THE EFFECTIVENESS OF DEBT RULE ON FISCAL SUSTAINABILITY: DO MACROECONOMIC DATA MATTER?

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ABSTRACT

The effectiveness of the debt rule to achieve a certain level of public debt and debt sustainability targets is one of the fiscal sustainability discussed in the literature. The current study attempts to estimate the impact of the debt rule on fiscal sustainability indicators for 77 countries during 1985 - 2018. There are two existing indicators are widely utilized cover primary gap and recursive algorithm. To deal with the potential of a random walk of the variables, the two-step system generalized method of moment (GMM) estimator is employed. Specifically, the current study constructs a new fiscal sustainability indicator by incorporating financial technology (FinTech) using principal component analysis (PCA) for 67 countries in 2014 and 2017. The new indicator is the main contribution on the existing literature of fiscal sustainability. The findings reveal that the debt rule has a positive and significant impact on the primary gap, either in the short- or medium-term, implying that the debt rule is effective in encouraging fiscal sustainability. Conversely, it has a negative and significant impact on the recursive algorithm. Similarly, this rule significantly contributes on the new indicator by incorporating FinTech. Therefore, policymakers are challenged to conduct this rule as a key fiscal rule in fiscal sustainability policy. The policymakers should also take more attention to increase the level of FinTech to guarantee fiscally sustainable level.

***Keywords*:** debt rule, fiscal sustainability, macroeconomic data, FinTech
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1. INTRODUCTION

Developing and developed countries have been advised to implement more prudent and disciplined fiscal policies to mitigate the impact of soaring public debt-to-GDP ratio and budget deficit (IMF, 2009). Besides, many academic papers hypothesize that fiscal rules can be utilized to stimulate and achieve more appropriate fiscal policy outcomes. One type of fiscal rule is the debt rule, which is a fiscal policy instrument that significantly contributes to fiscal sustainability because it is simple to communicate and monitor, and its policy framework is effective to implement (Tapp, 2013; Bergman, Hutchison & Jensen, 2016; and Dziemianowicz & Kargol-Wasiluk, 2017). Few empirical studies highlight the pivotal implications of the debt rule on fiscal sustainability (Bandaogo, 2020; Aaskoven & Wiese, 2019; Tapp, 2013; Brzozowski and Siwinska-Gorzelak, 2010). Conceptually, the contribution of debt rule on fiscal policy by considering rule breaking with extra cost and political process has been presented by Arawatari & Ono (2021). However, literature largely ignored the impact of debt rule on fiscal sustainability indicators in a better analysis. The better analysis can be depicted using a new fiscal sustainability indicator by considering multiple dimensions. Therefore, the current study will estimate the effectiveness of debt rule on new fiscal sustainability indicator. The new fiscal sustainability indicator will be constructed using principal component analysis (PCA). It can be called as new fiscal sustainability indicator by incorporating financial technology (FinTech). Empirically, PCA has been employed to assess new financial inclusion index by incorporating FinTech following Nizam, et al (2020).

The debt rule can be defined as the rule target for the level of public debt (Guerguil et al., 2017). There are several assumptions that should be fulfilled in the definition of the debt rule, that the fiscal policy framework considers the complete asset market without capital, the incomplete asset market without capital, and the incomplete asset market with capital (Fall, et al, 2015). Hence, the general definition of the debt rule is the thumb limit or target of the public debt-to-GDP ratio, which can produce a

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significant contribution to the level of fiscal sustainability. Guerson & Melina (2011) proposed some characteristics of debt rule such as credibility, primary expenditure smoothing, flexibility, and a medium-term macroeconomic framework.

The EU countries have discussed the debt rule as a fiscal policy framework for establishing debt anchors and debt sustainability (Hauptmeier & Christophe, 2020). In this context, they advocate a debt rule analysis framework based on the concept of a fiscal reaction function (FRF) to lead macroeconomic stability and debt sustainability in maintaining fiscal sustainability (Mackiewicz-Łyziak & Łyziak, 2019). In particular, the debt rule framework is aimed at achieving a prudent debt target to encourage fiscal discipline and allow for policy stabilization to promote fiscal sustainability (Salvi et al., 2020; Everaert & Jansen, 2018;OECD, 2015; Fall & Fournier, 2015). Moreover, the debt rule has particular advantages and disadvantages. For example, Dziemianowicz & Kargol-Wasiluk (2017) outlined some benefits of the debt rule consist of: (a) it provides a direct link to debt sustainability, and (b) it is simple to communicate and monitor. On the other hand, some disadvantages of the debt rule include: (a) the lack of clear operational guidance in the near term, (b) the absence of an economic stabilization feature, (c) the possibility to meet the rule through temporary measures, and (d) the vulnerability of public debt to external shocks.

Brzozowski & Siwinska-Gorzelak (2010) discovered that debt rule has a significant and negative effect on fiscal policy volatility in 89 countries between 1980 and 2006. Furthermore, Bergman et al. (2016) reinforced that between 1985 and 2012, as many as 8 of the 27 EU countries implemented the debt rule. They demonstrated that the debt rule has a significant and positive effect on the long-run viability of government finances. It suggests that a debt rule is an effective instrument for empowering fiscal sustainability. In contrast, from 1990 to 2012, the debt rule did not exhibit a significant effect on fiscal policy (such as public spending) in 167 developed and developing economies (Guerguil et al., 2017).

The debt rule can be assessed using a variety of indicators. The first indicator is a dummy variable as proposed by Brzozowski & Siwinska-Gorzelak (2010) and Guerguil et al. (2017). The second indicators include an index known as the fiscal rule index (FRI) and a dummy variable following Bergman et al. (2016). Subsequently, the debt rule can also be applied to a specific amount of nominal debt, such as a debt-to-GDP ratio of 60%. (Irish Fiscal Advisory Council, 2014). Therefore, the current study sets a dummy variable in which dummy equaling to 1 denotes the existence of a debt rule in a specific period of a country and dummy equaling to 0 denotes the absence of a debt rule in a particular period. The data of debt rule was gathered from the International Monetary Fund (IMF) fiscal rule dataset for 77 countries from 1985 to 2018.

Literature discuss the definition of fiscal sustainability in various ways. It means that there is no a unique definition and indicator of fiscal sustainability. For example, Blanchard, et al (1990) defined that sustainable fiscal policy concerns on the ratio of debt-to-GDP converges back towards its initial level. A simple definition argues that fiscal sustainability emphasizes a long-term fiscal policy without producing in excessive debt accumulation (Krejdl, 2006). In general, the fiscal sustainability reflects the ability of government to sustain current budget without default on debt obligations. Besides, the current study notes two existing indicators of fiscal sustainability can be widely employed such as a primary gap and recursive algorithm (Lau & Lee, 2021; Nxumalo & Hlophe, 2018; Asava-vallobh et al., 2018; Uryszek, 2016). These indicators are determined by public debt-to-GDP ratio, primary surplus-to-GDP ratio, real interest rate, and economic growth that are published by the World Bank and International Monetary Fund.

