

## Public Debt and Budget Deficit Threshold Levels on New Fiscal Sustainability Indicator

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### Abstract

*Fiscal sustainability can be determined and assessed using financial technology (FinTech). Consequently, a new indicator of fiscal sustainability can be constructed. This study also estimates threshold levels of public debt and budget deficit by considering institutions for 88 developing and 35 developed countries in 2014 and 2017. The principal component analysis (PCA) and the cross-section threshold regression are employed. The main findings revealed that the threshold levels of public debt-to-GDP ratio for developed and developing countries in 2014 were 100.37% and 63.04%, while that in 2017 were 90.09% and 84.28%, respectively. Moreover, the threshold levels of budget deficit-to-GDP ratio for developed and developing countries in 2014 were -3.04% and -1.24%, while those in 2017 were -0.97% and -5.75%, respectively. Therefore, policymakers should emphasize a certain public debt and budget deficit level to warrant a fiscally sustainable level.*

### Keywords:

new fiscal sustainability indicator; FinTech; public debt; budget deficit; institutions

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## INTRODUCTION

The scholars and policymakers in many countries pay more attention in rising level of public debt and government expenditure during recent decades especially since 2008 financial crisis (Berrittella & Zhang, 2015; Baharumshah et al., 2017; Lau & Syn-Yee, 2018; Akram & Rath, 2019; and Caselli & Wingender, 2021). The higher level of public debt produces the significant debate in the literature on fiscal sustainability. Specifically, there is no a unique definition and indicator of fiscal sustainability. Fiscal sustainability can be defined as “a sufficient yearly adjustment in the primary balance towards a target ratio consistent with a country-specific target debt ratio” (Croce & Juan-Ramon, 2003). Therefore, this study proposes new fiscal sustainability indicator by incorporating financial technology (FinTech) and estimates the threshold levels of public debt and budget deficit by considering institutions. Besides, institutions can determine fiscal sustainability level following some previous empirical studies such as Bergman et al. (2016), Ali & Ahmed (2017), and Cooray et al. (2017). The higher quality of institutions promotes sustainable public finance in the long-run.

The higher level of public debt-to-GDP ratio in some countries has been announced by the International Monetary Fund (IMF) that in 2019 the level of general government gross debt-to-GDP ratio is more than 100%. Those countries were Angola (109%), Bahrain (103%), Barbados (122%), Belize (105%), Bhutan (104%), Cabo Verde (125%), Eritrea (189%), Greece (181%), Italy (135%), Japan (238%), Lebanon (174%), Mozambique (104%), Portugal (118%), Singapore (130%), Sudan (201%), United States (108%), and Venezuela (233%). It motivates to examine the threshold level of public debt-to-GDP ratio in maintaining fiscally sustainable level.

Moreover, FinTech leads government revenue and expenditure in an efficient and transparent outcomes. Previous empirical studies found that digitalization of government budget and tax were accelerated by employing FinTech in fiscal policy (Otieno, et al, 2013; El Gohary, 2019; and Cangiano et al., 2019). FinTech delivers some benefits for fiscal policy such as support better transaction for government, business, and individual. The government utilizes e-budgeting to manage government revenue and expenditure. Meanwhile, the business and individual use e-taxation to pay their tax. Technically, FinTech can be proxied using some indicators following Thakor (2019) such as lending platforms, payment platforms, and bitcoin. The indicator of FinTech can also use Global Findex Database in 2014 and 2017 (Nizam, et al, 2020).

Literature reported that fiscal sustainability can be assessed using some indicators such as primary gap (Sulaiman et al., 2015; Uryszek, 2016; and Nxumalo & Hlophe, 2018) and recursive algorithm (Cruz-rodriguez, 2014; Sulaiman et al., 2015; Asava-vallobh et al., 2018; and Lau & Lee, 2021). They argued that these indicators were derived from the concept of intertemporal budget constraint (IBC). Conceptually, primary gap and recursive algorithm were determined by public debt-to-GDP ratio, primary surplus-to-GDP ratio, economic growth, and real interest rate. Nonetheless, there is no fiscal sustainability indicator constructed under a better framework and multiple dimension. Besides, this study formulates new fiscal sustainability indicator by incorporating FinTech

using principal component analysis (PCA). The new indicator will provide new evidence and contribute significantly on the existing literature.

This study examines the threshold levels of public debt and budget deficit on new fiscal sustainability indicators by incorporating FinTech using cross-section threshold regression for 88 developing and 35 developed countries in 2014 and 2017. These years are set following the publication of the Global Findex Database. In particular, this empirical model follows previous studies published by Tran (2018) and Bajo-Rubio et al. (2006). The sample comprises 88 developing and 35 developed countries in 2014 and 2017. The threshold regression also considers institutional indicators on new fiscal sustainability following Ali & Ahmed (2017).

This study fills empirical gaps in several ways. First, it provides a new fiscal sustainability indicator by incorporating FinTech using principal component analysis. The new indicator contributes significantly to the existing literature on fiscal sustainability by providing a better framework and multiple dimensions. The literature had previously ignored the indicator. Second, this study reveals threshold levels of public debt and budget on new fiscal sustainability indicators using cross-section threshold regression. This study also considers institutional indicators of new fiscal sustainability following Ali & Ahmed (2017), such as regulatory quality and the rule of law. Finally, policymakers in developed countries should control certain levels of public debt-to-GDP ratio and budget deficit to maintain a fiscally sustainable level. Besides, policymakers in developing countries should trim the threshold levels of public debt-to-GDP ratio and budget deficit to guarantee a fiscally sustainable level.

