Central European Journal of Economic Modelling and Econometrics

Can Emerging Countries Mitigate the Effect of Original Sin Problem in Achieving External Debt Sustainability?

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Submitted: 28.11.2022, Accepted: 5.07.2023

Abstract

Due to the spike in inflation, the implementation of easy monetary and fiscal policies since the pandemic appears to be coming to an end. The shift towards tighter policies raises concerns about debt sustainability in developing countries, particularly due to the challenge of the "original sin" problem. Given these premises, to analyze debt sustainability for emerging countries, this study focuses on foreign exchange revenue capability and employs external debt-creating (imports, reserves and interest payments) and reducing variables (exports, reserve return and net transfers) for 1995-2020. The results of this panel cointegration estimation for 15 EMDE countries are 0.74 and 0.70 for CCEMG and AMG estimators respectively which indicates moderate sustainability as whole sample countries. However, the individual estimators vary widely for each individual country from weak to strong sustainability.

Keywords: external debt, sustainability, panel cointegration, emerging markets

JEL Classification: F34, C23

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1 Introduction

At the beginning of the industrialization era, today's developed countries achieved high growth rates through the monetary transmission mechanism credit channel of the strong financial system. It was primarily an economic theory of development in which the right quantity and mixture of saving and investment enabled developed nations to proceed along a sustainable economic growth path. Developing countries had historically been advised to follow the same stages through saving and investment equivalence and if necessary, with foreign aid (Todaro and Smith, 2011). The more financially developed countries the more financial capital can be utilized to achieve high income levels. However, developing countries encounter completely reverse macroeconomic environments such as a lack of domestic savings and infrastructure due to low levels of financial development. Therefore, in the early stages of globalization, to remove capital constraints for growth and to establish infrastructure and institutional quality for development, massive transfers of capital and technical assistance comes from the developed to the less developed countries in terms of aid like the Marshall Plan. Then, owing to financial globalization and deregulation with the Washington consensus in the early 1980s, both the volume and mobility of financial capital increased. At this stage, developing countries, suffering from saving deficit problems, have an opportunity to finance growth from diverse external sources like portfolio investments, foreign direct investments, or loans. Since then, the combination of low-interest rates and excess liquidity in the global financial system has promoted investment and consumption through loans in developing countries. The usage of foreign loans resulted in the problem of original sin which is simply defined as the inability to borrow with domestic currency or the difficulty to borrow at long maturity at fixed rates even in domestic currency (Eichengreen and Hausmann, 1999; Eichengreen, Hausmann and Panizza, 2005). Deregulation and financial innovations have also intensified the borrowing capability in international markets since the 1980s. Nowadays policy implementations shift from easy to tighter monetary policy which caused it to be questioned whether the heavy external debt burden in both developed and emerging developing countries (EMDEs) is sustainable (Devlin, 1990).

The increase in external debt burden damages countries' macroeconomic stability in several aspects. First, high debt levels raise solvency risks and increase the cost of borrowing which constrain the ability of a government to use easy monetary and fiscal policy as a countercyclical tool to smooth volatility in the output. Then, the existence of high-interest rates due to risk premium or the need for fiscal tightening for debt repayment limits government expenditures and has an adverse impact on output growth which is known in the literature as the debt overhang problem (Diamond and He, 2012). Besides these effects, any foreign exchange rate appreciation limits aggregate demand due to the problem of original sin (Hausmann and Panizza, 2003; Baldacci, Gupta, and Mulas-Granados, 2010). The depreciation of domestic currency increases uncertainty and debt burden as well. Moreover, the heavy foreign debt

burden also limits central banks' lender-of- last-resort-role in case of liquidity crises (Eichengreen et al., 2007). The study by Hausmann et al. (2003) shows that the original sin ratio is highest (0.99 and 0.93) for developing countries for the periods 1993-1998 and 1999-2001 (There are alternative different indicators measuring both international and domestic original sin ratio. The further information can be found in study of Hausman and Panizza (2003). This study refers the original sin ratio "OSIN1" which gets 0 (or 1) if a country issues all its securities in its own currency (or foreign currency)). The lowest ratios are observed for major financial centers (0.53) and Euroland (0.52) countries. Eichengreen, Hausman and Panizza (2005) also mention that due to high real exchange rate volatility developing countries' real GDP growth fluctuations are higher when measured in US $ than industrialized countries. As a result, the existences of original sin result in greater output and capital flow volatility and a more limited independent monetary policy.

The adverse effects of external debt are even more severe for emerging countries due to several reasons. First, most of them suffer from a current account deficit which increases their dependency on international capital inflows. The possibility of the long-term domestic interest rate differing from the world interest rate or implementation of tight global liquidity policies can easily cause a financial crisis in EMDEs due to sudden stop because, all these countries had in common foreign-denominated (currency mismatches) and/or short-maturity external debt (maturity mismatches) which necessitates perpetual foreign financial capital inflows (Hausman and Panizza, 2003). Besides, rising interest and principal burden can cause liquidity crises and Ponzi financing which have large and lasting contagion effects on economic activity. Moreover, the combination of unproductive macroeconomic policies with structural and institutional weaknesses increases fragility and uncertainty as well. For these reasons there are three waves of debt accumulation that ended with crises in EMDEs which are the periods of 1970-1980, 1990-2000, and 2005-2008 (Köse et al., 2021).