Fiscal policy, apart from business activities, can also be stimulated by financial technology (FinTech) in the form of budget (e-budgeting) and tax digitalization (e-taxation). In general, the literature of FinTech are mostly linked with monetary policy and banking practice (Mumtaz & Smith, 2020). However, other literature argue that FinTech delivers some benefits to fiscal policy and practice such as transparency, easy to communicate and efficient. Leong & Sung (2018) explain that FinTech is a combination of multiple subjects and categories. The subjects cover finance, technology management, and innovation management, while the categories will promote business value consist of payment, advisory service, financing, and compliance. Although fiscal sustainability can be linked to FinTech (Gohary, 2019; Cangiano et al., 2019; Otieno, et al, 2013) but the assessment of a new fiscal sustainability indicator by incorporating FinTech is largely ignored. FinTech will lead economic transaction more efficient, transparent and easy to communicate. The general knowledge of FinTech has been elaborated by Financial Stability Board (2017) that a technology stimulates financial innovation that can create new business models or products with linkages to financial markets and institutions. Global Findex Database provides FinTech indicators following the empirical study published by Nizam, et al (2020).

The current study constructs a new indicator of fiscal sustainability by incorporating FinTech dimension using the principal component analysis (PCA). In more detail, it also estimates the impact of debt rule on the new indicator using static panel data for selected countries in 2014 and 2017 following the Global Findex Database. Conceptually, PCA has been described by Jollife (2002) that PCA will reduce dimensionality of a data set of a large number of interrelated variables, while preserve as much as possible of the variation of data. It means that PCA will create a benefit for constructing a new index of fiscal sustainability.
Moreover, the current study intends to estimate the impact of the debt rule on the existing indicators of fiscal sustainability for 77 countries between 1985 and 2018. The debt rule is also selected to provide new evidence of its impact on new fiscal sustainability indicator by incorporating FinTech for 67 countries in 2014 and 2017. Thus, the current study employs three indicators of fiscal sustainability cover primary gap, recursive algorithm and FinTech. Besides, the several control variables are widely used in empirical studies of fiscal sustainability consist of the output gap, inflation, trade openness and current account balance (Mackiewicz-Łyziak & Łyziak, 2019; Everaert & Jansen, 2018; Bergmanet al., 2016). They argued that macroeconomic variables will stimulate fiscal policy in the long-run.

Other literature discussed the contribution of debt rule on fiscal policy instrument in conjunction with macroeconomic and monetary indicators. Nevertheless, the current study does not emphasize on this analysis since it cannot explicitly discuss the effectiveness of the debt rule on fiscal sustainability. For example, the debt targeting rule was also applied by Ferrero (2012), Guerson & Melina (2011), Tapp (2013), and Reicher (2014) to determine the fiscal policy and macroeconomic indicators. Ferrero (2012) examined the impact of debt targeting on inflation targeting. He contended that fiscal and monetary policy can be balanced if flexible inflation targeting is more robust than flexible debt targeting. Similarly, Cavalcanti et al. (2018) focused on the implications of fiscal rules. Meanwhile, Canh (2018) noted that external debt limits the effectiveness of the fiscal policy, particularly in highly indebted countries.

In some ways, the current study contributes to the existing literature. First, the current study estimates the impact of the debt rule's effectiveness on fiscal sustainability indicators that have been overlooked in the previous studies such as Tapp (2013) and Bergman et al. (2016). Second, the two-step system generalized method of moment (GMM) developed by Blundell and Bond (1998) is intended to demonstrate new evidence of the effectiveness of the debt rule. The next, a new indicator of fiscal sustainability by incorporating FinTech will be constructed for 67 countries in 2014 and 2017. In particular, several control variables commonly used in fiscal sustainability analysis, such as the output gap, inflation, trade openness, and current account balance, have been defined. Finally, the policymakers should set the debt rule in stimulating fiscal sustainability level. They should also pay more attention to increase the level of FinTech to guarantee fiscally sustainable level.

Our findings provide some evidences of the debt rule's effectiveness. First, the effects of the debt rule's effectiveness on fiscal sustainability differ depending on the type of fiscal sustainability indicators. The results of the two-step system GMM estimation, for example, express that the debt rule has a significant and positive impact on the short- and medium-term primary gap, but it has a significant and negative impact on the recursive algorithm. In particular, the current study also demonstrates the significant impact of debt rule on the new indicator of fiscal sustainability by incorporating FinTech. Therefore, the findings substantiate literature asserting that the debt rule is an effective fiscal policy. Finally, the control variables have a significant contribution on the fiscal sustainability indicators. It indicates that the level of macroeconomic data will determine the level of fiscal sustainability.

The organization of the current study covers some sections as follows. The first section is an introduction while the second section is a literature review. The third section exhibits the methodology, followed by the data. The next section discusses the result and discussion of GMM estimation, followed by the robustness check and static panel data estimation. The final section of this paper presents the conclusion and recommendation.

2. LITERATURE REVIEW

Theoretically, fiscal sustainability can be elaborated under the concept of intertemporal budget constraint (Akram & Rath, 2020; Paniagua et al., 2017). They argue that intertemporal budget constraint (IBC) emphasizes in analyzing public debt and primary balance. The IBC delivers some basic concepts cover the key component of fiscal sustainability is public debt-to-GDP ratio, and government can finance the initial public debt stock from primary surplus. Meanwhile, the concept of debt rule on fiscal policy sustainability has been spelled out by Aaskoven & Wiese (2019) and Hauptmeier & Christophe (2020).

Aaskoven & Wiese (2019) noted two theories which qualified the linkage between fiscal rules and debt sustainability cover a fiscal benchmark (numerator) effect and credibility (denominator) effect. The fiscal benchmark emphasizes on fiscal consolidation to stimulate a significant contribution of fiscal rules in reducing the level of public debt. The higher contribution of fiscal rules lead the lower level of public debt. Consequently, the level of fiscally sustainable level can be obtained. The next theory is a credibility effect. It argued that the governments can promote the higher level of credibility by choosing the fiscal instrument to improving fiscal balance and cutting government expenditure. The result is government gain of credibility by showing commitment. Therefore, fiscal rules produce fiscal policy credibility and in a non-Keynesian model drives an output expansion or sustainable debt reduction.