Previous empirical study emphasizes the threshold level of public debt for 14 emerging economies from 1999-2016 using Hansen's panel threshold regression published by Tran (2018). The findings show that non-Latin American economies can maintain the sustainable public finance by conducting below the threshold bounds public debt-to-GDP ratio at 40-55% of GDP. Conversely, the Latin-American economies faced the threshold level of public debt of roughly 35% of GDP. Moreover, the threshold level of budget deficit-to-GDP ratio has been depicted by Bajo-Rubio et al. (2006) for Spanish fiscal policy using non-linear threshold cointegration. They found that the threshold level of budget deficit-to-GDP ratio is about 5.30% of GDP using annual data and at 7% of GDP using quarterly data. Nonetheless, these previous findings did not emphasize the contribution of institutions. Therefore, Ali & Ahmed (2017) estimate the impact of institutional quality on public debt sustainability for 17 countries in MENA region during 1996-2015. They argued that poor governance stimulates to higher public debt accumulation. Interestingly, three institutional indicators contribute significantly on public debt sustainability cover political stability and absence of violence, regulatory quality, and rule of law. Thus, this study provides a better analysis of threshold levels of public debt and budget deficit by considering quality of institutions on new fiscal sustainability indicator by incorporating FinTech.

The main findings reveal that developed countries can suppress the level of public debt-to-GDP ratio and budget deficit in 2014 and 2017. For example, at that time

the public debt-to-GDP ratio threshold was about 100.37% to 90.09%, while budget deficit-to-GDP ratio threshold was about -3.04% to -0.97%. In contrast, developing countries face a risk of higher levels of public debt-to-GDP ratio and budget deficit. In 2014 and 2017 the threshold levels of public debt-to-GDP ratio were 63.04% to 84.28%, while the threshold levels of budget deficit-to-GDP ratio were -1.24% to -5.75%, respectively. Furthermore, the findings also revealed that two institutional indicators contribute significantly on new fiscal sustainability indicator by incorporating FinTech such as regulatory quality and rule of law.

This study will be organized following some sections. The first section describes introduction which elaborates study issues, empirical gaps, study objectives, and contributions. The next section is method consists of data, principal component analysis (PCA), and cross-section threshold regression. The third section explores result and discussion of current findings compared to previous empirical studies. The fourth section expresses conclusion and policy implication.

## **METHOD**

### **Data**

This study employs fiscal, macroeconomic, financial technology and institutional indicators published by the World Bank, International Monetary Fund, Global Findex Database, and Worldwide Governance Indicators. Table 1 shows research variables were set to estimate the threshold levels of public debt and budget deficit on new fiscal sustainability indicator by incorporating FinTech using cross-section threshold regression. There are three dimensions to construct new fiscal sustainability indicator consist of primary gap, recursive algorithm, and financial technology. The collected data were from 2014 and 2017. These years demonstrate FinTech's contribution to the development of new fiscal sustainability indicators. In addition, the data from the two years were published by the Global Findex Database. Moreover, the threshold variables are depicted by public debt-to-GDP ratio and budget deficit. Besides, institutional indicators are illustrated by regulatory quality and rule of law following Ali & Ahmed (2017). This study also selects corruption perception index following Cooray, Dzhumashev & Schneider (2017). Several macroeconomic data are employed following the literature cover economic growth, inflation rate, and unemployment rate.

Table 2 explains descriptive statistics of research variables. Developed and developing countries take a beneficial impact from new fiscal sustainability indicator by incorporating FinTech such as lower value of the new indicator which reflects achieving fiscally sustainable level in 2014 and 2017. The level of public debt-to-GDP ratio for developed countries is higher than developing countries. Particularly, the level of budget deficit-to-GDP ratio for developed countries is lower than developing countries. The data indicate that developed countries faced a risk of public debt accumulation and lead to control the level of budget deficit. However, developing countries can manage the level of public debt accumulation and suffer a higher level of budget deficit.

Table 1. Research Variables

Variables	Description	Unit	Source
Primary gap indicator (pg)	Fiscal sustainability indicator is assessed using Intertemporal Budget Constraint following Sulaiman, Karim, & Khalid (2015); Uryszek (2016); and Nxumalo & Hlophe (2018).	Negative (-) equals fiscally sustainable level, positive (+) equals fiscally unsustainable level.	Literature and the Author's calculation
Recursive algorithm (ra)	Fiscal sustainability indicator is assessed using Intertemporal Budget Constraint following Cruz-rodriguez (2014); Sulaiman, Karim & Khalid (2015); Asava-vallobh, Aroonvisoot & Yangwiwat (2018); and Lau & Lee (2021).	Less than 1 equals fiscally sustainable level, more than 1 equals fiscally unsustainable level.	Literature and the Author's calculation
Financial technology (f)	Some indicators will be utilized, namely: (a) Used the internet to pay bills or to buy something online in the past year (% age 15+), (b) Paid utility bills: using a mobile phone (% age 15+), and (c) Made or received digital payments in the past year (% age 15+).	Percent	Global Index Database
New fiscal sustainability indicator by incorporating FinTech (nfsf)	New fiscal sustainability indicator is assessed using principal component analysis.	Negative (-) equals fiscally sustainable level, positive (+) equals fiscally unsustainable level.	The Author's calculation
Public Debt-to-GDP ratio (gggd)	Gross debt is the general amount of debt a country has. Gross debt is a good assessment of a country's debt in the long-run. Gross debt is intragovernmental and has no direct impact on an individual government's economy.	Percent	International Monetary Fund
Budget Deficit-to-GDP ratio (bd)	Budget deficit equals General Government Total Expenditure - General Government Revenue. A positive (+) value equals deficit while a negative (-) value equals surplus.	Percent	The World Bank, International Monetary Fund, and Author's calculation
Regulatory quality (rq)	Estimate of governance (ranges from approximately -2.5 (weak) to 2.5 (strong) governance performance).	Index	Worldwide Governance Indicators
Rule of law (rl)	Estimate of governance (ranges from approximately -2.5 (weak) to 2.5 (strong) governance performance).	Index	Worldwide Governance Indicators
Corruption perception index (cpi)	The CPI scores and ranks countries/ territories based on how corrupt a country's public sector is perceived to be by experts and business executives.	Index	Transparency International
Economic growth (eg)	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2010 U.S. dollars.	Percent	The World Bank
Inflation rate (inf)	Inflation rate, consumer prices.	Percent	The World Bank
Unemployment rate (ue)	Unemployment, total (% of total labor force).	Percent	The World Bank