Due to recent financial developments, the burden of debt has increased not only in developing countries but also in developed countries. For instance, in the aftermath of Global Financial Crises and Covid-19 pandemic, all developed countries implemented easy monetary and fiscal policies in order to mitigate the detrimental impact on output and employment. Fiscal measures announced to fight the pandemic was almost $16.5 trillion which further increased the global debt burden in 2020. Global government debt reached a level of close to 100 percent of global GDP (IMF, 2021; World Bank, 2021). Although global debt is a concern of both developed and developing countries, the solvency problem is not discussed intensely for developed countries because of the reasons that either their positive international investment position like Canada and Japan, or their borrowing capability in their domestic currency like the USA or United Kingdom. So, by taking the risk of inflation, monetary authorities of these countries can finance their external debt payments through seigniorage revenue as it is experienced in recent crises. For instance, during

the Global Financial Crisis and subsequent periods, including the Covid-19 pandemic, the Federal Reserve implemented Quantitative Easing (QE) to address the challenges posed by problematic assets such as trash or subprime mortgage-backed securities and credits within the financial system. However, an increase in external debt burden in developing countries has severe limits. If they increase domestic money supply to finance external debt, they face a problem of high inflation, high interest rate and high foreign exchange volatility which further increase external debt burden value in domestic currency and increase pessimistic expectations. An additional channel through which financial crises in developing countries relates to portfolio constraints faced by international investors. According to portfolio theory, in order to offset losses incurred in one country, investors may sell off their entire asset holdings within the same basket, even if the currencies of other EMDEs have not yet experienced depreciation. This action can precipitate financial crises in those affected countries. In such scenarios, efforts are made to contain the spread of crises and mitigate their global impact through the implementation of stabilization and structural adjustment reform programs facilitated by the International Monetary Fund (IMF). Consequently, achieving debt sustainability becomes one of the foremost objectives not only for the affected countries as a whole, but particularly for EMDEs.
This study investigates the debt sustainability in EMDEs. To this aim, we discuss theoretical roots in following section. In the third part, we summarize empirical literature. Then data, model specification, methodology and empirical results are presented. Finally, we conclude our study with policy implications.

2 Debt sustainability

Globalization and the new international monetary system achieved high growth rates with debt accumulation. If a country experiences a lack of saving due to the private sector or fiscal deficit, an increase in prosperity can be achieved through utilizing external sources. Debt is not considered as a problem if the debt interest burden is less than the expected return of the investment. So, it is assumed that there will be no debt solvency problem in case of long maturity and low interest rate combinations are used for productive investment expenditures. The debt solvency problem should not be simplified by just investigating government debt sustainability because there is a strong interaction among whole macroeconomic actors. For instance, the government's monetary and fiscal policy affects the indebtedness of both households and firms by changing long-run interest rates or vice versa. That's why external debt is the focus of this study rather than just analyzing government debt sustainability which is intensely discussed in the literature. The variation of external debt can be attributed to three key components: interest payments to foreign entities, the accumulation of new debt resulting from the current-account deficit and fiscal deficit, and fluctuations in the value of the domestic currency. According to traditional approach a non-increasing ratio of foreign debt to GDP is regarded as a

practical and sufficient condition for debt sustainability (Goldstein, 2003; Uctum et al., 2006). Unit root and cointegration tests have been used to get information about long run implications of debt sustainability and it is assumed that a country is a solvent if the GDP and debt growth rate co-integrate in the long run (Saadaoui et al., 2022; Mehrotra and Sergeyev, 2021; Reinhart and Rogoff, 2010). Several authors propose alternative variables, such as external debt to exports, debt service to exports. These indicators can be used as a proxy variable to measure foreign exchange revenue capability but still they are insufficient because the foreign exchange burden which arises from imports is not taken into consideration (Goldstein, 2003). Some other studies focus on primary fiscal balance and reserves by employing debt service to GDP, primary budget surplus, the reserve to debt, and interest rate to measure the capability roll on principals in short run. If the initial level of the debt is too high, in that case, the reserve capability and interest principal and maturity of the debt gain importance (Blanchard, 2019; Mehrotra and Sergeyev, 2021). External debt sustainability is a very complicated issue. There are diverse equations and models each have same privileges and deficiencies from one to another. EMDE countries' external debt sustainability is more fragile than developed countries because of their high exchange rate volatility. The exchange rate volatility of Turkey, Argentina, and Colombia, measured as the standard deviation of the USD/local currency exchange rates, has increased significantly since the global financial crisis in 2008. For instance, in Turkey, the exchange rate volatility rose from approximately 0.17 in 2008 to 5.05 in 2021. In Argentina, it increased from around 1.45 to 40.89 during the same period, while in Colombia, it surged from approximately 126.22 to 312.3 (Calculated by authors). Adverse exchange rate shocks increase their external debt burden in terms of domestic currency sharply. So, to measure external debt sustainability for EMDEs it is more important to focus on foreign exchange inflows and outflows rather than employing just government fiscal balance. Government debt can more easily become solvent because budget deficit can be financed through monetizing or additional domestic debt. However, to achieve external debt sustainability foreign exchange short position should be under control. If foreign exchange revenues cover outflows, the possibility of liquidity problem decreases. So, Sawada (1994) extended the external debt sustainability analysis by including external balance by employing not only export revenue but also import burden for 13 countries (HICs and some Asian countries) for the period from 1975 to 1990. Like Sawada (1994), this study also employs interest rate, reserves and the components of trade balance to investigate debt sustainability for specific EMDEs which is given in Equation (1) for period t;

$$GDP_t + (B_t - B_{t-1}) + TR_t = A_t + rB_{t-1} + \{N_t - (1 + i_t)N_{t-1}\} \tag{1}$$

where, GDP is the gross domestic product, B is net external debt, TR is net transfer receipts, A is total expenditure of domestic residents, r is the nominal interest rate, N is foreign currency reserves of the Central Bank and "i" is interest yield on these reserves. We assume the foreign exchange reserves do not contain interest, so we

accepted the interest yield is zero for the whole time dimension in the following equations. The left side of Equation (1) represents the total revenue for period t, while the right side represents the total expenditure. The equation (1) can be written by considering the trade balances (TB) of the countries under the assumption of $GDP_t - A_t = EX_t - IM_t$:

$$TB_t = EX_t - IM_t = rB_{t-1} - (B_t - B_{t-1}) - TR_t + \{N_t - (1 + i_t)N_{t-1}\}. \quad (2)$$

