Fiscal sustainability in developing Asia – new evidence from panel correlated common effect model

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Abstract

Purpose – The purpose of this paper is to investigate the problem of fiscal sustainability for a panel of developing Asian economies.

Design/methodology/approach – In this study, cross-section dependence and heterogeneity are controlled while estimating the fiscal reaction function, which shows how governments react to the accumulation of public debt. The study employs the common correlated effects mean group estimator in Pesaran (2006) for a panel of 22 developing Asian economies for the period 1999–2017.

Findings – It is found that the fiscal sustainability issue in the region is not so benign as in previous studies. Overall, fiscal policy is unsustainable, even for the nonlinear fiscal rule. Country-specific long-run coefficients are also examined in the study.

Research limitations/implications – The findings show that many developing economies in the region could not satisfy the intertemporal budget constraint, which raises concerns about debt sustainability in the area, especially for the post-crisis period.

Originality/value – This study investigates whether governments can maintain the sustainability of public finances in the long-run, if the ratios of public debt over GDP and primary deficit over GDP continue their recent problematic trends. Another novelty is controlling for heterogeneous effects among the countries in the region to give a more precise picture of debt sustainability. The empirical evidence also supports that insolvency risk can occur at low levels of public debt.

Keywords Fiscal sustainability, CCEMG, Developing Asia

Paper type Research paper

1. Introduction

The notion of fiscal sustainability indicates the ability of the government to smoothly finance its budget without excessive accumulation of public debt in the long-run. The government should be solvent and capable to repay its debt at a certain point in the future (Camarero *et al.*, 2015; Adams *et al.*, 2010). More often, a technical definition of fiscal sustainability can be derived from the government intertemporal budget constraint (IBC). A sustainable budget process requires that the expected present discounted value of all future stock of debt converges to 0 (Trehan and Walsh, 1991).

The two most important indicators of fiscal sustainability are the primary balance and the level of public debt. The sustainability of public finances in Asia is questionable when looking at the evolution of the primary balance and public debt series (Figure 1). The ratio of public debt over GDP tended to increase after 2010, along with the continuous degradation of the primary balance. The primary balance returned to its lowest level since 2000 in 2017.

Furthermore, the fiscal sustainability question in Asia should receive more attention after the implementation of the counter-cyclical fiscal stimulus packages, which were aimed
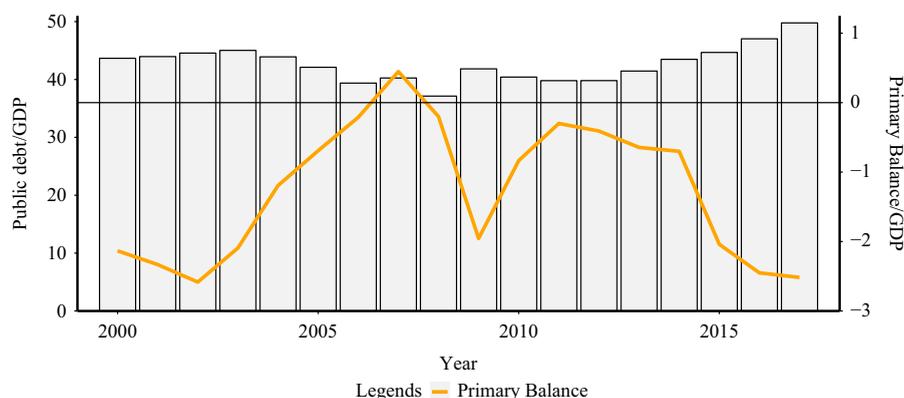
Source: WEO–IMF database (2018)

Figure 1.
Average public debt
and primary balance
in Asia (2000–2017)

to lift the region's economies from recession. The expansionary fiscal policy after the global financial crisis conducted in many countries in the regions would lead to higher levels of public debt and short-term refinancing costs. Increasing debt burden can have some mid-term to long-term negative impacts on the government budget balance. Thus, governments should design an appropriate exit strategy after injecting the liquidity to reverse the expansionary policy.

Even if the economy is not in recession, opposite political forces can put pressure on the reversal of tax reduction policy previously instrumented. Rolling back expansionary welfare programs implemented in a recession can also be difficult. In political economics literature, it is shown that increasing expenditures and cutting taxes during busts are more likely than reducing spending and raising taxes during booms. Thus, the aftermaths of an expansionary counter-cyclical fiscal policy can be unfavorable, with a tendency of increasing government expenditures and public debt (Adams *et al.*, 2010).