In 2014 developed countries have a minimum and maximum levels of public debt-to-GDP ratio were about 10.45% and 236.07%, respectively. However, in 2017 the minimum and maximum levels of public debt-to-GDP ratio were about 9.16% and

234.99%. The condition denotes that these countries try to control the public debt accumulation. On the other hand, the minimum and maximum levels of budget deficit-to-GDP ratio were about -6.02% and 0.66% in 2014, respectively. It shows that some developed countries obtain a just a few of budget surplus-to-GDP ratio. In contrast, in 2017 the minimum and maximum levels of budget deficit-to-GDP ratio were happened, namely -5.04% and -0.55%.

The minimum levels of public debt-to-GDP ratio for developing countries in 2014 and 2017 were about 0.07% and 0.06%. The condition expresses that several countries did not depend on public debt to financing domestic economy. Conversely, at the same time the maximum levels of public debt-to-GDP ratio were about 137.98% and 117.51%, respectively. Therefore, some developing countries can concern to trim the level of public debt accumulation gradually. Besides, in 2014 and 2017 the minimum levels of budget deficit-to-GDP ratio were about -5.98% and -5.59%, respectively. At the same time the maximum levels of budget deficit-to-GDP ratio were about -0.42% and -0.245, respectively. The condition shows that developing countries try to control the level of budget deficit-to-GDP ratio.

Quality of institutions for developed countries is better than developing countries. For example, in 2014 and 2017 the value of regulatory quality, rule of law and corruption perception index for developed countries is higher than developing countries. Technically, the positive value of institutional indicators reflects the higher quality of institutions and vice versa. Lastly, macroeconomic data for most developed and developing countries are less than two digits (<10%). It tells that these countries promote macroeconomic performance in a better condition.

## Principal Component Analysis

The principal Component Analysis (PCA) is utilized to assess new fiscal sustainability indicator by incorporating FinTech dimensions. It is employed to analyze multivariate data and assessed under a composite or multidimensional index (Wold et al., 1987; Jolliffe, 2002). In particular, Jolliffe (2002) argued that the central idea of principal component analysis (PCA) is to reduce the dimensionality of a data set consisting of a large number of interrelated variables, while retaining as much as possible of the variation present in the data set.

This study provides the basic equation of new fiscal sustainability indicator by incorporating FinTech (NFSF) following PCA. It is drawn by Equation (1) as follows:

$$NFSF = w_1 X_i^{pg} + w_2 X_i^{ra} + w_3 X_i^f + \varepsilon_i \quad (1)$$

$X^{pg}$ ,  $X^{ra}$ ,  $X^{se}$  and  $X^f$  denote the dimensions of primary gap, recursive algorithm, and financial technology, respectively. The primary gap is assessed following Sulaiman et al. (2015); Uryszek (2016); and Nxumalo & Hlophe (2018). Besides, the recursive algorithm is assessed following Cruz-rodriquez (2014); Sulaiman et al. (2015); Asava-vallobh et al. (2018); and Lau & Lee (2021). The “i” represents the 88 developing and 35 developed countries, while  $\varepsilon$  is the total variations in two orthogonal parts, consisting of the variation caused by causal variables and the variation that comes from errors.

Table 2. Descriptive Statistics

Variables	2014					2017				
	Mean	St Dev	Min	Max		Mean	St Dev	Min	Max	
<b>Developed Countries</b>										
New fiscal sustainability indicator by incorporating FinTech (nfsf)	0.92	0.66	-0.39	2.02	1.38	0.87	0.87	-0.47	2.87	
Public Debt-to-GDP ratio (eggd)	74.84	46.15	10.45	236.07	71.13	45.77	45.77	9.16	234.99	
Budget Deficit-to-GDP ratio (bd)	-1.59	3.06	-6.02	0.66	-1.71	1.24	1.24	-5.04	-0.55	
Regulatory quality (rq)	1.26	0.50	0.33	1.95	1.29	0.52	0.52	0.24	2.09	
Rule of law (rl)	1.32	0.65	-0.05	2.10	1.24	0.61	0.61	-0.04	2.03	
Corruption perception index (cpi)	67.80	15.50	43.00	92.00	67.86	14.33	14.33	43.00	89.00	
Economic growth (eg)	2.34	2.08	-1.86	8.71	3.32	1.60	1.60	1.51	8.15	
Inflation rate (inf)	0.57	0.94	-1.60	2.76	1.70	0.80	0.80	0.25	3.72	
Unemployment rate (ue)	9.48	5.35	3.04	26.50	7.02	3.92	3.92	2.83	21.45	
<b>Developing Countries</b>										
New fiscal sustainability indicator by incorporating FinTech (nfsf)	-0.70	0.63	-2.16	0.95	-0.24	0.81	0.81	-1.74	2.14	
Public Debt-to-GDP ratio (eggd)	42.05	23.17	0.07	137.98	50.87	24.67	24.67	0.06	117.51	
Budget Deficit-to-GDP ratio (bd)	-2.74	1.78	-5.98	-0.42	-2.55	2.24	2.24	-5.59	-0.24	
Regulatory quality (rq)	-0.24	0.79	-1.90	2.23	-0.25	0.77	0.77	-1.96	2.16	
Rule of law (rl)	-0.34	0.72	-1.92	1.86	-0.35	0.72	0.72	-2.26	1.82	
Corruption perception index (cpi)	37.86	14.30	5.00	84.00	37.58	14.16	14.16	6.00	84.00	
Economic growth (eg)	4.13	2.43	-3.89	9.25	3.28	3.44	3.44	-10.67	8.50	
Inflation rate (inf)	5.17	4.06	-1.09	12.17	10.00	16.48	16.48	-0.90	38.12	
Unemployment rate (ue)	7.42	6.27	0.69	35.30	7.73	6.51	6.51	0.14	30.50	