EX and IM represent nominal export and import values, respectively. Considering Equation (2), the dynamic budget equation explaining the change in external debt can be written as follows:

$$S_t = TB_t + TR_t - \{N_t - (1 + i_t)N_{t-1}\}, \quad (3)$$

$$B_t - B_{t-1} = r_t B_{t-1}) - S_t. \quad (4)$$

S_t is the net external surplus in the period t. We rewrite Equation (4) as follows:

$$B_t - B_{t-1} = \Delta B_t = IM_t + rB_{t-1} + N_t - (EX_t + TR_t + (1 + i_t)N_{t-1}). \quad (5)$$

If ΔB_t is stationary, the results indicate the existence of excess debt (Sawada, 1994). We can write Equation (5) by regrouping as $IX_t = EX_t + TR_t + (1 + i_t)N_{t-1}$ and $MM_t = IM_t + rB_{t-1} + N_t$. In this case, the cointegration relationship between IX and MM can be tested under the assumption that they are stationary at the first difference:

$$IX_t = \alpha + \beta MM_t + \mu_t. \quad (6)$$

According to Hakkio and Rush (1991) and Sawada (1994), the cointegration relationship between these two variables indicates that the country has a sustainable debt structure. In addition to this, the fact that the cointegration vector provides $\beta = (-1, 1)$ equality shows that the country's external debt, which is analyzed in terms of intertemporal budget constraint in the long run, has a strong sustainability structure (Baharumshah et al., 2003). If the cointegration parameter is less than 1 in the absolute value, it indicates weak sustainability of external debt (Öner and Utkulu, 2006).

Sawada's (1994) equation has some privileges from other studies. First of all, external debt sustainability problem due to depreciation of domestic currency can more clearly be analyzed by inclusion of export, import, reserves, and transfers. If sum of export and import demand elasticity higher than unity, the depreciation may increase export revenue more than foreign debt and import burden growth rate which may ensure sustainability. In addition to that if the initial debt burden is too high, the interest burden may force the country to achieve debt reduction for sustainability which included analysis. Moreover, net transfers, non-debt creating capital inflows, are important to service the interest payments on the debt so they are also employed in this analysis.

In EMDEs, the impact of external debt on per capita growth has been estimated to be negative at debt levels above 35-40 per cent of GDP (Pattillo et al., 2002). The existing external debt to GDP ratio is beyond this threshold with the effect of pandemic. To control debt ratio countries may limit aggregate demand which result in a decrease in GDP. Besides, it is expected that the analysis of debt sustainability will be more important because the excess liquidity will disappear in international markets in the near feature with the implementation of tight monetary policies in leading central banks. When developed countries increased the speed of monetary tightening policies, most of the developing countries will have both the problem of roll-on capability of their existing debt and problem of an increase in their external debt cost due to a rise in global interest rate.

3 Literature review

Numerous studies have extensively analyzed debt sustainability using unit root analysis and focusing on the debt to GDP ratio. However, this study takes a different approach by examining the foreign exchange revenue capability through the inclusion of various debt creating and reducing variables. In this section, we present a selection of studies that address the issue of debt sustainability by considering a diverse set of variables. It is widely acknowledged that if the accumulation of debt does not lead to higher potential growth and, crucially, increased exports, the sustainability of external debt is expected to become increasingly weak.

Sawada (1994) found that the current foreign debt obligation in Latin America and the Philippines is greater than the present value of the expected future trade surplus. It was emphasized that these countries, which are under excessive debt burden, should either reduce their payments arising from the current external debt or increase their export revenues. The results of the study reveal that East and Southeast Asian countries (except the Philippines, Korea, Malaysia, Thailand) do not have a sustainability problem with foreign debt payments.

Hostland and Karam (2006), in their analysis of debt sustainability for 31 developing countries, revealed that many interrelated factors such as risk premium, output volatility, sudden stop in capital movements and financial fragility (short-term or foreign currency borrowing) are employed as important variables in analysis of debt sustainability. The results of the study showed that the exchange rate and the pricing of tradable goods in foreign currency have a statistically significant impact on debt sustainability. It has been stated that the appreciation of the exchange rate may increases the debt burden borrowed in foreign currency on the one hand, and may increases export revenues, on the other hand, which can stabilize the debt burden. Manasse, Roubini and Schimmelpfennig (2003) investigated the major reasons of financial distress for 47 emerging markets over the period 1970-2002. The factors employed in the study are political uncertainty, high external debt, short debt maturity, high debt service payments, current account deficit, low growth rate,

high inflation, and tight US monetary policy. In addition, Kraay and Nehru (2006) mentioned the importance of institutional quality by stating that weak institutional quality increases the probability of financial distress. Manasse and Roubini (2009) draws attention to that overvaluation of exchange rate, low growth rate and high inflation which increases debt burden and may create financial liquidity problem. Besides that, high short-term debt to reserve ratio, number of years for next election, political uncertainty are mentioned as important variables in determination of debt sustainability.
Gapen, Gray, Lim, and Xiao (2008) analyzed risk variables for 12 emerging market economies together with traditional macroeconomic variables. A few key variables, such as market prices and uncertainty, as well as the prospective default probability of the consolidated government balance sheet, credit spreads and the amount of borrowing in foreign currency, are used to derive risk indicators. It is found that risk indicators for emerging market economies have strong and significant effects when compared to borrowing costs in other markets.

