and the budget surplus-to-GDP

**Table 7**. Dynamic panel threshold analysis of budget deficit-to-GDP ratio (Dependent variable: recursive algorithm)

| | Developed countries | | | Developing countries | | |
|---|---|---|---|---|---|---|
| | RQ | RL | CC | RQ | RL | CC |
| *Threshold estimates* | | | | | | |
| $\hat{\lambda}$ | 0.41 | 0.69[a] | 0.69[a] | 3.34 | 1.94 | 2.94 |
| 95% confidence interval | [-1.50 – 3.26] | [-1.50 – 3.26] | [-1.50 – 3.26] | [-5.80 – 4.29] | [-5.80 – 4.29] | [-5.80 – 4.29] |
| *Regime dependent Impact of budget deficit-to-GDP ratio* | | | | | | |
| $\widehat{\beta}_1$ | 5.57 | 1.64 | 3.91 | -6.43** | -11.32** | -3.06 |
| | (4.07) | (3.99) | (2.98) | (2.43) | (4.06) | (2.66) |
| $\widehat{\beta}_2$ | 6.93** | 7.43** | 9.16*** | -11.74*** | -17.01*** | -8.74*** |
| | (2.94) | (3.03) | (2.34) | (3.69) | (4.38) | (2.80) |
| *Regime independent Impact of covariates* | | | | | | |
| INITIAL RA | 0.53*** | 0.57*** | 0.56*** | 0.56*** | 0.53*** | 0.54*** |
| | (0.13) | (0.14) | (0.14) | (0.12) | (0.12) | (0.12) |
| CPI | -0.12 | -0.15 | -0.16* | -0.02 | -0.01 | -0.02 |
| | (0.08) | (0.08) | (0.08) | (0.04) | (0.04) | (0.04) |
| EG | -0.19 | -0.43 | -0.50 | 0.10 | 0.09 | 0.10 |
| | (0.75) | (0.84) | (0.75) | (0.13) | (0.12) | (0.12) |
| INF | 0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.01 |
| | (0.03) | (0.03) | (0.03) | (0.02) | (0.02) | (0.02) |
| UE | -0.25 | -0.21 | -0.16 | -0.04 | -0.11 | -0.08 |
| | (0.35) | (0.32) | (0.31) | (0.11) | (0.12) | (0.11) |
| $\widehat{\delta}_1$ | -2.05 | 10.67** | 10.14** | 4.27** | 5.29*** | 4.86** |
| | (4.98) | (5.19) | (4.13) | (2.13) | (1.73) | (1.92) |
| Observations | 36 | 36 | 36 | 106 | 106 | 106 |
| N | 180 | 180 | 180 | 521 | 521 | 521 |

Notes: The sample period is 1996–2018 (5-year average). RQ is regulatory quality, while RL and CC are rule of law and control of corruption, respectively. INITIAL RA, CPI, EG, INF and UE denote initial recursive algorithm indicator, corruption perception index, economic growth, inflation rate and unemployment rate, respectively. The standard errors are reported in parentheses. ***, ** and * indicate significance at 1%, 5% and 10% levels, respectively; [a] denotes threshold level of budget surplus-to-GDP ratio for developed countries.

ratio is approximately 0.69% for the RL and CC; however, the threshold point ($\hat{\lambda}$) of the budget deficit-to-GDP ratio for developing countries is approximately 3.34% under RQ. Additionally, the threshold points by considering the RL and CC are 1.94% and 2.94%, respectively. These findings indicate that developing countries face a higher risk of budget deficit-to-GDP ratio in maintaining a fiscally sustainable level than developed countries. The impact of coefficient ($\widehat{\beta}_1$) of budget deficit-to-GDP ratio on the RA for developing countries is negative and statistically significant at the 5% level for RQ. Conversely, coefficient ($\widehat{\beta}_2$) is positive and statistically significant at the 5% level. Moreover, the coefficient ($\widehat{\beta}_2$ ) is more than ($\widehat{\beta}_1$), indicating that a higher budget deficit-to-GDP ratio has a higher impact on the RA than a lower budget deficit-to-GDP ratio. In particular, the differences in the regime intercepts ($\widehat{\delta}_1$) are positive and statistically significant at the 5% level for the RL and corruption control for developed countries. Moreover, the regime intercept significantly contributes to RQ for developing countries. Additionally, the initial fiscal sustainability has a positive and significant contribution to the RA at the 1% level for RQ, the RL and CC for developed countries; however, the initial fiscal sustainability is statistically significant under RQ in developing countries.