FinTech is proxied by three indicators published by Global Findex Database in 2014 and 2017 cover using the internet to pay bills or to buy something online in the past year (% age 15+), paying utility bills using a mobile phone (% age 15+), and making or receiving digital payments in the past year (% age 15+). These indicators were selected following Nizam, et al (2020). They stated that the PCA estimation has a relatively difficult stage but the findings and conclusions are more precise and robust.

Finally, the new fiscal sustainability indicators by incorporating FinTech dimension can be formulated, resulting:

$$NFSF = \frac{1}{2} \left[ \frac{\sqrt{pg_k^2 + ra_k^2 + f_k^2}}{\sqrt{n}} + \left( 1 - \frac{\sqrt{(z - pg_k)^2 + (z - ra_k)^2 + (z - f_k)^2}}{\sqrt{n}} \right) \right] \quad (2)$$

$z$  indicates the weight of  $w_i$ , which is determined intrinsically.  $pg$ ,  $ra$ , and  $f$  are index dimensions which consist of primary gap, recursive algorithm, and financial technology. The finding of NFSF can be interpreted following two conditions, namely: fiscally sustainable level occurs when the value of NFSF is negative (-) and fiscally unsustainable level occurs when that of is positive (+). The condition is defined following the literature of the existing fiscal sustainability indicator.

### The Econometric Technique

This study estimates the threshold levels of public debt and budget deficit by considering quality of institutions on new fiscal sustainability indicator by incorporating FinTech. The cross-section threshold regression is employed introducing Hansen (1999, 2000). The basic empirical model follows previous studies published by Tran (2018), Bajo-Rubio et al. (2006), and Ali & Ahmed (2017). Cross-section threshold regression will be selected to qualify study objective. Equation (3) denotes the regression of threshold level of public debt-to-GDP ratio (GGGD) on NFSF, while Equation (4) indicates the regression of threshold level of budget deficit-to-GDP ratio (BD).

$$NFSF_{(gggd)i} = \alpha_0 + \beta_1 GGGD_i + \beta_2 X_i + \beta_3 Z_i + \varepsilon_i \quad (3)$$

$$NFSF_{(bd)i} = \alpha_0 + \beta_1 BD_i + \beta_2 X_i + \beta_3 Z_i + \varepsilon_i \quad (4)$$

GGGD is general government gross debt-to-GDP ratio as a proxy of public debt, BD equals budget deficit-to-GDP ratio, X describes macroeconomic variables, while Z is institutional indicators. The  $i$  presents 1, 2, ...,  $n$ . The  $\beta$  is parameter of independent variables, while  $\varepsilon$  is error term. The macroeconomic variables consist of economic growth (Akram & Rath, 2019), inflation rate (Ali & Ahmed, 2017), and unemployment rate (Giesenow et al., 2020). The institutional indicators cover regulatory quality and rule of law. Besides, the corruption perception index published by Transparency International is also selected following Cooray et al. (2017).

Equation (3) and (4) can be rewritten to draw cross-section threshold regression model, resulting:



$$NFSF_{(gggd)i} = (\beta_1 GGGD_i + \lambda_1 Z_i)I(GGGD_i \leq \gamma) + (\beta_2 GGGD_i + \lambda_2 Z_i)I(GGGD_i > \gamma) + \varepsilon_i \quad (5)$$

$$NFSF_{(bd)i} = (\beta_1 BD_i + \lambda_1 Z_i)I(BD_i \leq \gamma) + (\beta_2 BD_i + \lambda_2 Z_i)I(BD_i > \gamma) + \varepsilon_i \quad (6)$$

Equation (5) exhibits the cross-section threshold regression of institutional threshold level on new fiscal sustainability indicator by incorporating FinTech dimension for public debt-to-GDP ratio, while Equation (6) shows that of for budget deficit. GGGD and BD equal public debt-to-GDP ratio and budget deficit as threshold variables. The  $\gamma$  is the unknown threshold parameter, while  $I(.)$  is an indicator function of low or high regime. Lastly,  $\varepsilon$  denotes the error term.

Therefore, Equation (5) and (6) are formulated in threshold form as follows:

$$NFSF_{(gggd)i} = \begin{cases} \beta_0^1 + \beta_1^1 GGGD_i + \beta_2^1 X_i + \beta_3^1 Z_i + \varepsilon_i. & GGGD_i \leq \gamma \\ \beta_0^2 + \beta_1^2 GGGD_i + \beta_2^2 X_i + \beta_3^2 Z_i + \varepsilon_i. & GGGD_i > \gamma \end{cases} \quad (7)$$

$$NFSF_{(bd)i} = \begin{cases} \beta_0^1 + \beta_1^1 BD_i + \beta_2^1 X_i + \beta_3^1 Z_i + \varepsilon_i. & BD_i \leq \gamma \\ \beta_0^2 + \beta_1^2 BD_i + \beta_2^2 X_i + \beta_3^2 Z_i + \varepsilon_i. & BD_i > \gamma \end{cases} \quad (8)$$

$\beta_1^1$  is the parameter for countries with low regime, while  $\beta_1^2$  expresses the parameter for countries with high regime. The parameters will determine the threshold level of public debt-to-GDP ratio and budget deficit both in 35 developed and 88 developing countries in 2014 and 2017.