4 Data and methodology

4.1 Data description

In this study, we investigate the cointegration relationship between external debt-creating (imports of goods and services. Central bank's FX reserves and interest payments) and reducing variables (exports of goods and services. central bank FX reserve return and net transfers) for the period 1995-2020. We apply this relationship for EMDE countries. These countries are selected according to data availability. We present our variables and descriptive statistics in Table 1.
IX and MM are aggregate variables to define external debt sustainability in this study. We take the logarithms of IX_t ($LNIX_t$) and $MM_t(LNMM_t)$ for ease of interpretation and elasticity. According to descriptive statistics in Panel b, IX ranges from 7.8 billion to 6303.8 billion with an average value of 385.08 billion. Similarly, minimum, and maximum MM value of the sample countries is 9.9 billion and 6108.8 billion. All variables have a high standard deviation, indicating that their values expand over a broader range. Huge differences in maximum and minimum values indicate the variety in the panel countries.

4.2 Model specification

The model employed in this study is significant as it incorporates variables contribute to and alleviate external debt, thereby encompassing both economic and financial sustainability criteria. It recognizes that changes in the foreign trade deficit, as indicated by the national income equation in terms of expenditures (Eq. (1)), are the primary drivers behind the increase or decrease in the savings gap and borrowing.

Table 1: Variables (Panel a) and descriptive statistics (Panel b)

Panel a

Variables	Definition	Source
EX_t	Export of goods and services (Current USD)	Worlbank Development Indicator (`https://data.worldbank.org/`)
IM_t	Import of goods and services (Current USD)	Worlbank Development Indicator (`https://data.worldbank.org/`)
TR_t	Net current transfers from abroad (Current USD)	Worlbank Development Indicator (`https://data.worldbank.org/`)
N_t	Total Reserves excluding Gold (USD)	International Financial Statistics (`https://data.imf.org/regular.aspx?key=63087882`)
B_t	Total External Debt Stocks (Current USD)	Worlbank Development Indicator (`https://data.worldbank.org/`)
r_t	USD Libor Rates (Average-12 Month)	Macrotrends (`https://www.macrotrends.net/1433/historical-libor-rates-chart`)
i_t	Interest Rates on Total reserves	The interest rate is assumed to be zero in the following equation since the total reserves do not contain interest.

Panel b

Variable	Obs.	Mean	Standart Deviation	Min	Max
EX_t	390	199.5 Billion	409.3 Billion	4.1 Billion	2723.2 Billion
IM_t	390	190.5 Billion	366.8 Billion	6.6 Billion	2564.1 Billion
TR_t	390	7.5 Billion	13.7 Billion	12.7 Billion	76.4 Billion
N_t	390	191.3 Billion	570.3 Billion	548.3 Milion	3869.2 Billion
B_t	390	195.2 Billion	284.5 Billion	6.8 Billion	2349.4 Billion
r_t	26	3.02%	2.12%	0.57%	6.86%
$IX_t = EX_t + TR_t + (1+i_t)N_{t-1}$	390	385.08 Billion	952.9 Billion	7.8 Billion	6303.8 Billion
$MM_t = IM_t + r_t B_{t-1} + N_t$	390	385.8 Billion	931.5 Billion	9.9 Billion	6108.8 Billion

In order to comprehensively assess the sustainability of external debt for emerging market economies, this study expands the analysis by taking into account the interest burden on the current debt stock and variables that impact the total debt burden by influencing exports and imports. Considering the study of Sawada (1994), we specify

our empirical model to be estimated in this study for emerging market economies as follows:

$$LNIX_{it} = \alpha_{0i} + \alpha_{1i} LNMM_{it} + \mu_{it}. \tag{7}$$

The subscripts i and t denote country and time period, respectively.

4.3 Methodology

The empirical investigation of this study consists of four parts. We first test the existence of the cross-sectional dependence of the studied variables. To this end, we apply three different cross-sectional dependence tests. The first one is the Lagrange multiplier (LM) test, applicable if N is small and T is large (Breusch and Pagan, 1980). The second one is Pesaran (2004) CD test can be used when N and T are large or one of both is large. The last one is the modified version of the LM test. The bias-adjusted LM test proposed by Pesaran et al. (2008) investigates the sustainable power of exogenous regressors and normal errors in the panel. Therefore, we perform LM adjusted test to produce more robust results in comparison to the other cross-sectional dependence tests. The null hypothesis represents that the residuals are cross-sectional independent. Then, we examine the testing for slope heterogeneity in both data and model by using the Delta HAC test (Blomquist and Westerlund, 2013). Second, we investigate the stationarity of data. Since we find the cross-sectional dependence and homogeneity assumption in all variables according to the previous step of the empirical investigation, we perform the second-generation unit root tests. We implement three unit root tests: Harris-Tzavalis (1999), Breitung (2000) and Breitung and Das (2005) unit root test. Harris-Tzavalis test is based on the bias-corrected OLS estimator of coefficient and the errors in the OLS estimation are generated by a stationary AR(1) process (Blander and Dhaene, 2012:102). Breitung unit root test against the Harris-Tzavalis unit root test uses unbiased estimators rather than bias-corrected ones. The Breitung and Das unit root test used as a third test gives better results in small samples. All three tests have a better power under the assumption that there is the cross-sectional dependence and slope coefficients are homogeneous. The null hypothesis of these tests is the existence of the unit root for the panel.