Other theories of fiscal rules (debt rule) on fiscal sustainability consist of debt rule design-pro-cyclicality nexus, and debt rule design-fiscal target nexus (Hauptmeier & Christophe, 2020). The debt rule design-pro-cyclicality nexus reported that the debt adjustment can be directly determined by the cycle of the budget balance but also it will be indirectly lead by higher GDP growth and lower debt accumulation. However, the debt rule design-fiscal target nexus pays more attention on the primary balance target and debt target of 60% of GDP. The debt target can be split into three regimes such as low debt level (less than 60% of GDP), high debt level (100% of GDP), and very high debt level (140% of GDP). Simply put, the countries received the debt target, the interest-growth differential stimulates the debt-stabilising primary balance. The result promotes fiscally sustainable when the debt rule design suppresses the higher debt accumulation and enhances the higher primary balance.
The linkage between financial technology (FinTech) and fiscal sustainability can be traced by previous studies. However, fiscal sustainability indicator by incorporating FinTech dimension is largely ignored. It will raise a question, for example: “Can

financial technology be a determinant of fiscal sustainability indicator?". Another question is what financial technology indicators can be used. Some indicators published by Global Findex Database can be selected as FinTech indicators such as digital payments, internet payment, and mobile phones payment (Nizam et al., 2020; Thakor, 2020).

Previous empirical studies have estimated recent pieces of evidence of fiscal rules and fiscal policy effectiveness, such as fiscal rules (target of deficit or debt constraint) and fiscal policy volatility (Guerguil et al., 2017; Brzozowski & Siwinska-Gorzelak, 2010), fiscal policy under distinctions in institutions and external debt levels (Guerguil et al., 2017; Brzozowski & Siwinska-Gorzelak, 2010), fiscal policy under differences in institutions and external debt levels (Canh, 2018), debt threshold for fiscal sustainability (Tran, 2018), and effectiveness of government spending policy in Brazil (Holland et al., 2020). The current study, in particular, estimates the effectiveness of the debt rule on fiscal sustainability by using the empirical findings evaluated by Bergman et al. (2016). Furthermore, it also refers to some literatures such as Brzozowski et al. (2010) and Guerguil et al. (2017).

Bergman et al. (2016) examined the impact of fiscal rules on long-term public finance in 27 EU countries from 1990 to 2012. They used the fiscal rule index (FRI) and dummy variables to evaluate the effectiveness of the balanced budget rule, expenditure rule, revenue rule, and debt rule using Blundell-Bond's System GMM estimator (1998). The findings suggest that the debt rule, a type of fiscal rule that has been put in place in eight EU countries, seems to have an efficacious impact on the sustainability of public finance. This is also supported by Brzozowski & Siwinska-Gorzelak (2010). In a broad sense, Brzozowski & Siwinska-Gorzelak (2010) noted that the fiscal rule can inhibit the value of the fiscal deficit (destabilize fiscal policy), whereas rule can also constrain the value of the public debt (stabilize effect).

Although some research has found that the debt rule affects fiscal sustainability, the discoveries of Guerguil et al. (2017) showed the opposite. They asserted that the debt rule cannot have a significant impact on fiscal policy. Their study was conducted on 167 developed and developing countries during 1990-2012. The findings encouraged the use of dynamic panel GMM estimation to evaluate the impact of debt rules on fiscal sustainability for developed and developing countries.

Moreover, Guerson & Melina (2011) reported that the debt targeting rule should meet certain criteria, such as credibility (commitment to the public debt band), primary expenditure smoothing (medium-term debt threshold), flexibility (under public debt targeting, primary spending is recalculated each year), and a medium-term macroeconomic framework (public debt targeting requires fiscal projections over the medium term). The debt rule was effective while revenue and spending rules were ineffective for Canadian provincial governments during 1981-2007 (Tapp, 2013). There are two characteristics of effective rules, namely: clear numerical objectives, and explicit timelines for policy actions and outcomes. Effective rules have two characteristics, namely: clear numerical objectives and explicit timelines for policy actions and outcomes. Besides, Reicher (2014) argued that in the presence of a moderate debt-multiplier combination, a debt-GDP targeting rule can promote instability, whereas a debt-level targeting rule can yield stability.

3. METHODOLOGY

3.1. Econometrics Techniques

The current study compiles a dataset of fiscal sustainability indicators, debt rule, and several control variables to be estimated using System GMM estimation. The primary gap and the recursive algorithm are two existing fiscal sustainability indicators are widely selected in the literature. The key variable in assessing these indicators is the public debt-to-GDP ratio. In the context of debt management, a government can make debt sustainability and an effective fiscal policy by enacting a debt targeting rule as a fiscal policy instrument (Dziemianowicz & Kargol-Wasiluk, 2017; and Tapp, 2013).

The two-step system generalized method of moment (GMM) estimator is utilized to qualify the study objective (Blundell & Bond, 1998). It is classified into two categories: (a) different GMM estimator (Arellano & Bond, 1991), and (b) system GMM estimator (Blundell & Bond, 1998). In general, the Different GMM focuses on the transformation of the equation in the form of first-difference and lagged levels of the regressors to avoid simultaneity bias. In contrast, the System GMM centers on combining the level and difference equations, and the lagged differences of the regressors. Two-step System GMM is employed because of its efficiency if compared to the one-step (Blundell & Bond, 1998).

Bergman et al. (2016), Brzozowski & Siwinska-Gorzelak (2010), and Guerguil et al. (2017) provide empirical evidences of the effectiveness of debt rule on fiscal sustainability. The current study sets a specific dependent variable, which is the fiscal sustainability indicators. It is used to identify the effect of the debt rule on the specific fiscal sustainability indicator for 77 countries following the IMF publication in the Fiscal Rule Dataset from 1985 to 2018. Therefore, the empirical model to be estimated is as follows:

$$FSI_{it} = \alpha_0 + \gamma FSI_{it-1} + \beta_1 DR_{it} + \beta_2 X_{it} + \mu_i + \varepsilon_t + v_{it} \quad (1)$$

Equation (1) exhibits that the fiscal sustainability indicators (FSI) are determined by the lagged of the dependent variable, debt targeting rule (DR) and control variables (X) consist of GDP gap (GDPGAP), inflation rate (INF), trade openness (TO), and current account balance (CAB). The *"i"* and *"t"* represent 77 countries and the period of 1985-2018, respectively. The α_0 is the intercept, while γ, β_1 and β_2 are the parameters of independent variables. In addition, μ_i represents the country fixed effects, ε_t is the time-specific effects, and v_{it} symbolizes the error term. The v_{it} is assumed to be independent and identically distributed with a mean zero and variance of σ^2. This empirical model is developed based on Blundell & Bond's system GMM (1998). Equation (1) can be rewritten as follows, where $u_{it} = \mu_i + \varepsilon_t + v_{it}$:

$$FSI_{it} = \alpha_0 + \gamma FSI_{it-1} + \beta_1 DR_{it} + \beta_2 X_{it} + u_{it} \quad (2)$$

The System GMM estimator was also applied by Bergman, Hutchison & Jensen (2016) to estimate the impact of the fiscal rule on sustainable public finance for 27 EU countries during 1990-2012. In particular, the current study re-estimates Equation (2) using the Difference GMM proposed by Arellano & Bond (1991). Through robustness checks, this estimation is performed to invest in the effectiveness of the debt rule on fiscal sustainability indicators.