## RESULT AND DISCUSSION

### Public Debt-to-GDP Ratio Threshold on New Fiscal Sustainability

This section demonstrates the empirical findings of the cross-section threshold regression of public debt-to-GDP ratio on new fiscal sustainability indicator by incorporating FinTech following Equation (5). The finding revealed that the threshold levels of public debt-to-GDP ratio for developed and developing countries in 2014 were 100.37% and 63.04%, respectively (Table 3).

The new fiscal sustainability indicator by incorporating FinTech of Global OLS and Regime 1 ( $q \leq 100.37$ ) for developed countries is determined by the corruption perception index (CPI), inflation rate (INF), and unemployment rate (EU) at 1% level. It means that higher CPI level, inflation rate, and unemployment rate will lead fiscally unsustainable level. Conversely, economic growth (EG) has a negative and significant impact at 1% level following Regime 1, which means that higher economic growth will guarantee fiscally sustainable level. The number of samples for developed countries is 35 countries which are divided into 27 countries under Regime 1 and 8 countries under Regime 2. The findings of the threshold level of public debt on new fiscal sustainability indicator by incorporating FinTech dimension following Regime 2 are determined negatively and significantly at 1% level by inflation rate and unemployment rate. It indicates that increased inflation and unemployment rates will enhance fiscally sustainable level. Economic growth has a positive impact at 1% level, which shows that a higher level of growth will lead fiscally

unsustainable level. However, regulatory quality stresses the level of fiscal sustainability. Therefore, policymakers should focus on maintaining fiscally sustainable level in the long-run by managing inflation and unemployment rates, including encouraging sustainable economic growth in the long-run and stimulating quality of institutions.

**Table 3. Public Debt Threshold on New Fiscal Sustainability Indicator in Developed and Developing Countries, 2014**  
Dependent Variable: New Fiscal Sustainability Indicator by Incorporating FinTech

	Developed Countries			Developing Countries		
	Global OLS	Regime1 (q<=100.37)	Regime2 (q>100.37)	Global OLS	Regime1 (q<=63.04)	Regime2 (q>63.04)
Intercept	-1.71** [0.63]	-1.58*** [0.44]	5.17*** [0.14]	-0.34 [0.58]	-0.02 [0.68]	-0.05 [0.94]
RQ <sub>i</sub>	0.26 [0.41]	0.18 [0.31]	-0.96*** [0.19]			
RL <sub>i</sub>				0.38 [0.23]	0.56** [0.26]	-1.11* [0.55]
CPI <sub>i</sub>	0.03*** [0.01]	0.03*** [0.01]	-0.01 [0.01]	0.01 [0.01]	-0.01 [0.01]	0.05*** [0.01]
INF <sub>i</sub>	0.22** [0.09]	0.27*** [0.07]	-0.87*** [0.08]	0.01 [0.01]	0.02* [0.01]	-0.15*** [0.05]
UE <sub>i</sub>	0.05*** [0.01]	0.05*** [0.01]	-0.23*** [0.01]	-0.01 [0.01]	-0.01 [0.01]	-0.09** [0.04]
EG <sub>i</sub>	-0.01 [0.05]	-0.08*** [0.02]	0.18*** [0.01]	-0.06*** [0.02]	-0.04* [0.02]	-0.32*** [0.09]
R-squared	0.62	0.86	0.98	0.25	0.26	0.70
Heteroskedasticity Test (P-Value)	0.77			0.89		
Threshold	100.37			63.04		
0.95 Confidence Interval	[100.37, 100.37]			[15.60, 67.21]		
LM-test for no threshold	11.37			8.11		
Bootstrap P-Value	0.20			0.78		
Observation	35	27	8	88	74	14

Notes: The standard errors are reported in parentheses. \*\*\*, \*\* and \* indicate significance at 1%, 5% and 10% levels, respectively.

Developing countries receive a benefit of rule of law. The rule of law has a positive impact on new fiscal sustainability indicator following Regime 1 at 5% level for 74 countries and negative impact following Regime 2 at 10% level for 14 countries. It reveals that 74 countries should be careful in controlling the risk of fiscally unsustainable level when the quality of institutions is getting better. In contrast, 14 countries benefit from the improvement of institutional quality to ensure fiscally sustainable level. Besides, Regime 2 provides a significant impact of corruption perception index (CPI) and macroeconomic

variables. For example, higher quality of corrupt practice control will drive higher value of new fiscal sustainability indicator, which can probably mean a fiscally unsustainable level. The higher inflation rate, unemployment rate and economic growth promote in declining value of new fiscal sustainability, which will benefit policy makers in ensuring fiscally sustainable level.

In 2017 developed and developing countries still faced higher threshold level of public debt-to-GDP ratio on new fiscal sustainability by incorporating FinTech. The threshold level for these countries were 90.09% and 84.28%, respectively (Table 4). It is lower than the threshold level of public debt-to-GDP ratio for developed countries and higher than those of developing countries as described in Table 2. The findings spell out that developed countries can suppress the level of public debt, while developing countries suffer higher level of public debt-to-GDP ratio.