Thirdly, we examine the cointegration relationship. To this end, we apply Gengenbach, Urbain ve Westerlund (2016) panel error correction model. The panel cointegration test suggested by Gengenbach, Urbain and Westerlund (2016) use a common factor structure with error correction model by considering cross-sectional dependence and heterogeneity assumption. Lastly, we estimate the long-run parameters. We utilize two different estimators in the study: Common Correlated Effects Mean Group estimator (CCEMG) (Pesaran, 2006), and Augmented Mean Group estimator (AMG) (Eberhardt and Bond, 2009; Eberhardt and Teal, 2010). Both CCEMG and AMG estimators are augmented versions of the panel error correction model. FMOLS and

DOLS estimators, which are generally preferred in the literature, provide strong long-run forecasting results if there is cross-section independence in the model. Our study focuses on examining the debt sustainability of emerging countries, which is characterized by high cross-sectional dependency due to the contagion effect of crises. Because of the cross-section dependency in the model we prefer CCEMG and AMG tests. These estimators are specifically designed to address cross-sectional dependence and heterogeneity across panel members, making them effective in panel data analysis (Kassouri and Altıntaş, 2020). The CCEMG estimator considers the cross-sectional averages of the variables as a common factor, thus eliminating the heterogeneous effects of shocks. On the other hand, the AMG estimator uses the $(T-1)$ dummy coefficients with the first difference method to estimate common factors not observed. The AMG estimator combines the advantages of the CCEMG estimator with the inclusion of time-varying heterogeneity. It allows for individual-specific effects to vary over time, accommodating both cross-sectional dependence and individual heterogeneity. By employing these augmented estimators, we are able to better capture the complexities and nuances of panel data, enhancing the accuracy and robustness of their empirical analyses.

5 Empirical results

Before the empirical examination of the relationship between external debt-creating and reducing variables, we firstly analyze the homogeneity and cross-sectional dependence for model and variables. The results of the homogeneity and cross-sectional dependence tests are reported in Table 2.

Table 2: Homogeneity and cross-sectional dependency test results for model and variables

Tests	$LNIX_t$	$LNMM_t$	Model
Δhac	-1.433	-1.194	-2.58**
	(0.15)	(0.23)	(0.01)
Δhac_{adj}	-1.532	-1.277	-2.827***
	(0.13)	(0.20)	(0.00)
LM	919.16***	729.38***	192.49***
	(0.00)	(0.00)	(0.00)
LM_{adj}	58.18***	43.09***	6.04***
	(0.00)	(0.00)	(0.00)
CD	28.97***	25.19***	4.03***
	(0.00)	(0.00)	(0.00)

Notes: **,*** denotes cross-sectional dependence at the 5% and 1% level. Numbers in the parentheses ( ) are p-values.

The homogeneity test (Δhac and Δhac_{adj}) results show that the slope of coefficients is homogeneous for variables but it is heterogeneous for the model. Also, according to the test statistics of LM, LMadj, and CD, the null of no cross-sectional dependence is strongly rejected in both the model and variables. When we pay regard to the balance of payments and borrowing structure of the analyzed emerging market countries, we are unsurprised by the result of the cross-sectional dependence for the variables and the model. Therefore, we apply the second-generation unit root tests with the homogeneity assumption because all variables are cross-sectional dependent and homogenous. We use the second generation cointegration test because of the cross-sectional dependence and heterogeneity in the model.

We have performed three different second-generation unit root tests: the Harris-Tzavalis ($\rho_{Harris-Tzavalis}$) (1999), Breitung ($\lambda_{Breitung}$) (2000) and Breitung and Das ($\lambda^{*}_{Breitung}$) (2005) tests. The stationarity results are presented in Table 3.

The results in panel (a) accept the alternative hypothesis of cointegration and verify the cointegration relationship between external debt-creating ($LNMM_t$) and reducing variables ($LNIX_t$). The cointegration test results show that countries have a sustainable debt structure. However, we estimate the β parameter (in Eq.(6)) for more interpretable results. When the parameter is $\beta = (-1, 1)$, which means there is a strongly sustainable debt structure (Hamilton and Flavin, 1986; Baharumshah et al., 2003; Önel and Utkulu, 2006). If there is weak sustainability, the country will have difficulty finding external debt (Quintos, 1995). We use two different estimators, i.e., CCEMG and AMG to estimate the long-run parameter (β) of panel and countries. The results are presented in panel (b). Based on these findings, we get the following outcomes. When we evaluate the panel, we confirm that the debt is weakly sustainable in emerging countries. According to cross-section results, we find the cointegration vector (β) of Bangladesh, Morocco and nearly Mexico has strongly debt sustainability and satisfies the necessary and important assumption of intertemporal borrowing constraint. We observe that the $LNIX_t$ and $LNMM_t$ variables converge in the long run for these countries. Common feature of the countries which suffer from weak debt sustainability in this study like Argentina (0.4222-0.4778), Turkey (0.4579-0.5848), South Africa (0.5386-0.5753), and Colombia (0.6316-0.5703) experienced high current account deficit which is perceived as a crisis signal in many other studies. When a country's current account deficit to gdp ratio is above the %4 percent for years, it become more vulnerable to international capital flows volatility. There is a sharp increase in debt ratio for Argentina and Turkey which implies ponzi financing under liquidity constraints since 2016. Although Morocco suffers from high current account deficit since 2007; its sustainability coefficient is very strong. When we look at the historical root of the data, it is seen that it experienced recovery last few years. Besides that, Mexico and Morocco external debt ratio were relatively low until 2010. So, their coefficients 0.97 and 1.04 respectively indicate strong external debt sustainability in the long run. Bangladesh has the highest cointegration coefficient which indicates no