The above arguments put a question on fiscal sustainability in the Asian region in recent years. If the ratios of public debt over GDP and primary deficit over GDP continue to rise, can the governments maintain the sustainability of public finances in the long-run? Previous empirical studies on the region have the sample ended before 2010, whereas the evolution of public debt and primary balance shows an unambiguous increasing trend after 2010 (Adams *et al.*, 2010; Thornton and Adedji, 2010; Ferrarini and Ramayandi, 2016). Thus, these studies do not account for the fiscal sustainability in the post-crisis period. Our paper is filling this gap in the recent literature. In addition, the paper contributes to the related literature by showing that the problem of unsustainability can occur at low levels of public debt in the Asia-Pacific region. This result relates directly to the notion of debt-intolerant countries (Reinhart *et al.*, 2003). These economies would have lower debt thresholds because of weak fiscal structures and financial systems. Another reason steams from the predominance of pro-cyclical policies in Asian countries, which is well documented in previous studies (Bui *et al.*, 2018; Frankel *et al.*, 2013). Pro-cyclical spending bias, narrow automatic stabilizers and limited access to credit markets create insufficient fiscal space for these countries to react (Kaminsky *et al.*, 2004). Thus, insolvency can occur at very shallow debt levels.

Furthermore, estimates from previous studies may be biased and inconsistent since the problems of cross-section dependence and heterogeneity among countries were not considered. Much attention has been paid to the cross-section dependence in macro-panel data recently (Mercan, 2014; Paniagua *et al.*, 2017; Feld *et al.*, 2018). Panel members can be

commonly affected by global shocks with different impacts, such as the global financial crisis. Besides, the conduct of fiscal policy can be different among the countries in the region because of their diverse characteristics. Thus, the assumption of a homogeneous slope coefficient is a strong assumption and is more likely to be violated. This problem deserves full attention because of the perplex interactions and dependencies across time dimension and a cross-section dimension of a panel data (Afonso and Rault, 2010). Another contribution relates to the fact that, after controlling for cross-section dependence, our findings challenge the previous results of previous literature, for instance Thornton and Adedji (2010) and Adams *et al.* (2010).

The rest of the paper is organized as follows. Section 2 reviews the literature on fiscal sustainability. Section 3 provides an analytical framework and existing empirical strategies that are used to examine sustainability. We also discuss the shortcomings of each method and decide the most suitable strategy in our situation. Section 4 presents and discusses the empirical results. Finally, Section 5 concludes the study.

2. Literature review
2.1 Development in methodology
The origin of literature on fiscal sustainability dates back to the late 1980s and early 1990s (Buiter, 1985; Hamilton and Flavin, 1985; Blanchard, 1990; Blanchard *et al.*, 1991; Trehan and Walsh, 1988, 1991; Hakkio and Rush, 1991). Hamilton and Flavin (1985) are among the first authors to examine fiscal sustainability through testing the IBC. In a similar vein, fiscal policy is considered sustainable if the government can fulfill its intertemporal liabilities (Blanchard, 1990) or the ratio of public debt/GNP converges to its initial value (Blanchard *et al.*, 1991).

Another strand of literature concentrates on the transversality condition of the IBC. Fiscal sustainability requires that there is No-Ponzi scheme, that is the government cannot roll over its debt forever. This condition implies that government receipts and government expenditures inclusive of interest payment should exhibit a long-run co-integration relationship (Hakkio and Rush, 1991). This co-integration approach is similar to Haug (1991), but Hakkio and Rush (1991) assumed varying real interest rate, whereas Haug (1991) assumed constant real interest rate. The real interest rate is assumed stationary around a constant mean, which implies that the government budget constraint should not be analyzed in nominal term, as the probability of stationarity of nominal interest rate is less (Hakkio and Rush, 1991). An equivalent test is examining the co-integration between the deficit inclusive of interest and the stock of debt (Trehan and Walsh, 1988). Trehan and Walsh (1991) went further with the interest rate assumption. If the real interest rate is constant, the co-integration test is valid, and the IBC holds, if the interest-inclusive deficit is stationary. However, given that the expected real interest rate is not a constant, then the validity of the co-integration test is no longer ensured. Fortunately, on the condition that the real interest rate is positive, the stationarity of the deficit inclusive of interest satisfies the IBC. Their empirical findings suggest that the assumption of a constant real interest rate is questionable and the null hypothesis of unit root is difficult to reject with short time series.

The unit root test approach is challenged by Bohn (1998), who took a whole different strategy to analyze fiscal sustainability. The inconsistency and misleading of the non-stationary test come from the fact that it does not take into account cycle variations in GDP and government expenditures. He proposed a new way to test fiscal sustainability by estimating a fiscal reaction function. If the primary balance increases after any arbitrary accumulation in lagged public debt, the fiscal policy is deemed to be sustainable. A positive response of the primary balance suggests that the government is counteracting the increase in public debt. This approach has several advantages since it does not impose any restrictions on the interest rate and its assumption is relatively weak (Bohn, 1998). In his

recent work, Bohn (2007) criticized further the validity of the unit root and co-integration tests. He showed that the IBC is still satisfied after an arbitrary number of differencing procedures of the debt series, as well as the government revenues and expenditures inclusive of interest. However, he reconciled the approach in the works of Bohn (1998) and Trehan and Walsh (1991), by showing that the error-correction type of model can imply sustainability without stationary driving process of the debt series.