**Table 4. Public Debt Threshold on New Fiscal Sustainability Indicator in Developed and Developing Countries, 2017**  
Dependent Variable: New Fiscal Sustainability Indicator by Incorporating FinTech

	Developed Countries			Developing Countries		
	Global OLS	Regime1 (q<=90.09)	Regime2 (q>90.09)	Global OLS	Regime1 (q<=84.28)	Regime2 (q>84.28)
Intercept	-1.94** [0.79]	-2.14*** [0.62]	1.92*** [0.61]	0.47 [0.42]	0.14 [0.63]	-0.02 [0.49]
RQ <sub>i</sub>	0.47 [0.37]	0.69** [0.30]	0.61 [0.63]			
RL <sub>i</sub>				0.71*** [0.17]	0.6*** [0.24]	-0.16 [0.41]
CPI <sub>i</sub>	0.03*** [0.01]	0.03*** [0.01]	-0.02* [0.01]	-0.01 [0.01]	0.01 [0.01]	0.01 [0.01]
INF <sub>i</sub>	0.12 [0.10]	-0.01 [0.08]	0.84*** [0.15]	0.01 [0.01]	-0.01 [0.01]	-0.07*** [0.01]
UE <sub>i</sub>	0.06*** [0.02]	0.16*** [0.03]	-0.02 [0.03]	0.01 [0.01]	0.01 [0.01]	-0.02* [0.01]
EG <sub>i</sub>	-0.08 [0.05]	-0.07** [0.03]	-0.49*** [0.08]	-0.09*** [0.02]	-0.09*** [0.02]	0.19*** [0.05]
R-squared	0.70	0.84	0.91	0.35	0.37	0.71
Heteroskedasticity Test (P-Value)	0.84			0.94		
Threshold	90.09			84.28		
0.95 Confidence Interval	[87.14, 90.09]			[84.28, 84.28]		
LM-test for no threshold	7.61			8.40		
Bootstrap P-Value	0.81			0.70		
Observation	35	26	9	88	78	10

Notes: The standard errors are reported in parentheses. \*\*\*, \*\* and \* indicate significance at 1%, 5% and 10% levels, respectively.

Table 4 snapshots the determinant of public debt-to-GDP ratio threshold levels on new fiscal sustainability indicator by incorporating FinTech for developed countries in 2017. It explores that the corruption perception index (CPI) has a positive impact at 1% level following Global OLS and Regime 1. Nonetheless, the CPI has a negative and significant impact at the 10% level, which means that the increasing quality of controlling corrupt practices stimulates fiscally sustainable level. Besides, two macroeconomic variables also have a significant impact on the new fiscal sustainability indicator following Regime 2, which consists of the inflation rate and economic growth. The inflation rate has a positive and significant impact at 1% level, as is the impact of the unemployment rate following Global OLS and Regime 1. Interestingly, economic growth has a negative and significant impact at 1% level, which gives a positive indication to policymakers to guarantee fiscally sustainable level. Similarly, the negative impact of economic growth also occurs in the findings of Regime 1. The number of samples for developed countries can be classified as follows: 35 countries under Global OLS, 26 countries under Regime 1, and 9 countries under Regime 2.

The quality of institutions (rule of law) has a positive effect at 1% level following Global OLS and Regime 1 for developing countries. It portrays that policymakers should be more careful in encouraging fiscally sustainable level in relation to the improvement of institution quality. In addition, Regime 2 exhibits that inflation rate and unemployment rate have a negative effect at 1% and 10% levels, respectively. It means that higher inflation and unemployment rate will encourage fiscally sustainable level. Furthermore, economic growth has a negative effect at 1% level following Global OLS and Regime 1. It expresses that increasing economic growth drives in achieving fiscally sustainable level. However, economic growth has a positive effect at 1% level following Regime 2, which illustrates that policymakers should pay more attention to enhance economic growth and the value of the new fiscal sustainability indicator. The next, the number of samples for developing countries is 88 countries, consisting of 78 countries under Regime 1 and 10 countries under Regime 2.

### **Budget Deficit-to-GDP Ratio Threshold on New Fiscal Sustainability**

This section estimates Equation (6) to reveal the threshold level of budget deficit on new fiscal sustainability indicators by incorporating FinTech for developed and developing countries in 2014 and 2017. The main findings were outlined by Table 5 that the threshold levels of budget deficit-to-GDP ratio for developed and developing countries in 2014 were -3.04% and -1.24%, respectively.

Interestingly, the empirical findings reveal that the threshold level of budget deficit on new fiscal sustainability indicator for developed countries is determined negatively and significantly by quality of institutions (regulatory quality) at 5% level following Regime 1. It explains that increased quality of institutions will stimulate fiscally sustainable level. However, corruption perception index (CPI) contributes positively and significantly at 1% level following Global OLS and Regime 1, which

means that strengthening corruption-free practices can encourage an increase in the value of fiscal sustainability. Thus, policymakers are expected to pay more attention to control corruption level in achieving fiscally sustainable level. Inflation rate have a positive and significant impact following Global OLS and Regime 2. Similarly, a positive and significant impact is also contributed by unemployment rate following Global OLS and Regime 1 at 1% level. Interestingly, economic growth has a negative and significant impact at 1% level, which means that improving economic growth will encourage achieving fiscally sustainable level. Therefore, policymakers can focus on sustainable economic growth, low inflation rate, and low unemployment rate to ensure a level of fiscally sustainable. The number of samples for developed countries can be categorized as follows 35 countries under Global OLS, 16 countries under Regime 1, and 19 countries under Regime 2.