Moreover, the impact of debt rule on the new fiscal sustainability indicator by incorporating FinTech dimension will be estimated using statics panel data. The current study will re-estimate the Equation (2) following the basic statics panel data, resulting:

$$FSf_{it} = \alpha_0 + \beta_1 DR_{it} + \beta_2 X_{it} + u_{it} \quad (3)$$

Fest denotes new fiscal sustainability by incorporating FinTech dimension, DR is dummy variable of debt rule, and X presents macroeconomic data. Besides, the Equation (3) will be estimated using Panel-OLS, Fixed Effects and Random Effects Methods.

3.2. Principal Component Analysis (PCA)

The current study constructs a new indicator of fiscal sustainability by incorporating financial technology (FinTech) dimension. The FinTech will be proxied by some indicators consisting of internet to pay bills or to buy something in the past year (% age 15+), mobile phone to pay bills (% age 15+) and digital payments in the past year (% age 15+) (Global Findex Database). The indicators have been selected by Nizam, et al (2020) to construct new financial inclusion index.

Jollife (2002) has elaborated the stages of PCA method by emphasizing the components of vector of variable, variance, covariance, and principal component. New fiscal sustainability indicator by incorpoting FinTech can be depicted following the basic Equations (4). The equations are formulated using the PCA approach, resulting:

$$FSf = w_1 X_i^{pg} + w_2 X_i^{ra} + w_3 X_i^{f} + \varepsilon_i \quad (4)$$

The X^{pg}, X^{ra}, and X^{f} are the dimensions of primary gap, recursive algorithm, and financial technology, respectively. The "i" represents the 77 countries, while ε is the total variations in two orthogonal parts, consisting of the variation caused by causal variables and the variation that comes from errors.

Nizam et al (2020) discussed the second stage of PCA which describes the assessment of new fiscal sustainability indicator by incorporating FinTech dimension (Equation 5), the equation is as follows:

$$FSf = \frac{\sum_{j=1}^{p} \lambda_j P_{ki}}{\sum_{j-1}^{p} \lambda_j} \quad (5)$$

Finally, the new fiscal sustainability indicator by incorporating FinTech dimension (Equation 6) can be obtained through the following PCA, resulting:

$$FSf = \frac{1}{2}\left[\frac{\sqrt{pg_k^2 + ra_k^2 + f_k^2}}{\sqrt{n}} + \left(1 - \frac{\sqrt{(z - pg_k)^2 + (z - ra_k)^2 + (z - f_k)^2}}{\sqrt{n}}\right)\right] \quad (6)$$

The *z* represents 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. Moreover, the basic equation of new indicator following Nizam et al. (2020), which is to estimate the financial inclusion index (IFI) of 63 countries in 2014 and 2017. They stated that the PCA estimation has a relatively difficult stage but the findings and conclusions produced are more precise and robust. The new fiscal sustainability indicator denotes that fiscally sustainable occurs when the value of the indicator is negative (-), while fiscally unsustainable occurs when the value of the indicator is positive (+).

3.3. Dataset

The dummy variable can be selected to assess the debt targeting rule indicator (Guerguil et al., 2017; Bergman et al., 2016; Brzozowski & Siwinska-Gorzelak, 2010). It corresponding to 1 indicates that a country's debt rule exists during a specific period, whereas 0 represents that the debt rule does not exist during that period. The data were gathered from the IMF fiscal rule dataset for 77 countries from 1985 to 2018.

Moreover, the data on the public debt-to-GDP ratio, primary surplus, real interest rate, and GDP growth are acquired from World Bank and IMF publications to estimate the recursive algorithm (Cruz-Rodrguez, 2014) and the primary gap (Uryszek, 2016; and Nxumalo & Hlophe, 2018). Some control variables, such as the output gap, inflation, trade openness and current account balance (Mackiewicz-Łyziak & Łyziak, 2019; Everaert & Jansen, 2018; Bergman et al., 2016) have been established. These variables are obtained from the World Bank and IMF. Tables 1 and 2 provide detailed descriptions of study variables and descriptive statistics.

Table 1: Research Variables

Variables	Description
Short-term primary gap using general government gross debt-to-GDP ratio (pggds)	a negative value equals fiscal sustainability while a positive value equals fiscal unsustainability
Short-term primary gap using general government net debt-to-GDP ratio (pgnds)	
Medium-term primary gap using general government gross debt-to-GDP ratio (pggdm)	
Medium-term primary gap using general government net debt-to-GDP ratio (pgndm)	
Recursive algorithm using general government gross debt-to-GDP ratio (ragd)	less 1 (sustainable) or more and equal 1 (unsustainable)
Recursive algorithm using general government net debt-to-GDP ratio (rand)	
Debt rule (dr)	Dummy of debt rules (1 = debt rule exists in a certain period and 0 = debt rule does not exist in a certain period).
Output gap (gdpgap)	The different of actual GDP and potential GDP. Output gap in a percent of potential GDP. Furthermore, GDP gap will be estimated as the deviation of actual GDP from long-run Path. The long-run path is estimated using Hodrick-Prescott (HP) filter.
Inflation rate (inf)	Inflation rate, consumer prices (percent).
Trade openness (to)	Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product. TO is in percent of GDP.

Variables	Description
Current account balance (cab)	Current account balance is the sum of net exports of goods and services, net primary income, and net secondary income. CAB is in percent of GDP.
New fiscal sustainability by incorporating FinTech dimension using general government gross debt-to-GDP ratio (fsfg) New fiscal sustainability by incorporating FinTech dimension using general government net debt-to-GDP ratio (fsfn)	An index of new fiscal sustainability indicator using financial technology (FinTech) dimensions. The FinTech indicators are proxied by internet payment (%), mobile payment (%) and digital payment (%). The index denotes that a negative value equals sustainable, while a positive value equals unsustainable.

Source: The World Bank, IMF, Global Findex Database and authors' calculation

Table 2 exhibits that three indicators of fiscal sustainability deliver various characteristics of fiscal sustainability levels. For example, the primary gap (both short- and medium-term) and recursive algorithm indicators have mean more than one (positive value). Consequently, most of samples (both developed and developing countries) face the risk of fiscally unsustainable level. In a certain period some countries are able to maintain fiscally sustainable level expressed by the negative of minimum values. Moreover, the new fiscal sustainability indicator by incorporating FinTech dimension demonstrates the fiscally sustainable for most samples. It can be tracked from the mean and minimum values are less than 1. The current study argues that the new indicator provides new evidence and contribution to the existing literature. Thus, FinTech significantly contributes to guarantee fiscal sustainability level in developed and developing countries.