Previous literature has developed a robust framework to test for fiscal sustainability. The first generation of tests relies on testing the consistency of fiscal variables with the IBC. However, Bohn (1998, 2007) pointed out the limitation of these tests and proposed another test, focussing on estimating a fiscal reaction function to circumvent the weaknesses of the former.

2.2 Empirical results for developed economies
Empirical studies on fiscal sustainability mainly focus on developed economies, namely the G7, OECD or Western European countries (Afonso, 2005; Afonso and Jalles, 2015; Feve and Henin, 2000; Fincke and Greiner, 2011; Ghosh *et al.*, 2013; Guleryuz, 2017; Mercan, 2014; Miyazaki, 2014; Neaime, 2015). Feve and Henin (2000) examined the sustainability of public finances in the G7 countries by employing the stationarity of the public debt ratio, rather than using the No-Ponzi condition. However, they did not discard the unit root and co-integration tests, but rather, they augmented the ADF test with the feedback from inherited debt to current surplus to form a new feedback unit root test. This new test can reject the null hypothesis of non-stationarity more than two cases, compared to the conventional ADF test. Their empirical results show a robust unsustainable fiscal policy in continental Europe and Canada. In a recent work on the G7 group, Guleryuz (2017) investigated the fiscal policy before, during and after the global financial crisis in 2008. Fiscal sustainability is negatively affected by the crisis, population aging and rising expenditures in healthcare.

For the OECD countries, Mercan (2014) retained the approach through the fulfillment of the IBC of the fiscal variables. Using the panel co-integration test after controlling for cross-section dependence, structural breaks and unit root, he showed that budget deficits in 18 OECD countries from 1980 to 2012 are sustainable in a weak form. Similar results for the OECD group in the period 1970–2010 can be found in the work of Afonso and Jalles (2015). Whereas Mercan (2014) only considered co-integration between government receipts and spending, Afonso and Jalles (2015) considered both types of co-movements: revenues and expenditures, primary balance and lagged debt. However, they found that the marginal long-run coefficients in both specifications are 0.

Another bulk of papers investigated the fiscal sustainability for European countries. Afonso's (2005) research for 15 European economies showed that most governments in the continent have to face the unsustainable issue, even though the debt ratio tends to be stable since the late 1990s. Germany, Netherlands, Finland, Austria and the UK are five countries having the least problem of unsustainable policy, but they should take into account the problem of weak sustainability as well as population aging. Different from the empirical approach in the study of Afonso (2005), Fincke and Greiner (2011) adopted the strategy proposed by Bohn (1998) by investigating how the primary balance responds to changes in the debt ratio. Among the seven European countries in the sample (France, Germany, Ireland, Portugal, Spain, Italy and Greece), they found that fiscal policy is unsustainable in Greece and Italy. These seven European countries are also investigated in the study of Neaime (2015). France and Germany have the highest sustainability. For the remaining economies, their fiscal policies are sustainable in the 1970s and 1980s, but their weaknesses start to appear after the financial crisis of 2008. Recent work has started to consider cross-section dependence and heterogeneity among these countries (Mercan, 2014; Afonso and Jalles, 2015).

2.3 Empirical results for Asian countries

Compared to the developed countries, fiscal sustainability is also examined for Asia, but with a lesser frequency (Adams *et al.*, 2010; Ferrarini and Ramayandi, 2016; Thornton and Adedji, 2010). Using panel co-integration techniques, Thornton and Adedji (2010) showed that fiscal policies in five Asian economies are in a weak form of sustainability. In particular, government revenues and expenditures are co-integrated, but the long-term coefficients are strictly less than one. Adams *et al.* (2010) and Ferrarini and Ramayandi (2016) came up with entirely different results regarding the fiscal sustainability in the region. Their regression results show that public finance situations in Asia are sustainable. However, the regressions in the work of Adams *et al.* (2010) can be biased and inconsistent since they do not take into account the sizable heterogeneity with the region and cross-correlation among panel members. The recent study of Shastri *et al.* (2018) employed panel co-integration techniques to study fiscal sustainability in five South Asian economies. The results are similar to the study by Thornton and Adedji (2010), supporting a weak form of sustainability.

Fiscal sustainability in Asia is also assessed using country-specific time series, for instance Japan (Doi *et al.*, 2011; Sakuragawa and Hosono, 2011), China (Cuestas and Regis, 2018), India (Pradhan, 2014) and Vietnam (Hoai *et al.*, 2015). For the Japanese case, all the studies conclude that fiscal policy is unsustainable. The primary balance does not respond to the debt ratio (Doi *et al.*, 2011). If the Japanese government does not take any corrective measures to the country's fiscal crisis, the debt ratio will take on the explosive path (Sakuragawa and Hosono, 2011). For China, the government should be cautious with the unsustainable tendency after 2014 (Cuestas and Regis, 2018). Similarly, fiscal policy in Vietnam is not sustainable for the period 1990–2013 (Hoai *et al.*, 2015).