Table 3: Unit root test results

Variables	Constant			Constant & Trend		
	$\rho_{(Harris-Tzavalis)}$	$\lambda_{(Breitung)}$	$\lambda^{*}_{Breitung}$	$\rho_{(Harris-Tzavalis)}$	$\lambda_{(Breitung)}$	$\lambda^{*}_{Breitung}$
$LNIX_t$	0.9225	2.2934	2.1919	0.8471	1.7754	1.6413
	(0.87)	(0.99)	(0.99)	(0.99)	(0.96)	(0.95)
$LNMM_t$	0.9109	1.7444	1.9873	0.8329	1.5204	1.3100
	(0.77)	(0.96)	(0.98)	(0.99)	(0.94)	(0.91)
$\Delta LNIX_t$	0.3458***	-5.8791***	-4.2316***	0.3993***	-5.0764***	-2.3095**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
$\Delta LNMM_t$	0.3025***	-6.3860***	-4.2926 ***	0.3500***	-6.4196***	-2.7884***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Notes: ** and *** denote the stationarity at the 5% and 1% levels. Numbers in the parentheses ( ) are p-values. Δ denotes the first differences of variables.

Table 4: Results of Cointegration test (Panel a) and the long-run parameters (Panel b)

Panel a Mean-Group correction models with variable cross-sectional averages		
Coefficient	T-bar	P-Value
-0.730***	-4.208	$\leqslant 0.01$

Panel b				
	CCEMG		AMG	
	B	Constant Term	β	Constant Term
Panel	0.7467*** (0.00)	0.1027 (0.88)	0.7094*** (0.00)	7.0652*** (0.00)
Argentina	0.4778*** (0.00)	5.3003*** (0.00)	0.4222*** (0.00)	14.095*** (0.00)
Bangladesh	1.0305*** (0.00)	-0.1295 (0.79)	1.0329*** (0.00)	-1.0157 (0.29)
Brazil	0.6334*** (0.00)	-1.1552** (0.01)	0.6125*** (0.00)	9.6251*** (0.00)
China	0.7633*** (0.00)	-3.7886** (0.01)	0.7649*** (0.00)	6.1303** (0.02)
Colombia	0.6316*** (0.00)	1.0465*** (0.00)	0.5703*** (0.00)	10.1071*** (0.00)
Egypt	0.8069*** (0.00)	1.8734 (0.20)	0.7067*** (0.00)	7.0191** (0.02)
India	0.7056*** (0.00)	-2.2352***(0.00)	0.6963*** (0.00)	7.5419*** (0.00)
Morocco	1.0472*** (0.00)	0.1397 (0.70)	1.0406*** (0.00)	-0.9988 (0.57)
Mexico	0.9753*** (0.00)	-0.7895 (0.10)	0.9782*** (0.00)	0.4906 (0.67)
Pakistan	0.8685*** (0.00)	1.6909** (0.04)	0.6805*** (0.00)	7.4798** (0.04)
Romania	0.6245*** (0.00)	-5.2572*** (0.00)	0.6925*** (0.00)	6.9275*** (0.00)
Russian Federation	0.8699*** (0.00)	0.2787 (0.68)	0.7695*** (0.00)	5.9114*** (0.00)
Thailand	0.6427*** (0.00)	0.7659 (0.15)	0.6414*** (0.00)	9.0074*** (0.00)
Turkey	0.5848*** (0.00)	1.5244**(0.01)	0.4579*** (0.00)	13.3788*** (0.00)
South Africa	0.5386*** (0.00)	2.2771*** (0.00)	0.5753*** (0.00)	10.2777*** (0.00)

Notes: ** and *** denote the stationarity at the 5% and 1% levels. Numbers in the parentheses ( ) are p-values.

debt solvency problem with its positive trade balance and low-level debt to GDP ratio. Rest of sample countries coefficients like China, Russia, India, Pakistan, and Egypt indicate moderate debt sustainability. However, except China they have high export concentration in relatively low value added well, energy and agriculture which has high price volatility in international markets. Argentina, Turkey, South Africa, Brazil, and Morocco have the lowest reserve deficit ratio which is important in financing short term foreign exchange payments. Although Morocco has no sustainability problem at this stage but in the near feature it has also potential to lose this sustainability in this respect.

According to test results in Table 3, the variables are not stationary in both constant and constant and trend models at the level, but they are stationary at their first differences. We can say that internal and external shocks to the variables of these countries are permanent. Therefore, to analyze the long-term relationship between the variables, we test the existence of a cointegration relationship. We perform a cointegration test and estimate the long-run parameters considering the cross-sectional dependence and heterogeneity. The cointegration test and long-run parameters results are given in panel (a) and panel (b) of Table 4.