Table 2: Descriptive Statistics

Variable	Mean	Std. Dev.	Min.	Max.
pggds	9.12	62.14	-88.25	90.05
pgnds	8.35	40.06	-75.20	89.17
pggdm	9.05	63.35	-87.56	90.01
pgndm	7.64	45.68	-78.59	90.02
ragd	8.01	17.80	-10.28	33.82
rand	6.05	15.39	-8.75	28.62
dr	0.54	0.50	0.00	1.00
gdpgap	-1.08	13.15	-228.88	9.16
inf	2.31	2.47	-1.42	12.44
to	86.43	48.69	17.32	396.55
cab	-4.33	7.84	-68.98	18.36
fsfg	0.07	1.02	-2.06	3.51
fsfn	-0.01	0.96	-1.97	2.69

Source: The World Bank dan IMF (processed)

4. RESULT AND DISCUSSION

4.1. The Main Findings

The empirical results of Equation (1) and (2) are presented in Table 3. Fiscal sustainability indicators include short-term primary gap, medium-term primary gap and recursive algorithm. As one of the key variables, the public gross debt-to-GDP ratio determines all of these indicators. In general, the findings depict that the debt rule has a direct and positive impact on the medium-term primary gap (Model 1d) under the two-step system GMM (Blundell & Bond, 1998). The findings of this research are following the results of the study conducted by Bergman et al. (2016). Therefore, the debt rule demonstrates an effective rule in fiscal sustainability policy.

However, the findings also portray that the debt rule has a significant and negative effect on the recursive algorithm (Model 1f) following the two-step system GMM, which is in line with the study by Brzozowski & Siwinska-Gorzelak (2010). This implies that the diverse indicators of fiscal sustainability will be responded to differently by the debt rule. Furthermore, because the level of public debt-to-GDP in developed countries is relatively higher than that in developing countries, the difference in the level of public debt-to-GDP between countries as the study samples also serves as a consideration for the effectiveness of the debt rule. Finally, the debt rule is ineffective since it does not show a discernible effect on the short-term primary gap (Model 1b).

Table 3: Results of Dynamic Panel System-GMM Estimations
Dependent Variable: Fiscal Sustainability Indicator
Period: 1985–2018, 5-year average

	Model 1a PGGDS-One Step	Model 1b PGGDS-Two Step	Model 1c PGGDM-One Step	Model 1d PGGDM-Two Step	Model 1e RAGD-One Step	Model 1f RAGD-Two Step
$PGGDS_{it-1}$	0.31*** (6.88)	0.26*** (8.34)				
$PGGDM_{it-1}$			0.32*** (6.65)	0.25*** (7.43)		
$RAGD_{it-1}$					0.17*** (3.93)	0.15*** (7.11)
DR_{it}	60.54 (1.23)	53.81 (1.57)	63.89 (1.24)	57.68* (1.81)	-7.54 (-1.24)	-8.77*** (-3.13)
$GDPGAP_{it}$	-22.17*** (-3.24)	-16.81*** (-4.39)	-21.99*** (-3.05)	-18.22*** (-4.52)	1.68** (2.02)	1.16*** (3.43)
INF_{it}	-6.52*** (-4.61)	-6.01*** (-7.56)	-7.30*** (-4.92)	-6.86*** (-13.05)	-0.01 (-0.13)	-0.01** (-2.00)
To_{it}	-3.59*** (-2.88)	-3.36*** (-3.57)	-4.29*** (-3.31)	-3.80*** (-3.88)	-0.12 (-0.82)	-0.00 (-0.06)
CAB_{it}	-3.03 (-0.85)	-7.83*** (-2.60)	-4.48 (-1.20)	-9.13*** (-3.13)	0.03 (0.05)	-0.17 (-0.84)
Sargan test	91.55	24.21	71.99	23.67	35.76	22.16
(p-value)	(0.00)	(0.19)	(0.00)	(0.21)	(0.01)	(0.28)
Autocorrelation of Order 1		-3.58		-3.09		-3.10
(p-value)		(0.00)		(0.00)		(0.00)
Autocorrelation of Order 2		-1.83		-1.87		0.85
(p-value)		(0.07)		(0.06)		(0.39)
N x T	77 x 7	77 x 7	77 x 7	77 x 7	77 x 7	77 x 7

Notes: All models are estimated using the Blundell and Bond (1998) estimations (Stata xtdpdsys command). Figures in the parentheses are t-statistics. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

The estimation results suggest the significant impact of control variables such as GDP (output) gap, inflation rate, and trade openness on fiscal sustainability indicators (short- and medium-term primary gap) under one- and two-step System GMM at 1% level (Model 1a-1d). Similarly, the current account balance has a noteworthy and negative effect on the short-term primary gap (Model 1b) and the medium-term primary gap (Model 1d). The findings reveal that only the GDP gap and inflation rate have statistically substantial implications for the recursive algorithm. For example, at a significance level of 1% under two-step System GMM (Model 1f) and 5% under one-step System GMM, the GDP gap has a significant and positive effect on the recursive algorithm (Model 1e). Meanwhile, at a significance level of 5%, the inflation rate has a significant and negative effect on the recursive algorithm in the two-step System GMM (Model 1f).

The control variables have a significant impact on fiscal sustainability. Bergman et al. (2016) argue that the lagged output gap shows a significant and negative impact, whereas inflation and trade openness demonstrate a positive impact. They specifically reported that an increase in inflation and trade openness would promote an increase in primary excess supply. Everaert & Jansen (2018) have both reviewed the same findings. Furthermore, they discuss that trade openness can reflect an international shock, which can be followed by more prudent fiscal policies. Mackiewicz-Łyziak & Łyziak (2019) found that the output gap has a significant and positive contribution to fiscal sustainability of 12 out of 27 countries, but a significant and negative impact on fiscal sustainability of 1 out of 27 countries.

Table 4 shows the estimation results of several fiscal sustainability indicators. The debt rule demonstrates an effective impact on fiscal sustainability for 77 countries in both one-step and two-step System GMM under short- and medium-term primary gap (Model 1g-1j). Therefore, the presence of a debt rule can encourage maintaining a certain level of fiscal sustainability.

The findings presented in Table 4 also reveal that the control variables have different contribution on different type of fiscal sustainability indicators. The output gap, for example, has a significant and negative impact on the short- and medium-term primary gap (Model 1g-1j), but it has a significant and positive impact on the recursive algorithm (Model 1l). This signals to policymakers that the output gap is a notable variable in the formulation of fiscal policy.