Overall, empirical studies on fiscal sustainability in Asia are scant and have not reached a consensus. In particular, some of the issues in macro-panel data are not taken into consideration, namely heterogeneous slope coefficients and unobservable common factors. Neglecting these problems may lead to inconsistent and erroneous estimates and subsequently, misleading empirical results.

3. Methodology and data

3.1 Analytical framework

In this section, we explain how the previous literature determines whether a fiscal stance is sustainable and discuss our empirical strategies. The theoretical framework of analyzing fiscal sustainability often starts with the government budget identity. Following Bohn (2007), the budget equation can be written as the following:

$$D_t = G_t^0 - T_t + (1+r_t)D_{t-1}. \tag{1}$$

Hence, government debt at the end of period t (D_t) is determined by the net-of-interest government expenditures (G_t^0), government receipts (T_t), the interest rate (r_t) and last period public debt (D_{t-1}). Subtracting D_{t-1} from both sides of Equation (1) gives the change in public debt:

$$D_t - D_{t-1} = \Delta D_t = G_t^0 - T_t + r_t D_{t-1}. \tag{2}$$

Thus, in this approach, the first difference of the stock of debt equals the government deficit inclusive of interest payment (i.e. the overall budget deficit). The primary budget deficit (the deficit exclusive of interest payment) is defined by the term $S_t \equiv G_t^0 - T_t$. To get the (IBC, one needs to solve Equation (1) for D_t. However, this equation cannot be solved directly, as we need several restrictions on the interest rate r_t. In particular, if it is assumed that the

interest rate follows a stochastic process with mean $r > 0$, then Equation (1) can be rewritten as follows:

$$D_t = G_t^0 - T_t + D_{t-1} + r_t D_{t-1} - rD_{t-1} + rD_{t-1}$$

$$= G_t + (1+r)D_{t-1} - T_t, \qquad (3)$$

where $G_t = G_t^0 + D_{t-1}(r_t - r)$ is the adjusted government expenditures. Equation (3) is true for any period t, $t+1$, $t+2$, ... So we can write D_t as follows:

$$D_t = \beta \mathbb{E}_t[T_{t+1} - G_{t+1} + D_{t+1}], \qquad (4)$$

with $\beta = (1)/(1+r) < 0$ and $?_t$ is the expectation operator at time t. With the previous assumptions imposed on the interest rate, one can solve Equation (4) using forward substitution to derive the government IBC:

$$D_t = \sum_{i=1}^{\infty} \beta^i \mathbb{E}_t(T_{t+i} - G_{t+i}) + \lim_{n \to \infty} \beta^n \mathbb{E}_t(D_{t+n}). \qquad (5)$$

The IBC implies that a sustainable fiscal policy must rule out any Ponzi scheme, that is the present value of the expected future stock of debt must converge to 0. In other words, fiscal sustainability requires that the government cannot roll over its debt perpetually. Hence, the transversality condition is expressed as follows:

$$\lim_{n \to \infty} \beta^n \mathbb{E}_t(D_{t+n}) = 0. \qquad (6)$$

If Equation (6) is satisfied, the IBC implies that the value of the current stock of debt must equal the discounted present value of all future budget surpluses. The IBC and the transversality condition define the analytical framework.

3.2 Empirical strategy
One can derive a conclusion about fiscal sustainability by examining whether the data generating processes of fiscal variables are consistent or inconsistent with the IBC. Here, the main empirical strategies can be summarized:

(1) Testing the stationarity of the first difference of the stock of public debt (Trehan and Walsh, 1988, 1991), that is the debt series is $I(1)$.

(2) Testing the co-integration between government receipts and government expenditures inclusive of interest. If the two variables are $I(1)$, they should be co-integrated. Sustainability requires that the two variables must be co-integrated with vector $(1, -1)$ (Hakkio and Rush, 1991).

(3) Estimating a fiscal reaction function (Bohn, 1998, 2007).

The first two methods involve examining time-series properties, that is stationarity and co-integration, of fiscal variables. However, the application of these approaches to our case has several difficulties. First, unit root tests require long time series. Very few countries in developing Asia can satisfy this requirement. The second problem is the low power of unit roots test in finite samples, which means the tests can hardly differentiate highly persistent stationary processes from non-stationary processes.

Although recent development in panel data techniques, which take into account both cross-sectional dimension and time dimension, can mitigate these limitations, Bohn (1998, 2007) claimed in his work that the conventional use of unit root test and co-integration test in examining fiscal sustainability is invalid. In his first paper, Bohn (1998) showed that

using conventional unit root tests is misleading because they do not account for cycle variations in output and government expenditures. In his next paper, Bohn (2007) proved that the IBC is still satisfied if we difference the fiscal time series often enough. In other words, the debt series, receipts and expenditure inclusive of interest will be consistent with the IBC even if they are integrated at arbitrarily high order (but still finite). Furthermore, sustainability does not require orders-of-integration conditions.