The current study uses PCA-based fiscal sustainability indicators to examine the impact of a budget deficit-to-GDP ratio threshold for developed and developing countries (Table 8). The findings reveal that the threshold point ($\hat{\lambda}$) of the budget surplus-to-GDP ratio is approximately 0.04% under RQ, the RL and CC for developed countries. This finding suggests that policymakers should design a budget surplus policy to maintain a fiscally sustainable level. Moreover, policymakers in developed countries can manage fiscal policy more appropriately, one of which is by improving their institutional quality. The impact of the coefficients $\widehat{\beta}_1$ ($\widehat{\beta}_2$) of budget surplus-to-GDP ratio on PCA-based FSI in the low (high) level is negative at the 5% level for ($\widehat{\beta}_1$) and at the 1% level for ($\widehat{\beta}_2$) by considering RQ and the RL. The coefficient ($\widehat{\beta}_2$) is less than ($\widehat{\beta}_1$). This finding indicates that a higher budget surplus-to-GDP ratio has a lower impact on the PCA-based FSI than a lower budget surplus-to-GDP ratio. The differences in the regime intercepts ($\widehat{\delta}_1$) are negative and significant at the 5% level under the RL and CC.

The findings also show that the initial fiscal sustainability contributes positively and significantly to the PCA-based FSI at the 1% level under RQ, the RL and CC. EG positively and significantly impacts the PCA-based FSI at the 5% level for RQ. Moreover, EG significantly contributes at the 10% level by considering the RL. In addition, the unemployment rate has a positive and significant effect at the 5% level under RQ and at the 1% level for the RL and CC.

Developing countries have a threshold point of the budget deficit-to-GDP ratio of approximately 0.05% under RQ, the RL and CC. This threshold point is lower than the findings in Tables 6 and 7, indicating that developing countries can pay more attention to setting a lower budget deficit-to-GDP ratio.

## 5. Conclusion and Policy Implications

The current study estimates the threshold effect of the public debt-to-GDP ratio and budget deficit on fiscal sustainability under three institutional indicators using dynamic panel threshold regression proposed by Kremer et al. (2013). The sample covers 106

**Table 8**. Dynamic panel threshold of budget deficit-to-GDP ratio (Dependent variable: PCA-FSI)

| | Developed countries | | | Developing countries | | |
|---|---|---|---|---|---|---|
| | RQ | RL | CC | RQ | RL | CC |
| *Threshold estimates* | | | | | | |
| $\hat{\lambda}$ | 0.40[a] | 0.40[a] | 0.40[a] | 0.05 | 0.05 | 0.05 |
| 95% confidence interval | [-1.50 – 3.26] | [-1.50 – 3.26] | [-1.50 – 3.26] | [-2.69 – 4.02] | [-2.24 – 4.02] | [-2.21 – 4.02] |
| *Regime dependent Impact of budget deficit-to-GDP ratio* | | | | | | |
| $\widehat{\beta}_1$ | -0.56** | -0.54** | -0.26 | -0.01 | -0.15 | 0.12 |
| | (0.19) | (0.20) | (0.13) | (0.09) | (0.09) | (0.08) |
| $\widehat{\beta}_2$ | -0.72*** | -0.67*** | -0.38** | -0.01 | -0.17* | 0.09 |
| | (0.21) | (0.21) | (0.15) | (0.07) | (0.08) | (0.07) |
| *Regime independent Impact of covariates* | | | | | | |
| INITIAL PCA-FSI | 0.58*** | 0.60*** | 0.59*** | 0.89*** | 0.91*** | 0.88*** |
| | (0.08) | (0.08) | (0.08) | (0.05) | (0.06) | (0.06) |
| CPI | 0.01 | 0.01 | 0.01 | -0.01 | -0.01 | -0.01 |
| | (0.02) | (0.01) | (0.01) | (0.02) | (0.02) | (0.03) |
| EG | 0.39** | 0.40* | 0.08 | -0.01 | -0.01 | -0.01 |
| | (0.17) | (0.20) | (0.17) | (0.03) | (0.02) | (0.04) |
| INF | -0.03** | -0.01 | -0.01 | -0.01 | -1.26* | -0.01 |
| | (0.01) | (0.01) | (0.01) | (0.02) | (1.57) | (0.02) |
| UE | 0.03** | 0.04*** | 0.03*** | 0.01 | 0.01 | 0.01 |
| | (0.01) | (0.01) | (0.01) | (0.03) | (0.03) | (0.03) |
| $\widehat{\delta}_1$ | -0.44 | -0.42** | -0.38** | 0.20*** | 0.22*** | 0.21*** |
| | (0.28) | (0.20) | (0.16) | (0.03) | (0.04) | (0.03) |
| Observations | 36 | 36 | 36 | 106 | 106 | 106 |
| N | 144 | 144 | 144 | 424 | 424 | 424 |