6 Conclusions

The debt sustainability analysis results are diverse not only with their theoretical roots like employing government primary balance variables or covering diverse external debt variables but also with their methodologies like unit root or cointegration analysis. Moreover, the results of the studies including different samples and periods also show no uniform results. Besides the importance of internal factors in the analysis of debt sustainability, global macroeconomic developments and perceptions about future expectations also affect the cost, maturity, and availability of the debt. So rather than clear-cut statements about debt sustainability more moderate explanations may give some clues about a country's debt solvency situation.

This study covers 15 emerging countries' debt sustainability for the period 1995-2020. The results of this panel cointegration estimation for EMDE countries are 0.74 and 0.70 for CCEMG and AMG estimators respectively which indicates moderate sustainability as whole sample countries. However, the individual cointegration values vary widely from weak to strong sustainability.

Debt solvency is a complicated issue that cannot be simplified in a few variables. For instance, the country's product and export complexity and sophistication level are as much important as the current account balance. Because the only way to achieve higher export revenue is to increase value added. The higher the export revenue the less detrimental effect of the original sin is expected. An increase in export value added is important to get a trade surplus and long run revenue source of achieving debt sustainability. In this context, the relatively high country and product complexity levels (The comparison is done according to data derived from Atlas of Economic Complexity Rankings (ECI) which measures product complexity rankings of an economy. `https://atlas.cid.harvard.edu/rankings`) for China, Mexico, Romania and Thailand in this sample indicates that by improving their export revenue they may reduce their debt sustainability risk in the future. Bangladesh and Morocco have high debt sustainability coefficient results but low-level value-added export complexity (ECI, 2019). Although Russia relatively moderate debt sustainability ratio, it highly depends on natural resources for export earnings. The high volatility in petroleum product prices sharply affects its GDP and fragility.

Monetary and fiscal policy accommodation is important to safeguard EMDEs'

macroeconomic stability in a fragile global economic environment. Financial market deepening can help mobilize savings, which may be a more stable source of financing than foreign borrowing. Financial sector regulation and supervision are also obligatory to identify and act on emerging risks. In addition to that the level of institutional quality has a major impact on macroeconomic stability and government effectiveness which in the end directly affects fiscal balance and external debt sustainability (Köse et al., 2021).
This study focused on specifically international constraints of debt sustainability issues by focusing on variables creating foreign exchange inflows and outflows. However, as it is stated above emerging countries represent some features of the developed countries but have some fragility in some fields like the problems of the original sin, inflation, relatively low level of product quality, complexity, and export sophistication, etc. These fragilities also increased their risk premium which largely effects the interest burden and maturity of the existing debt. Moreover, the implementation of easy monetary and fiscal policies to cure Covid-19 has increased international liquidity and debt burden sharply. However, nowadays the excess global liquidity seems to disappear with tight monetary policy implementations in the short run. So, whether these resources have been used for proper investment projects which increase potential output and value added or just increase consumption as a Keynesian multiplier will determine the debt sustainability in the long run. In this context, a country's governance quality, production capability, export sophistication level, global macroeconomic policies, expectations, and some other variables for macroeconomic stability should be taken into consideration to make a proper debt sustainability analysis.

References

[1] Baharumshah A. Z., Lau E., Fountas S., (2003), On the sustainability of current account deficits: evidence from four ASEAN countries, *Journal of Asian Economics* 14(3), 465–487.

[2] Baldacci E., Gupta S., Mulas-Granados C., (2010), Restoring debt sustainability after crises: Implications for the fiscal mix, International Monetary Fund, IMF Working Papers, No 232, available at `https://doi.org/10.5089/9781455209323.001`.

[3] Blanchard O.,(2019), Public Debt and Low Interest Rates, *American Economic Review* 109 (4), 1197–1229.

[4] Blomquist J., Westerlund J., (2013), Testing slope homogeneity in large panels with serial correlation, *Economics Letters* 121(3), 374–378.

[5] Breitung J., Samarjit D., (2005), Panel unit root tests under cross-sectional dependence, *Statistica Neerlandica* 59(4), 414–433.

[6] Breitung J., (2000), The local power of some unit root tests for panel data, [in:] *Nonstationary Panels, Panel Cointegration, and Dynamic Panels, Advances in Econometrics*, [ed.:] B. H. Baltagi, vol. 15, 161–178.

[7] Breusch T. S., Pagan A. R., (1980), The lagrange multiplier test and its applications to model specification in econometrics, *The Review of Economic Studies* 47(1), 239–253.

[8] De Blander R., Dhaene G., (2012), Unit root tests for panel data with AR (1) errors and small T, *The Econometrics Journal* 15(1), 101–124.

[9] Devlin R., (1990), *Debt and crisis in Latin America: The supply side of the story*, Princeton University Press, Princeton, NJ.

[10] Diamond D. W., He Z., (2012), A theory of debt maturity: The long and short of debt overhang, NBER Working Paper, No. 18160.

[11] Eberhardt M., Bond S., (2009), Cross-section dependence in nonstationary panel models: a novel estimator, MPRA Paper No. 17692, 07 Oct., available at `https://mpra.ub.uni-muenchen.de/17692/`.

[12] Eberhardt M., Teal F., (2010), Productivity analysis in global manufacturing production, Economics Series Working Papers 515, University of Oxford, Department of Economics.

[13] ECI, (2019), Atlas of Economic Complexity Economic Complexity Rankings, available at https://atlas.cid.harvard.edu/rankings.

[14] Eichengreen B., Hausmann R., (1999), *Exchange rates and financial fragility, In New Challenges for Monetary Policy*, Proceedings of a symposium sponsored by the Federal Reserve Bank of Kansas City.