Bohn (2007) built upon Trehan and Walsh (1991)'s conditions of the form error-correction type model, which also coincides with the specification in the work of Bohn (1998):

$$S_t = \rho D_{t-1} + \alpha Z_t + \epsilon_t = \rho D_{t-1} + \mu_t, \tag{7}$$

where S_t denotes the primary surplus and Z_t is a set of control variables. The fiscal reaction function (7) is another approach to test the fiscal sustainability. It shows the response of the government to the accumulation of debt. In particular, the coefficient ρ represents the reaction of the primary budget surplus to a unit increase in the last period debt stock. This approach has several advantages. First, it does not depend on any stationary driving processes (Bohn, 2007). Second, its validity is still applicable for any debt management policies in any circumstances of uncertainty and risk aversion. This method does not require any restrictions on government bond rates and economic growth rate (Bohn, 1998). Third, it is satisfied with any assumptions on the interest rate. Thus, under fairly weak conditions, the IBC is satisfied with a positive ρ.

In particular, the sustainable condition requires that the estimated coefficient of $\hat{\rho}$ should be positive and also less than unity. The closer $\hat{\rho}$ is to unity, the larger is the response of primary surplus to an increase in public debt. On the contrary, if $\hat{\rho}$ is negative or not significantly different from 0, the primary surplus reduces after an increase in public debt or does not respond at all. This situation implies an unsustainable fiscal policy.

Following Bohn (1998), the control variables are chosen from the tax-smoothing model of Barro (1979). According to his theoretical framework, the temporary government expenditure (denoted GVAR) and the cyclical variations of output (denoted YVAR) are two main non-debt determinants of the primary surplus. We use these variables in estimating Equation (7) to account for any potential omitted variables bias. The definitions and calculations are taken directly from the study of Barro (1986).

3.3 Estimation method

As above-mentioned, macroeconomic panel data set can have serious contemporaneous correlation issues or even co-integration among panel units. However, few of the studies have taken this problem into account (Mercan, 2014). Cross-section dependence can originate from various sources, such as unobserved common factors or spillover effects. For this reason, we need to control cross-section dependence while estimating Equation (7). Pesaran's (2006) common correlated effects mean group (CCEMG) estimator is an effective method to control this problem. The following panel setup can be considered:

$$y_{it} = x'_{it}\beta_i + \mu_{it}, \tag{8}$$

where $x_{it} = \alpha_{2i} + \lambda_i f_t + \gamma_i g_t + \varepsilon_t$ and $\mu_{it} = \alpha_{1i} + \lambda_i f_t + e_{it}$. x_{it} and y_{it} are the observable variables. β_i refers to panel-specific slope coefficients. α_{ji} with $j = \{1, 2\}$ refers to standard individual fixed-effect capturing time-invariant heterogeneity. f_t and g_t are unobserved common factors with heterogeneous factor loadings λ_i and γ_i, accounting for time-variant heterogeneity and cross-section dependence.

Pesaran's (2006) CCEMG estimator controls cross-section dependence, time-variant unobserved factors with heterogeneous effects across units and identification problem. To solve these problems, the CCEMG estimator augments the group-specific regression equations with cross-section averages of the dependent and observable independent

variables. These averages serve as proxies for the unobserved common factors. This estimator is proved robust to both local spillover effects and global shocks (Pesaran and Tosetti, 2011). Furthermore, the estimator is consistent and asymptotically normal distributed in both scenarios: the time dimension is larger or smaller than the cross-sectional dimension. It also provides individual-specific long-term co-integration coefficients.

3.4 Data and variables
All data are taken from the World Economic Outlook Database , covering the period 1999–2017 for 22 developing Asian economies[1]. Table I reports summary statistics for our main fiscal variables, namely the primary balance, public debt, government revenues and government expenditures. All the variables are calculated as a percentage to GDP. The calculations of YVAR and GVAR are taken directly from the work of Barro (1986):

$$\text{YVAR}_t = \left(1 - \frac{y_t}{y_t^*}\right)\frac{g_t^*}{g_t} \quad \text{and} \quad \text{GVAR}_t = \frac{g_t - g_t^*}{y_t},$$

where y_t and g_t are real GDP and real government expenditures exclusive of interest payment. y_t^* and g_t^* are real potential output and net-of-interest government expenditures, calculated using the Hodrick–Prescott filter. GVAR refers to temporary real government spending and YVAR is proportional to a temporary shortfall of output (Barro, 1986) (Table II).