Table 4: Results of Dynamic Panel System-GMM Estimations
Dependent Variable: Fiscal Sustainability Indicator
Period: 1985–2018, 5-year average

	Model 1g PGNDS-One Step	Model 1h PGNDS-Two Step	Model 1i PGNDM-One Step	Model 1j PGNDM-Two Step	Model 1k RAND-One Step	Model 1l RAND-Two Step
$PGNDS_{it-1}$	0.26*** (5.34)	0.25*** (15.51)				
$PGNDM_{it-1}$			0.26*** (5.37)	0.25*** (15.20)		
$RAND_{it-1}$					0.01 (1.26)	0.05*** (60.61)
DR_{it}	60.47* (1.69)	31.44* (1.74)	64.74* (1.79)	45.26** (2.29)	-0.19 (-0.01)	0.70 (0.69)
$GDPGAP_{it}$	-14.78*** (-2.93)	-5.63* (-1.68)	-14.60*** (-2.86)	-7.63** (-2.42)	1.21 (0.46)	1.26*** (5.18)
INF_{it}	-0.41 (-0.40)	-0.24 (-1.03)	-0.42 (-0.41)	-0.26 (-1.06)	-0.01 (-0.21)	-0.02*** (-5.03)
To_{it}	-2.23** (-2.42)	-1.93*** (-5.82)	-2.35** (-2.51)	-2.01*** (-5.91)	0.18 (0.53)	0.18*** (22.97)
CAB_{it}	-7.27*** (-2.81)	-4.67*** (-3.37)	-7.09*** (-2.71)	-5.16*** (-3.78)	-0.67 (-0.45)	-0.63*** (-10.01)
Sargan test	69.38	25.15	67.15	26.76	3.2	27.99
(p-value)	(0.00)	(0.16)	(0.00)	(0.11)	(1.00)	(0.08)
Autocorrelation of Order 1		-2.08		-2.02		-1.84
(p-value)		(0.04)		(0.04)		(0.07)
Autocorrelation of Order 2		-2.06		-2.07		0.92
(p-value)		(0.04)		(0.04)		(0.36)
N x T	77 x 7	77 x 7	77 x 7	77 x 7	56 x 7	56 x 7

Notes: All models are estimated using the Blundell and Bond (1998) estimations (Stata xtdpdsys command). Figures in the parentheses are t-statistics. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

The inflation rate expresses a significant and negative effect on recursive algorithm following the two-step System GMM at 1% level. This implies that an increase in the inflation rate can provide changes to a particular level of fiscal sustainability for 77 countries. Meanwhile, trade openness has a significant and negative impact on the short- and medium-term primary gap at 1% level. Therefore, policymakers can be wary of international shocks in the formulation of fiscal sustainability policies. Finally, the current study discovers that the current account balance has a significant and negative impact on the short- and medium-term primary gap under the two-step System GMM at 1% level.

4.2. Robustness Checks

The robustness check is executed by re-estimating Equations (1) and (2) under the Difference GMM estimator (Arellano & Bond, 1991) under both one-step and two-step estimations. The findings reveal that the debt rule has a significant and negative impact on the recursive algorithm at 10% level (Models 2e and 2f). Furthermore, Table 5 confirms that the findings of the system GMM (Tables 3 and 4) provide a better empirical evidence about the effectiveness of the debt rule on fiscal sustainability for 77 countries during 1985-2018.

Table 5: Results of Dynamic Panel Difference-GMM Estimations
Dependent Variable: Fiscal Sustainability Indicator
Period: 1985–2018, 5-year average

	Model 2a	Model 2b	Model 2c	Model 2d	Model 2e	Model 2f

	PGGDS-One Step	PGGDS-Two Step	PGGDM-One Step	PGGDM-Two Step	RAGD-One Step	RAGD-Two Step
	0.17***	0.16***				
$PGGDS_{it-1}$	(2.88)	(4.44)				
			0.17	0.15		
$PGGDM_{it-1}$			(2.75)***	(4.14)***		
					0.09	0.08***
$RAGD_{it-1}$					(1.51)	(4.14)
	35.06	35.67	36.83	35.15	-9.95*	-6.35*
DR_{it}	(0.75)	(1.03)	(0.75)	(1.00)	(-1.69)	(-1.91)
	-21.68***	-15.59***	-22.34***	-15.73***	1.92**	1.10**
$GDPGAP_{it}$	(-3.35)	(-3.79)	(-3.28)	(-3.67)	(2.41)	(2.42)
	-7.53***	-6.79***	-8.14***	-6.87***	-0.01	-0.01***
INF_{it}	(-5.69)	(-11.85)	(-5.86)	(-8.31)	(-0.26)	(-3.36)
	-5.89***	-4.61***	-6.37***	-4.76***	-0.07	0.04
To_{it}	(-4.24)	(-3.95)	(-4.35)	(-3.86)	(-0.42)	(0.49)
	-4.42	-4.91	-4.44	-5.06	-0.12	-0.09
CAB_{it}	(-1.18)	(-1.55)	(-1.12)	(-1.56)	(-0.25)	(-0.33)
Sargan test	43.10	16.33	38.32	16.42	20.34	13.32
(p-value)	(0.00)	(0.29)	(0.00)	(0.29)	(0.12)	(0.50)
Autocorrelation of Order 1	-4.81	-3.37	-5.02	-3.07	-5.36	-3.16
(p-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Autocorrelation of Order 2	-3.09	-2.00	-2.66	-2.04	-0.40	0.54
(p-value)	(0.00)	(0.05)	(0.01)	(0.04)	(0.69)	(0.59)
N x T	77 x 7	77 x 7	77 x 7	77 x 7	77 x 7	77 x 7

Notes: All models are estimated using the Arellano and Bond (1991) estimations (Stata xtabond command).
Figures in the parentheses are t-statistics. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

4.3. New Evidence of Debt Rule on Fiscal Sustainability

The current study estimates Equation (3) about the impact of the debt rule on the new indicator of fiscal sustainability by incorporating FinTech dimension. The new indicator can be interpreted as follows, a negative value indicates a country is able to maintain the level of fiscal sustainability, while a positive value depicts that a country faces the risk of fiscal unsustainability.

The findings elaborate that the debt rule has a significant and negative impact on new fiscal sustainability indicator under Random Effects estimation. It means that the debt rule contributes significantly to the level of fiscal sustainability in selected countries in 2014 and 2017. Policymakers should take more attention to the debt rule within the framework of fiscal sustainability policies and practices. Several macroeconomic variables have a significant impact on fiscal sustainability, including the inflation rate and current account balance. These macroeconomic variables will stimulate the level of fiscal sustainability. Macroeconomic policies should be synergized within the fiscal sustainability framework. In particular, the result in Table 6 reflects new evidence and a significant contribution in the literature of fiscal sustainability.