**Table 5. Budget Deficit Threshold on New Fiscal Sustainability Indicator in Developed and Developing Countries, 2014**

**Dependent Variable: New Fiscal Sustainability Indicator by Incorporating FinTech**

	Developed Countries			Developing Countries		
	Global OLS	Regime1 (q<=-3.04)	Regime2 (q>-3.04)	Global OLS	Regime1 (q<=-1.24)	Regime2 (q>-1.24)
Intercept	-1.71*** [0.63]	-3.93*** [0.40]	0.43 [0.74]	-0.63* [0.33]	-0.57* [0.32]	-2.39 [1.87]
RQ <sub>i</sub>	0.26 [0.41]	-0.67** [0.30]	0.23 [0.48]	0.30*** [0.12]	0.34*** [0.11]	-0.23 [0.47]
CPI <sub>i</sub>	0.03*** [0.01]	0.07*** [0.01]	0.01 [0.01]	0.01 [0.01]	0.01 [0.01]	0.05 [0.05]
INF <sub>i</sub>	0.22** [0.09]	-0.10 [0.10]	0.34*** [0.13]	0.01 [0.01]	0.01 [0.01]	0.09*** [0.01]
UE <sub>i</sub>	0.05*** [0.01]	0.04*** [0.01]	-0.04 [0.03]	-0.01 [0.01]	-0.01 [0.01]	0.01 [0.02]
EG <sub>i</sub>	-0.01 [0.04]	0.09*** [0.02]	-0.11*** [0.04]	-0.05 [0.02]	-0.06*** [0.02]	-0.04 [0.06]
R-squared	0.62	0.89	0.68	0.27	0.33	0.46
Heteroskedasticity Test (P-Value)	0.67			0.53		
Threshold	-3.04			-1.24		
0.95 Confidence Interval	[-3.13, -1.5]			[-5.39, -1.24]		
LM-test for no threshold	14.41			7.94		
Bootstrap P-Value	0.01			0.80		
Observation	35	16	19	88	77	11

Notes: The standard errors are reported in parentheses. \*\*\*, \*\* and \* indicate significance at 1%, 5% and 10% levels, respectively.

The empirical findings for developing countries demonstrate that quality of institutions (regulatory quality) contributes positively at 1% level following Global

OLS and Regime 1. It portrays that higher quality of institutions encourages higher value of fiscal sustainability. In addition, an interesting finding was presented by the negative and significant impact of economic growth following Regime 1, which gives the appropriate signal for policymakers in maintaining fiscally sustainable level. The number of samples for developing countries can be categorized into the following: 88 countries under Global OLS, 77 countries under Regime 1, and 11 countries under Regime 2.

Another finding is exhibited by the cross-section threshold regression for developed and developing countries in 2017 (Table 6). The threshold levels of budget deficit-to-GDP ratio for developed and developing countries were -0.97% and -5.75%, respectively. It indicates that developed countries have stimulated to trim the level of budget deficit-to-GDP ratio, while developing countries faced a risk of higher budget deficit-to-GDP ratio. Therefore, the developed countries should control the level of budget deficit in maintaining fiscally sustainable level in the long-run.

**Table 6. Budget Deficit Threshold on New Fiscal Sustainability Indicator in Developed and Developing Countries, 2017**  
Dependent Variable: New Fiscal Sustainability Indicator by Incorporating FinTech

	Developed Countries			Developing Countries		
	Global OLS	Regime1 (q<=-0.97)	Regime2 (q>-0.97)	Global OLS	Regime1 (q<=-5.75)	Regime2 (q>-5.75)
Intercept	-1.94** [0.79]	-1.48 [1.02]	-11.54*** [-1.06]	-0.17 [0.37]	7.31*** [0.92]	-0.44 [0.36]
RQ <sub>i</sub>	0.47 [0.37]	0.86* [0.40]	-1.35 [0.84]	0.43** [0.17]	2.13*** [0.30]	0.41** [0.17]
CPI <sub>i</sub>	0.03*** [0.01]	0.02* [0.01]	0.02 [0.14]	0.01 [0.01]	-0.15*** [0.03]	0.01 [0.01]
INF <sub>i</sub>	0.12 [0.10]	0.40*** [0.14]	-0.22 [0.48]	-0.01 [0.01]	-0.01 [0.01]	0.01 [0.01]
UE <sub>i</sub>	0.06*** [0.02]	0.05** [0.02]	0.02 [0.45]	0.01 [0.01]	-0.04 [0.03]	0.01 [0.01]
EG <sub>i</sub>	-0.08 [0.05]	-0.15** [0.07]	-0.15 [0.17]	-0.08*** [0.02]	-0.17* [0.10]	-0.08*** [0.02]
R-squared	0.70	0.81	0.90	0.34	0.83	0.41
Heteroskedasticity Test (P-Value)	0.73			0.97		
Threshold	-0.97			-5.75		
0.95 Confidence Interval	[-2.80, -0.81]			[-5.76, -2.20]		
LM-test for no threshold	13.2			13.57		
Bootstrap P-Value	0.04			0.08		
Observation	35	24	11	88	10	78

Notes: The standard errors are reported in parentheses. \*\*\*, \*\* and \* indicate significance at 1%, 5% and 10% levels, respectively.

Quality of institutions (regulatory quality) has a positive and significant effect for developed countries (Regime 1) and developing countries (Global OLS, Regime 1 and Regime 2). It explains that improving the quality of institutions will create an increase in the value of fiscal sustainability. The increasing value of fiscal sustainability indicator promotes the risk of fiscally unsustainable level. Besides, a positive and significant impact is also shown by the inflation rate (Regime 1) and unemployment rate (Global OLS and Regime 1) for developed countries. Specifically, the findings are presented by economic growth, which has a negative impact for developed countries (Regime 1) and developing countries (Global OLS, Regime 1 and Regime 2). It denotes that developing countries benefit from increased economic growth in ensuring the level of fiscally sustainable level. The sample size for developed countries is 35 countries, consisting of 24 countries under Regime 1 and 11 countries under Regime 2. Meanwhile, the sample size for developing countries is 88 countries, which includes 10 countries under Regime 1 and 78 countries under Regime 2.