4. Discussions of empirical results
The first step of the empirical strategies involves testing the presence of cross-section dependence, using the Pesaran (2004) CD test in panel time-series data. If the panel members are cross-correlated or, more seriously, cross-sectionally co-integrated, the estimation results could be biased and inconsistent (Pesaran, 2004). The test is also appropriate for a panel with time dimension being smaller than the cross-section dimension. Table III reports the cross-section dependence test. With high Pesaran CD statistics obtained for all fiscal

	Observations	Mean	SD	Min.	Max.
Primary balance	415	−0.888	5.170	−22.814	45.737
Public debt	405	46.340	23.747	7.441	216.035
Government revenues	416	27.896	20.873	8.466	155.802
Government expenditure	416	30.358	19.754	10.030	131.557
YVAR	415	0.016	0.661	−3.354	4.928
GVAR	415	−0.004	2.567	−14.827	19.238

Table I.
Summary statistics

	Primary balance	Public debt	Government revenues	Government expenditure	YVAR	GVAR
Primary balance	1.000					
Public debt	−0.084 (0.093)*	1.000				
Government revenues	0.250 (0.000)***	−0.393 (0.000)***	1.000			
Government expenditure	0.007 (0.892)	−0.358 (0.000)***	0.968 (0.000)***	1.000		
YVAR	−0.131 (0.008)***	0.052 (0.294)	−0.027 (0.579)	0.006 (0.902)	1.000	
GVAR	−0.255 (0.000)***	−0.004 (0.938)	0.097 (0.048)**	0.168 (0.001)***	0.001 (0.980)	1.000

Notes: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

Table II.
Correlation matrix

variables, we can reject the null hypothesis of cross-section independence at 1 percent level of significance.

Given the presence of cross-section dependence in the panel, we estimate the long-run coefficients in Equation (7) with Pesaran's (2006) CCEMG estimator. This estimator helps to control cross-country correlation and heterogeneity.

The dependent variable in all specifications is the primary surplus. The main independent variables are lagged public debt and squared lagged public debt for the nonlinear decision rule. The control variables are YVAR and GVAR, taken from the tax-smoothing model of Barro (1979). To account for unobservable common factors, the CCEMG estimator adds the cross-section averages of all observable variables to the regression.

According to the theoretical prediction of Barro's model, the coefficients of the control variables YVAR and GVAR should be negative. In our regressions, the estimated coefficients of GVAR are significantly negative at 1 percent level, whereas the estimated coefficients of YVAR are significantly negative (except for specification (5) and (6)). If the absolute value of the estimated coefficient of YVAR is larger than unity, it implies that government receipts drop more than GDP in a recession. This result is consistent with optimal polity when tax distortions vary over the business cycle (Bohn, 1998). Our results are different from those of Adams *et al.* (2010), who found a positive value of the estimated coefficient of YVAR. Their models did not account for cross-section dependence and slope heterogeneity.

Table IV reports the estimations of Equation (7) using Pesaran's (2006) CCEMG estimator. In Models (1) and (2), we estimate the fiscal reaction functions for a panel of 22 developing Asian economies for the period 1999–2017. We consider the estimations of Equation (7) without individual-specific trend in (1) and with a trend in (2). Overall, adding a trend does not change the significance of the variables and does not affect our results. The estimated coefficients of lagged public debt are positive but not significant, which suggests that the primary balance does not react to any accumulations in public debt. According to Bohn (1998), this finding implies that, on average, governments do not take into account any corrective measures when the public debt begin accumulating, which could lead to unsustainable debt policy. The baseline findings from this study contradict the findings of Adams *et al.* (2010), who found a positively significant estimate of ρ. As aforementioned, unlike our estimators, previous work did not take into consideration sizable heterogeneity across countries and overtime and also cross-section dependency. They admitted that a one-size-fits-all specification could not well depict the average fiscal reaction in the region because of heterogeneous unobservable factors. The CCEMG estimator, on the contrary, can address these problems effortlessly and, better yet, report the country-specific long-run co-integration coefficients. Table V shows the individual estimates of ρ_i. Under the null hypothesis, the Z-score is asymptotically distributed as $N(0, 1)$. Standard two-tailed test indicates that very few governments in the region would take corrective measures when the public debt rises (for example the Philippines, India and Indonesia); several countries even

	Pesaran CD satatistics	Average correlation coefficient	Absolute correlation coefficient
Primary balance	6.695	0.102	0.273
Public debt	6.019	0.096	0.554
YVAR	10.121	0.154	0.257
GVAR	2.517	0.038	0.216
Government revenues	8.305	0.127	0.393
Government expenditure	5.622	0.086	0.347
Note: Under the null hypothesis of cross-section independence CD ~ N(0, 1)			

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged debt	−0.024	0.017	0.055	0.292	−0.008	0.337	−0.158**	−0.078
Squared lagged debt			−0.000	−0.001				
YVAR	−1.230***	−1.332***	−1.573***	−1.272**	−1.387	−0.785	−1.311*	−1.237*
GVAR	−0.734***	−0.716***	−0.701***	−0.728***	−0.574***	−0.729***	−0.792***	−0.777***
CA primary balance	0.072	0.137	0.218	0.132	0.182	0.157	−0.336	−0.201*
CA debt	0.028	0.057	0.036	0.043	−0.014	−0.625*	0.171**	0.082
CA YVAR	0.388	0.297	0.738	−0.222	0.242	1.026	0.901*	0.739*
CA GVAR	−0.284*	−0.291**	−0.285	−0.296***	0.122	0.334	−0.195*	−0.201
GA trend		−0.010		−0.137		−0.073		−0.001
CA squared debt			0.001	0.000				
Observations	398	398	398	398	198	198	218	218
N_g	22	22	22	22	22	22	12	12
χ^2	76.585	70.457	86.865	101.090	10.870	18.043	39.149	60.762
p	0.000	0.000	0.000	0.000	0.012	0.000	0.000	0.000