Notes: PCA-FSI is PCA-based fiscal sustainability indicator. The sample period is 1996–2015 (5-year average). RQ is regulatory quality, while RL and CC are rule of law and control of corruption, respectively. INITIAL PCA-FSI, CPI, EG, INF and UE denote initial PCA-based fiscal sustainability indicator, corruption perception index, economic growth, inflation rate and unemployment rate, respectively. The standard errors are reported in parentheses. ***, ** and * indicate significance at 1%, 5% and 10% levels, respectively; [a] denotes threshold level of budget surplus-to-GDP ratio for developed countries.

developing and 36 developed countries from 1996 to 2018. The two existing fiscal sustainability indicators used in the current study are the PG (Nxumalo & Hlophe, 2018; Uryszek, 2016) and the RA (Asava-vallobh et al., 2018; Cruz-Rodriguez, 2014; Lau & Lee, 2021). The literature shows a lack of fiscal sustainability analysis in a better framework; therefore, the current study constructs PCA-based fiscal sustainability indicators. The indicator provides new evidence and a significant contribution to the existing literature on fiscal sustainability. Additionally, the effects of institutions on fiscal sustainability are modelled in terms of RQ, the RL and CC.

The main findings can be highlighted as follows. First, the highest threshold level of the public debt-to-GDP ratio is 59.56% for developed countries and approximately 64.87% for developing countries. Second, the highest threshold level of budget deficit-to-GDP ratio is approximately 0.41% for developed countries and around 3.34% for developing countries. Third, three institutional indicators contribute significantly to fiscal sustainability: RQ, the RL and CC. Furthermore, the CPI and EG positively impact fiscal sustainability. A higher CPI and EG contribute to achieving a fiscally sustainable level.

The current study suggests that policymakers must pay more attention to the threshold points of the public debt-to-GDP ratio and budget deficit to ensure a fiscally sustainable level. Policymakers should set institutional quality and debt management improvement. Some steps that can be taken include reducing the levels of public debt and budget deficit when these levels exceed a certain threshold that is detrimental to fiscal sustainability. Policymakers can also improve the quality of institutions through good regulation, law enforcement and CC.

Moreover, policymakers can formulate a diverse range of fiscal policies to ensure fiscal sustainability. The current study serves as a warning to policymakers to maintain fiscal sustainability after reaching definite thresholds. For example, the highest threshold point of the public debt-to-GDP ratio is approximately 59.56% for developed countries and 64.87% for developing countries. Additionally, policymakers of developing countries should focus on reducing the budget deficit-to-GDP ratio to ensure a fiscally sustainable level. Furthermore, policymakers should improve the quality of institutions by increasing policy transparency, law enforcement and control of corrupt practices.

The social implication of the findings lies in the significant contribution of PCA-based FSI and CPI. The PCA-based indicator provides new evidence on the public debt-to-GDP ratio and the budget deficit for developed and developing countries. Developed and developing countries can maintain a fiscally sustainable level using the PCA-based FSI. A higher CPI also contributes to achieving a fiscally sustainable level; thus, developed and developing countries should work to better suppress corrupt practices.

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