## DISCUSSION

Public debt-to-GDP ratio, budget deficit-to-GDP ratio and institutions broadcast a significant contribution on new fiscal sustainability indicator by incorporating FinTech following Table (3) – (6). The findings of public debt-to-GDP ratio depict that developed countries can trim the threshold level from 2014 (100.37% of GDP) to 2017 (90.09% of GDP). Conversely, developing countries face a risk of higher public debt-to-GDP ratio is about 63.04% to 84.28% of GDP. Similarly, the countries suffer the higher budget deficit-to-GDP ratio is about -1.24% to -5.75%. Interestingly, developed countries also able to control the level of budget deficit-to-GDP ratio from -3.04% to -0.97%. Besides, two institutional indicators deliver significant impact on new fiscal sustainability indicator such as regulatory quality and rule of law. Corruption perception index (CPI) also contributes in a certain finding. Nguyen & Luong (2021) state that weak governance in controlling corruption leads to higher accumulation of public debt.

The current literature argued that higher public debt-to-GDP ratio can sustain without leading a risk of fiscal sustainability (Alloza, et al, 2020). They found that prudent debt level for Spanish can be obtained following an anchor of 60% of GDP. It tells that the level of public debt-to-GDP ratio will stimulate fiscally sustainable level when it threshold around 60% of GDP. In particular, Wang et al. (2021) revealed that the higher external debt stresses economic growth in low- and middle-income countries during 1970-2018. It means that the external borrowing of public sector stimulate the macroeconomic fragility. In term of threshold level, Law et al.s (2021) express that 71 developing countries obtained public debt-to-GDP ratio about 51.65% during 1984-2015.

Furthermore, literature also provide empirical evidence of budget deficit-to-GDP threshold. For example, Peppel-Srebrny (2021) the higher budget deficit due to higher

government investment can trim the effect of inflationary of fiscal policy and bond yield. It delivers an insight that the budget deficit can be decided in maintaining fiscal sustainability under government investment policy. However, Ahmad & Aworinde (2019) argued that about 12 African countries suffer an inflationary effect of budget deficit during 1980:1 – 2018:4. Therefore, policymakers should manage and control the level of budget deficit-to-GDP ratio to guarantee fiscal sustainability and avoid inflationary effect. Besides, Pfeiffer et al. (2021) argued that low interest rate of government bond will stimulate the optimal mix between spending and revenue. The budget deficit is also delivering a burden impact to national economy as well as the level of well-being for future generation (Al-Rubaie & Ahmed, 2021).

Bergman et al. (2016) emphasize institutions' contributions to promoting sustainable public finances. They argue that the effect of institution is less critical as government efficiency increases. This shows that fiscal rules and government efficiency are institutionally equivalent. In addition, Cooray et al. (2017) revealed the relationship between corruption, the shadow economy, and public debt. They found that (a) a 1-unit increase in the corruption index of Transparency International leads to a 0.13% increase in the debt-to-GDP ratio, and (b) a 1-unit increase in the Kaufmann et al. corruption index leads to a 0.11% increase in the debt to GDP ratio. Pradhan (2019) state that continuous assesment of fiscal sustainability is essential for identifying the sources of risk and vulnerability in the fiscal and macro structure of a country. Makala (2022) suggest that the fiscal policy authorities to integrate the expenditure rule in their fiscal policy framework.

## CONCLUSION

This study examines threshold levels of public debt and budget deficit by considering institutions on new fiscal sustainability indicator by incorporating FinTech for 88 developing and 35 developed countries in 2014 and 2017 using cross-section threshold regression. It provides new evidence on literature of fiscal sustainability. In particular, FinTech stimulates governments to conduct fiscal policy using e-budgeting and e-taxation. The main results show that the public debt-to-GDP ratio threshold for developed countries in 2014 was higher than in 2017, while it was lower for developing countries in 2014. It indicates that developed countries can reduce public debt accumulation. Conversely, developing countries cannot control higher public debt accumulation. Surprisingly, the findings about the public debt threshold also apply to the budget deficit threshold. It shows that a higher budget deficit-to-GDP ratio causes a higher public debt-to-GDP ratio in developing countries.

On the other hand, lower public debt-to-GDP ratio accumulation is stimulated by lower budget deficit-to-GDP ratio for developed countries. Besides, two institutional indicators contribute significantly to the public debt threshold covering regulatory quality and the rule of law. The threshold level of a budget deficit is determined by regulatory quality on a certain regime. The corruption perception index also benefits the threshold regression of public debt and budget deficit in a certain regime. Finally, the findings



present that macroeconomic data contribute significantly to new fiscal sustainability indicators by incorporating FinTech for public debt and budget deficit threshold levels in a certain regime.

Policymakers must seek to keep the public debt and budget deficit at sustainable levels for the economy. By doing this, they will be able to sustain government revenue and repay the current and future public debt. They also should pay more attention to improving the quality of institutions, such as regulatory quality and the rule of law. Better control of corrupt practices will provide a better and more transparent fiscal policy in the long run. In addition, policymakers should incorporate FinTech (e-budgeting and e-taxation) into fiscal policy to guarantee fiscal sustainability in the long run. E-budgeting and e-taxation can enhance fiscal sustainability and prudence and promote ideal levels of public debt and budget deficits.

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