Notes: CA, cross-section average. All variables are calculated as a percentage to GDP. Models (1) and (2) report the estimations for the whole period from 1999 to 2017, without individual-specific trend and with trend, respectively. Models (3) and (4) report the estimations for a nonlinear decision rule, without trend and with trend, respectively. Models (5) and (6) report the estimations for the period after 2008, without trend and with trend, respectively. Models (7) and (8) report the estimations for countries whose debt/GDP ratio is less than 60 percent, without trend and with trend, respectively. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

Table IV.
Estimation of the
fiscal reaction function

Country	Estimated coefficients	SE	Z-score
Bangladesh	0.035	0.042	0.835
Bhutan	−0.033	0.050	−0.655
Cambodia	0.070	0.271	0.257
China	−0.073	0.044	−1.662**
Fiji	0.045	0.031	1.425
India	0.199	0.075	2.649***
Indonesia	0.076	0.043	1.762**
Kiribati	0.782	0.543	1.44
Lao	−0.196	0.202	−0.973
Malaysia	0.037	0.033	1.12
Maldives	−0.005	0.089	−0.061
Marshall Islands	−0.746	0.167	−4.462***
Micronesia	−0.154	0.298	−0.517
Myanmar	−0.012	0.020	−0.602
Nepal	−0.078	0.042	−1.83**
Papua New Guinea	−0.241	0.125	−1.935**
The Philippines	0.086	0.038	2.254***
Solomon	0.147	0.113	1.297
Sri Lanka	0.115	0.080	1.431
Thailand	−0.141	0.040	−3.503***
Vanuatu	−0.269	0.070	−3.86***
Vietnam	−0.130	0.059	−2.213***

Notes: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

Table V.
Panel-specific long-run
coefficients
(1999–2017)

have a significantly negative $\hat{\rho}$ (for instance: Marshall Islands, Papua New Guinea, Thailand, Vanuatu and Vietnam).

Apart from the linear decision function, we also examine the potentially nonlinear response of the primary balance to any changes in the public debt ratio. In this nonlinear

specification, we investigate whether the governments react more to accumulations in debt when the level of debt is high. We add a quadratic term into the regression while estimating Equation (7). The results are reported in Models (3) and (4), without a country-specific trend and with a trend, respectively. Similar to the case of linear decision rule, we do not find any evidence supporting a sustainable reaction of the government to an increase in public debt.

As we discussed in the Introduction, injection of massive fiscal stimulus packages in response to the global financial crisis of 2008 may leave behind some consequences regarding fiscal sustainability. A rise in the stock of public debt to finance the stimulus packages leads to increased cost of debt and worsens the government budget balance. Thus, it would be interesting to investigate how governments in the region react to accumulation in debt after the global financial crisis. We then estimate Equation (7) for the period after the global financial crisis and report the results in Models (5) and (6). Adding a country-specific term does not alter the empirical findings. Similar to previous cases, we do not find a significantly positive response of the primary balance to a rise in debt stock. Again, the country-specific long-run coefficients are shown in Table VII. Only a few countries are found with a sustainable fiscal response, namely Fiji, Kiribati, Maldives[2] and Solomon[3]. Some countries even change their status from being fiscal responsible to fiscal irresponsible: India, Indonesia and the Philippines (Tables VI and VII).

Another interesting question is examining how countries with the debt/GDP ratio less than 60 percent behave when the levels of public debt rise. In our sample, 12 economies have the debt ratio less than 60 percent, and the estimations for this sub-sample are represented in Models (7) and (8). There is a difference between the model without a trend and the one with the trend. The estimated ρ is significantly negative at 5 percent level in the model without a time trend and not significant in the model with a time trend. However, all these findings bring the same conclusion of an unsustainable fiscal policy in these markets.

As a post-estimation test, a unit root of the residuals in all empirical specification (the results are available upon request) is tested for the cross-section dependence. Pesaran's (2004) CD test

Country	Estimated coefficients	SE	Z-score
Bangladesh	−0.322		
Bhutan	−0.035	0.157	−0.223
Cambodia	0.720	0.232	3.108***
China	0.197	0.017	11.474***
Fiji	0.028	0.054	0.515
India	0.299	0.027	11.233***
Indonesia	1.059		
Kiribati	3.021	0.098	30.747***
Lao	−0.344		
Malaysia	0.227	0.083	2.75***
Maldives	0.497	0.316	1.57
Marshall Islands	−0.904	0.177	−5.12***
Micronesia	0.280	0.700	0.4
Myanmar	0.003	0.052	0.051
Nepal	0.212		
Papua New Guinea	−0.302	0.065	−4.659***
The Philippines	0.102	0.176	0.581
Solomon	1.352		
Sri Lanka	0.141	0.148	0.956
Thailand	−0.530	0.280	−1.894**
Vanuatu	−0.267	0.147	−1.818***
Vietnam	−1.037		