Table 6: Results of Statics Panel Estimations
Dependent Variable: Indicators of Fiscal Sustainability by Incorporating FinTech dimension
Period: 2014 and 2017

	Indicator of FSFG			Indicator of FSFN		
	Model 3a OLS	Model 3b Fixed Effects	Model 3c Random Effects	Model 3d OLS	Model 3e Fixed Effects	Model 3f Random Effects
	2.90***	-1.09	2.91***	2.22***	0.03	2.19***
Constant	(4.26)	(-0.90)	(3.35)	(3.37)	(0.02)	(2.56)
	-2.93***	0.41	-2.92***	-2.29***	-0.33	-2.33***
DR_{it}	(-4.35)	(0.52)	(-3.39)	(-3.50)	(-0.46)	(-2.74)
	0.09**	0.04	0.07*	0.06	0.13**	0.10**
INF_{it}	(2.16)	(0.77)	(1.80)	(1.27)	(2.06)	(2.33)
	-0.01	-0.04	-0.03	0.01	-0.02	-0.01
$GDPGAP_{it}$	(-0.11)	(-1.34)	(-0.99)	(0.17)	(-0.55)	(-0.27)
	-0.01	0.01	-0.01	-0.01	-0.01	-0.01
TO_{it}	(-0.48)	(0.83)	(-0.34)	(-0.69)	(-0.04)	(-0.59)

	Indicator of FSFG			Indicator of FSFN		
	Model 3a OLS	Model 3b Fixed Effects	Model 3c Random Effects	Model 3d OLS	Model 3e Fixed Effects	Model 3f Random Effects
CAB_{it}	0.04** (2.50)	0.06* (1.86)	0.04** (2.29)	0.02 (1.25)	0.05 (1.27)	0.04* (1.82)
R-squared	0.15	0.0005	0.17	0.10	0.02	0.14
Observation	127	127	127	96	96	96
Group	67	67	67	50	50	50

Notes: The Hausman test and Breusch & Pagan Lagrangian multiplier test indicate that Random Effects (RE) estimation is appropriate at significant level of more than 5% and less than 5%, respectively. Moreover, the multicollinearity test presents that panel data is less collinearity (mean vif = 1.30). The values in parantheses () denote t-statistics, while ***, ** and * indicate significant level at 1%, 5% and 10%, respectively.

5. CONCLUSION

The findings reveal that the effectiveness of the debt rule on fiscal sustainability varies according to the type of fiscal sustainability indicators and the public debt-to-GDP ratio as one of the key variables. For example, the debt rule has a significant effect on the medium-term primary gap and recursive algorithm when the estimation of Equations (1) and (2) employ the public gross debt-to-GDP ratio. Meanwhile, valuing the two equations using the public net debt-to-GDP ratio denotes that the debt rule has a significant impact on the short- and medium-term primary gap. The Equation (3) results a new evidence the significant impact and negative of debt rule on new fiscal sustainability indicator by incorporating FinTech dimension. It means that policymakers should take more attention the role of debt rule on fiscal sustainability policy and practice.

The policymakers are challenged to conduct the debt rule as policy rule to stimulate fiscal sustainability. Policymakers are also expected to be more careful and disciplined in formulating and implementing fiscal policy. The new evidence expresses that debt rule significantly contributes to new fiscal sustainability indicator by incorporating FinTech dimension, so the policymakers should increase the level of FinTech and maintain public debt-to-GDP ratio at a certain level. In addition, macroeconomic variables (domestic shock) such as the output gap and inflation rate as well as international shock such as trade openness and current account balance also have significant impacts on fiscal sustainability. Therefore, policymakers can synchronize macroeconomic and fiscal sustainability policy in the future.

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REFERENCES

Aaskoven, L. & Wiese, R. (2019). *How Fiscal Rules Matter for Government Debt Reduction: Theory and Evidence. PEIO*. Retrieved from https://www.peio.me/wp-content/uploads/2019/01/PEIO12_paper_14_pdf.

Akram, V. & Rath, B.N. (2020). What Do We Know about Fiscal Sustainability Across Indian States? *Economic Modelling, 87*, 307-321. https://doi.org/10.1016/j.econmod.2019.08.005

Arawatari, R., & Ono, T. (2021). Public Debt Rule Breaking by Time-Inconsistent Voters. *European Journal of Political Economy, 69*, 102010. doi:10.1016/j.ejpoleco.2021.102010

Arellano, M. & Bond, S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and An Application to Employment Equations. *Review of Economic Studies*, *58*(2), pp. 277–297.

Asava-vallobh, N., Aroonvisoot, R. & Yangwiwat, C. (2018). Fiscal Sustainability Assessment: The Case of Thailand. *Journal of Economics and Management Strategy, 5*(2), 111-134.

Bandaogo, M.S. (2020). Fiscal Rules in Times of Crisis. *Research and Policy Brief*, No. 36, 1-4. World Bank. This paper is available at: https://documents1.worldbank.org/curated/en/929971594958133343/pdf/Fiscal-Rules-in-Times-of-Crisis.pdf.

Bergman, U. M., Hutchison, M.M. & Jensen, S.H.E. (2016). Promoting Sustainable Public Finances in The European Union: The Role of Fiscal Rules and Government Efficiency. *European Journal of Political Economy, 44,* 1–19. doi:10.1016/j.ejpoleco.2016.04.005

Blanchard, O., Chouraqui, J.-C., Hagemann, R.P. & Sartor, N. (1990). The Sustainability Fiscal Policy: New Answers to An Old Questions. *OECD Economic Studies*, *15*, 1–36.

Blundell, R. & Bond, S. (1998). Initial Conditions and Moment Restrictions in Dynamic Panel Data Models. *Journal of Econometrics*, 87, 115–143.

Brzozowski, M. & Siwinska-Gorzelak, J. (2010). The Impact of Fiscal Rules on Fiscal Policy Volatility. *Journal of Applied Economics, XIII, 2,* 205-231.

Cangiano, M., Gelb, A. & Goodwin-Groen, R. (2019). Public Financial Management and the Digitalization of Payments. *CGD Policy Paper 144,* 1-32. Center for Global Development. This paper is available at: https://www.cgdev.org/sites/default/files/public-financial-management-and-digitalization-payments.pdf

Canh, N. P. (2018). The Effectiveness of Fiscal Policy: Contributions from Institutions and External Debts. *Journal of Asian Business and Economic Studies, 25, 1,* 50-66. https://doi.org/10.1108/JABES-05-2018-0009

Cavalcanti, M. A.F.H., Vereda, L., Doctors, R. de B., Lima, F. C., & Maynard, L. (2018).The Macroeconomic Effects of Monetary Policy Shocks Under Fiscal Rules Constrained by Public Debt Sustainability. *Economic Modelling, Vol. 71,* 184-201. https://doi.org/10.1016/j.econmod.2017.12.010

Cruz-rodriguez, A. (2014). Assessing Fiscal Sustainability in Some Selected Countries. *Theoretical and Applied Economics, Asociatia Generala a Economistilor Din Romania - AGER, 6*(595), 7–22.

Dziemianowicz, R.I. & Kargol-Wasiluk, A. (2017). The Influence of Fiscal Rules on the Fiscal Stability in the EU Member States. *European Journal of Economics and Business Studies, 3*(2), 212-224.

Everaert, G. & Jansen, S. (2018). On The Estimation of Panel Fiscal Reaction Functions: Heterogeneity or Fiscal Fatigue? *Economic Modelling, 70,* 87–96. doi:10.1016/j.econmod.2017.10.014

Fall, F. & Fournier, J.-M. (2015). Macroeconomic Uncertainties, Prudent Debt Targets and Fiscal Rules. *OECD Working Paper No. 1230,* 1-46.