[15] Eichengreen B., Hausmann R., Panizza U., (2005), The pain of original sin, [in:] *Other people's money: Debt denomination and financial instability in emerging market economies*, [eds.:] B. Eichengreen, R. Hausmann, 13–47.

[16] Eichengreen B., Hausmann R., Panizza U., (2007), *Currency Mismatches, Debt Intolerance and Original Sin: Why They Are Not the Same and Why it Matters. Capital Controls and Capital Flows in Emerging Economies: Policies, Practices and Consequences*, University of Chicago Press, 121–170.

[17] Gapen M., Dale G., Lim C. H., Xiao Y., (2008), Measuring and analyzing sovereign risk with contingent claims, IMF Staff Papers 55, 109–148, doi:10.1057/palgrave.imfsp.9450026.

[18] Gengenbach C., Urbain J. P., Westerlund J., (2016), Error correction testing in panels with common stochastic trends, *Journal of Applied Econometrics* 31(6), 982–1004.

[19] Goldstein M.,(2003), Debt Sustainability, Brazil, and the IMF, Working Paper Series WP03-1, Peterson Institute for International Economics.

[20] Hakkio C., Rush M., (1991), Is the budget deficit too large?, *Economic Inquiry* 29, 429–445.

[21] Hamilton J. D., Flavin M., (1986), On the limitations of government borrowing: A framework for empirical testing, *American Economic Review* 76, 809–819.

[22] Harris R. D. F., Tzavalis E., (1999), Inference for unit roots in dynamic panels where the time dimension is fixed, *Journal of Econometrics*, 91(2), 201–226.

[23] Hausmann R., Panizza U., (2003), On the determinants of Original Sin: An empirical investigation, *Journal of International Money and Finance* 22 (7), 957, doi: 10.1016/j.jimonfin.2003.09.006.

[24] Hostland D., Karam P., (2006), Assessing debt sustainability in emerging market economies using stochastic simulation methods, World Bank Policy Research Working Paper, 3821, 1–34.

[25] IMF, (2015), As of October, available at `http://www.imf.org/external/pubs/ft/weo/2015/02/pdf/text.pdf`.

[26] Kassouri Y., Altıntaş H., (2020), Human well-being versus ecological footprint in MENA countries: a trade-off?, *Journal of Environmental Management* 263, 110405.

[27] Köse M. A., Nagle P., Ohnsorge F., Sugawara N., (2021), *Global waves of debt: Causes and consequences*, Washington, DC, World Bank, doi:10.1596/978-1-4648-1544-7, License: Creative Commons Attribution CC BY 3.0 IGO.

[28] Kraay A., Nehru V., (2006), *When is external debt sustainable?*, Oxford University Press on behalf of the World Bank, World Bank, available at `https://openknowledge.worldbank.org/handle/10986/16425`

[29] IMF, (International Monetary Fund), (2021), World Economic Outlook: Managing Divergent Recoveries, Washington, DC, April.

[30] Manasse P., Roubini N., Schimmelpfenning A., (2003), Predicting sovereign debt crises, IMF Working Paper No. 03/221.

[31] Manasse P., Roubini N., (2009), "Rules of thumb" for sovereign debt crises, *Journal of International Economics* 78, 192–205.

[32] Mehrotra N. R., Sergeyev D., (2021), Debt Sustanibility in a low interest rate world, *Journal of Monetary Economics* 124(S), 1–18.

[33] Önel G., Utkulu U., (2006), Modeling the long-run sustainability of Turkish external debt with structural changes, *Economic Modelling* 23, 669–682, available at `http://dx.doi.org/10.1016/j.econmod.2006.03.006`.

[34] Pattillo C., Poirson H., Ricci L., (2002), External debt and growth, IMF Working Paper, 1–49.

[35] Pesaran M. H., (2004), General diagnostic tests for cross section dependence in panels, CESifo Working Papers, No.1233, 255–60.

[36] Pesaran M. H., (2006), Estimation and inference in large heterogeneous panels with a multifactor error structure, *Econometrica* 74(4), 967–1012.

[37] Pesaran M. H., Ullah A., Yamagata T., (2008), A bias-adjusted LM test of error cross-section independence, *The Econometrics Journal* 11(1), 105–127.

[38] Reinhart C. M., Rogoff K. S., (2010), Growth in a time of debt, *American Economic Review* 100(2), 573–578.

[39] Sawada Y., (1994), Are the heavily indebted countries solvent?: Tests of intertemporal borrowing constraints, *Journal of Development Economics* 45, 325–337.

[40] Saadaoui J., Keung Lau M. C., Cai Y., (2022), Assessing Debt Stationarity and Sustainability in the Longer-Run with Fourier DF Unit Root Tests and Time-Varying Fiscal Reaction Functions, Working Papers 2022.07, International Network for Economic Research - INFER.

[41] Quintos C. E., (1995), Sustainability of the deficit process with structural shifts, *Journal of Business and Economic Statistics* 13(4), 409–417.

[42] Todaro M. P., Smith S. C., (2011), *Economic Development*, 11th Edition, Pearson Education and Addison-Wesley.

[43] Uctum M., Thurston T., Uctum R., (2006), Public Debt, the Unit Root Hypothesis and Structural Breaks: A Multi-Country Analysis, *Economica* 73, 129–156.

[44] World Bank, (2021), Global economic prospects, June 2021, Washington, DC, doi:10.1596/978-1-4648-1665-9, Attribution CC BY 3.0 IGO.