Notes: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

Table VI.
Panel-specific long-run coefficients (1999–2008)

Country	Estimated coefficients	SE	Z-score
Bangladesh	0.038	0.380	0.101
Bhutan	−0.076	0.086	−0.877
Cambodia	0.290	0.722	0.401
China	−0.202	0.125	−1.611
Fiji	0.073	0.006	11.517***
India	−0.388	0.216	−1.795**
Indonesia	0.176	0.501	0.352
Kiribati	2.503	0.355	7.047***
Lao	−0.183	0.345	−0.531
Malaysia	0.224	0.182	1.231
Maldives	0.538	0.015	35.444***
Marshall Islands	−0.694	0.596	−1.163
Micronesia	−1.714	0.637	−2.691***
Myanmar	−0.554	0.268	−2.069***
Nepal	0.198	0.577	0.343
Papua New Guinea	−0.426	0.285	−1.495
The Philippines	−0.088	0.041	−2.13***
Solomon	0.533	0.098	5.463***
Sri Lanka	0.512	0.476	1.076
Thailand	0.183	0.233	0.787
Vanuatu	−0.209	0.126	−1.66**
Vietnam	−0.192	0.446	−0.431

Notes: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

Table VII.
Panel-specific long-run
coefficients
(2008–2017)

is used and the null hypothesis of cross-section independence cannot be rejected. Thus, the residuals are free of cross-section dependence. The CD test is crucial before implementing the panel unit root test because of the cross-section dependence assumption. There are first-generation panel unit root tests and second-generation panel unit root tests. The former assumes cross-section independence, whereas the later assumes cross-section dependence. Thus, if panel members are correlated with each other, applying the first-generation unit root tests leads to the problem of low power test. In our case, since the residuals have cross-section independence, we can apply any first-generation unit root tests. In this case, we employ Maddala and Wu's (1999) unit root test. The results show that all the residual series are $I(0)$.

5. Conclusion
In this paper, we review and discuss the issue of fiscal sustainability, using a fiscal reaction function as the cornerstone of our empirical analysis. The problems of cross-section dependence and heterogeneity were controlled in our study by employing Pesaran (2006)'s CCEMG estimator.

Focusing on a macro-panel data of 22 developing Asian economies from 1999 to 2017, the paper's findings reveal that, on average, fiscal policy in the region is not sustainable. The results are robust to various specifications. The null hypothesis of the nonlinear response of the primary balance to public debt is also rejected. Furthermore, fiscal policy is found unsustainable in the period after the recent global financial crisis. Similar to Reinhart *et al.* (2003), the findings reinforce the idea that insolvency risk can occur at low levels of public debt.

These results can have some policy implications. The findings show that many developing economies in the region could not satisfy the IBC, which raises concerns about debt sustainability in the region, especially for the post-crisis period. The results imply strengthening and adapting appropriate fiscal consolidation framework. Given the rising trend in public debt levels after the global crisis, the findings urge the governments to be

ready to take any corrective measures against the accumulation of public debt. Another critical question is whether the anti-crisis stimulus packages further jeopardized the public debt liabilities of the governments. Reforming the tax system and debt management policy also helps to pursuit a sustainable fiscal policy. The tax base is still narrow, on average, in the Asian region, and the possibility to enlarge the base is still promising. Another policy implication is the debt intolerance phenomenon, which states that insolvency can happen even at low levels of debt (Fournier and Fall, 2017). It is considered as the problem of market confidence loss, increasing debt burdens, and subsequent default. Thus, governments with low debt levels should also be cautious about their fiscal stance.

We assess fiscal sustainability by estimating a fiscal reaction function and testing the significance of the debt coefficient. One drawback of this method is that it only considers how variations in fiscal surpluses react to changes in debt and do not consider the actual fiscal position. Further research should take this issue into consideration, such as performing sensitivity analysis or other debt sustainability analysis.

Notes

1. Countries: Bangladesh, Bhutan, Cambodia, China, Fiji, India, Indonesia, Kiribati, Lao, Malaysia, Maldives, Marshall Islands, Micronesia, Myanmar, Nepal, Papua New Guinea, the Philippines, Solomon, Sri Lanka, Thailand, Tuvalu, Vanuatu and Vietnam.

2. For these three countries, we should take the results with caution. For example, past fiscal surpluses of Kiribati mainly came from fishing license fees, which are only windfall revenue and should not be considered as sustainable revenue. For the whole period 1999–2007, the fiscal responses of the three countries are unsustainable, which correspond with IMF's classification of high risk of debt distress.

3. Solomon Islands' government debt was in default on all of its official debts. The government then signed an agreement in 2005, the Honiara Club Agreement, to bring the debt position to a sustainable level. Recently, the IMF has raised the debt status of the island from red light to yellow light, that is from high level of debt unsustainability to moderate risk of unsustainability.

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