Fall, F., Bloch, D., Fournier, J.-M. & Hoeller, P. (2015). Prudent Debt Targets and Fiscal Frameworks. *OECD Economic Policy Papers*, No. 15. Paris: OECD Publishing. https://doi.org/10.1787/5jrxtjmmt9f7-en.

Ferrero, A. (2012). The Advantage of Flexible Targeting Rules. *Journal of Money, Credit and Banking, 44*(5), 863-881. https://doi.org/10.1111/j.1538-4616.2012.00513.x

Financial Stability Board (2017). *Financial Stability Implication from FinTech*. Switzerland. This paper is available at: https://www.fsb.org/2017/06/financial-stability-implications-from-fintech/

Gohary, E.E. (2019). The Impact of Financial Technology on Facilitating E-Government Services in Egypt. *Journal of Distribution Science, 17*(5), 51-59. http://dx.doi.org/10.15722/jds.17.05.201905.51

Guerguil, M., Mandon, P. & Tapsoba, R. (2017). Flexible Fiscal Rules and Countercyclical Fiscal Policy. *Journal of Macroeconomics, 52, 189–220.* doi:10.1016/j.jmacro.2017.04.007

Guerson, A. & Melina, G. (2011). Public Debt Targeting: An Application to the Caribbean. *IMF Working Paper*, No. WP/11/203, 1-38. IMF. This paper is available at: https://www.imf.org/en/Publications/WP/Issues/2016/12/31/Public-Debt-Targeting-An-Application-to-the-Caribbean-25184

Hauptmeier, S. & Christophe, K. (2020). Debt Rule Design in Theory And Practice: the SGP's debt benchmark revisited. *European Central Bank Working Paper Series No. 2379,* 1-40.

Holland, M., Marcal, E. & de Prince, D. (2020). Is Fiscal Policy Effective in Brazil? An Empirical analysis. *The Quarterly Review of Economics and Finance, 75,* 40-52. https://doi.org/10.1016/j.qref.2019.03.002

Howlin, J. (2014). Future Implication of the Debt Rule. *Analytical Note* No. 5, 1-7. Irish Fiscal Advisory Council. This paper is available at: https://www.fiscalcouncil.ie/wp-content/uploads/2015/03/Website-AN5.pdf

IMF (2009). Fiscal Rules: Anchoring Expectations for Sustainable Public Finances. *Policy Paper*, 1-72. This paper is available at: https://www.imf.org/en/Publications/Policy-Papers/Issues/2016/12/31/Fiscal-Rules-Anchoring-Expectations-for-Sustainable-Public-Finances-PP4402

Jollife, I.T. (2002). *Principal Component Analysis.* Second Edition. New York: Springer-Verlag.

Krejdl, A. (2006). Fiscal Sustainability-Definition, Indicators and Assessment of Czech Public Finance Sustainability. *Working Paper Series,* No. 3. Czech National Bank. This paper is available at: https://www.cnb.cz/en/economic-research/research-publications/cnb-working-paper-series/Fiscal-Sustainability-Definition-Indicators-and-Assessment-of-Czech-Public-Finance-Sustainability-00001

Lau, E. P. H. & Lee, A. S.-Y. (2021) Tracing Fiscal Sustainability in Malaysia. *Journal of Asian Finance, Economics and Business, 8 (3),* 91-98. doi:10.13106/jafeb.2021.vol8.no3.0091

Leong, K. & Sung, A. (2018). FinTech (Financial Technology): What is It and How to Use Technologies to Create Business Value in FinTech Way? *International Journal of Innovation, Management and Technology, Vol. 9, No. 2,* 74-78. doi: 10.18178/ijimt.2018.9.2.791

Mackiewicz-Łyziak, J. & Łyziak, T. (2019). A New Test for Fiscal Sustainability with Endogenous Sovereign Bond Yields: Evidence for EU Economies. *Economic Modelling, 82,* 136-151. doi:10.1016/j.econmod.2019.01.001

Mumtaz, M. Z., & Smith, Z.A. (2020). Empirical Examination of The Role of FinTech in Monetary Policy. *Pacific Economic Review, 25*(5), 620-640. doi:10.1111/1468-0106.12319

Nizam, R., Karim, Z. A., Rahman, A. A. & Sarmidi, T. (2020). Financial Inclusiveness and Economic Growth: New Evidence Using A Threshold Regression Analysis. *Economic Research, 33 (1),* 1465-1484, DOI:10.1080/1331677X.2020.1748508

Nxumalo, W. N. & Hlophe, N. F. (2018). Assessing Fiscal Sustainability in Swaziland. South African *Journal of Economic and Management Sciences 21(1)*, a1821. https://doi.org/10.4102/ sajems.v21i1.1821

OECD (2015). Achieving Prudent Debt Targets Using Fiscal Rules. *Policy Notes,* No.28, 1-8. http://www.oecd.org/eco/achieving-prudent-debt-targets-using-fiscal rules.htm

Otieno, O. C., Oginda, M., Obura, J. M., Aila, F. O., Ojera, P. B., & Siringi, E. M. (2013). Effect of Information Systems on Revenue Collection by Local Authorities in Homa Bay County, Kenya. *Universal Journal of Accounting and Finance, 1(1),* 29-33. DOI: 10.13189/ujaf.2013.010104

Paniagua, J., Sapena, J. & Tamarit, C. (2017). Fiscal Sustainability in EMU countries: A Continued Fiscal Commitment? *Journal of International Financial Markets, Institutions and Money, 50,* 85–97. Doi:10.1016/j.intfin.2017.08.014

Reicher, C. A. (2014). Fiscal Targeting Rules And Macroeconomic Stability Under Distortionary Taxation. *Kiel Working Paper*, No. 1968, 1-34. Kiel Institute for the World Economy (IfW), Kiel. This paper is available at: https://www.econstor.eu/bitstream/10419/103771/1/803541775.pdf

Salvi, M., Schaltegger, C. A. & Schmid, L (2020). Fiscal Rules Cause Lower Debt: Evidence from Switzerland's Federal Debt Containment Rule. *Kyklos: International Review for Social Science, 73*(4), 605-642. doi:10.1111/kykl.12251

Tapp, S. (2013). The Use and Effectiveness of Fiscal Rules in Canadian Provinces. *Canadian Public Policy /Analyse de Politiques, 39*(1), 45-70. http://www.jstor.org/stable/23594702

Thakor, A. V. (2020). Fintech and Banking: What Do We Know? *Journal of Financial Intermediation*, *41*, 100833. DOI: https://doi.org/10.1016/j.jfi.2019.100833

Uryszek, T. (2016). Primary Deficit Indicator, Tax Gap, and Fiscal Sustainability: Evidence from Central and Eastern EU Member States. *Finance – Journal of the Committee on Financial Sciences of the Polish Academy of Sciences*, *9(1),* 103-116.