CESifo WORKING PAPERS

10074
2022

November 2022

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CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editor: Clemens Fuest
https://www.cesifo.org/en/wp
An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
· from the RePEc website: www.RePEc.org
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CESifo *Working Paper No. 10074*

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Abstract

For emerging economies, borrowing abroad is a double-edged sword: it can buffer against adverse economic shocks and smooth their domestic consumption; however, it can also amplify volatility in consumption, depending on the currency in which the debt is denominated and cyclicality in the borrower's exchange rate. We empirically investigate the nexus among external debt portfolios, exchange rate cyclicality, and volatility in consumption of low- and middle-income countries. Since 1980, many countries have concentrated their external debt portfolios' currency composition. By constructing debt-weighted effective exchange rates, we find that currency concentration magnifies exchange rate pro-cyclicality, making domestic consumption more volatile when national income fluctuates. Our results endorse diversifying the currency composition of external debt to mitigate the negative consequences of "original sin."

JEL-Codes: F340, F310.

Keywords: external debt, currency portfolio, original sin, exchange rate cyclicality, volatility in consumption.

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This version: October 2022
An early version of the paper was circulated under the title of "Currency Portfolio of External Debt, Exchange Rate Cyclicality, and Consumption Volatility" (CESifo Working Papers 8287). This research is supported by JSPS KAKENHI Grant Number 18K01715. The author is grateful to anonymous referees, Xingwang Qian, Isabelle Mejean, workshop participants at Université Catholique de Louvain, and seminar participants at the Center for Risk Research of Shiga University for helpful comments and suggestions. All errors are solely the author's.

1. Introduction

Access to global financial markets enables low- and middle-income countries (LMICs) with underdeveloped financial markets to buffer domestic income shocks and stabilize household consumption. Unfortunately, LMICs confront what Eichengreen, Hausmann, and Panizza (2005) call "original sin": the inability to borrow abroad in their home currencies. The far-reaching effects of external debt denominated in a foreign currency include the borrower's macroeconomic volatility (Korinek, 2011), default risk (Gumus, 2013), and currency regime (Bleaney and Ozkan, 2011). Perhaps the most evident risk is that the sovereign borrower's home currency depreciates against the borrowed currency; depreciation magnifies the principal borrowed and interest paid in the borrower's home currency. Escaping original sin is desirable but challenging for many LMICs so long as the currencies of affluent economies dominate international borrowing.[1] If LMICs continue to borrow in foreign currencies, they must attenuate its adverse consequences. This imperative motivates this study.

LMICs can borrow in multiple foreign currencies, but simplifying theoretical models assume their choice is binary, i.e., borrow in their home or foreign currency. Moreover, LMICs can shift their debt's currency composition, a portfolio perspective that previous studies disregard. In this study, we argue that adopting a portfolio perspective allows LMICs to attenuate the undesirable consequences of borrowing in foreign currencies.

More specifically, LMICs' choice of debt-denominating currencies shapes cyclicality in their home currencies' exchange rates. Exchange rate pro-cyclicality is defined as a tendency of the borrower's domestic currency to depreciate (appreciate) in response to

[1] Recently some emerging market economies improved their ability to borrow abroad in their home currencies (Arslanalp and Tsuda 2014; Du and Schreger 2016). Nonetheless, original sin remains generally prevalent among LMICs.

unfavorable (favorable) macroeconomic conditions. If LMICs' exchange rates are pro-cyclical, debt denominated in foreign currencies engenders larger (smaller) repayment in the borrower's home currency during bad (good) economic times. Fluctuations in national output also can amplify volatility in domestic household consumption. These effects depend on the currencies that dominate a portfolio of external debt and the borrowing nation's exchange rate cyclicality.

This study empirically examines the nexus among a portfolio of external debt, exchange rate cyclicality, and volatility in household consumption for numerous LMICs. Using data for their public and publicly guaranteed (PPG) external debt spanning 1980–2017, we construct debt-weighted effective exchange rates (DEER) indices to quantify LMICs' exposure to the foreign exchange-related revaluation of their debt. We investigate how the composition of currencies in an external debt portfolio relates to exchange rate cyclicality and volatility in consumption.

Our chief findings are as follows. In general, LMICs' external debt has been denominated primarily in foreign currencies, particularly the US dollar (USD), since 1980. The rising share of debt denominated in foreign currencies as a percentage of total debt and its concentration in a single currency further characterize the four-decade trend. Currency concentration became notable after the advent of the euro (EUR).

Holding the share of debt denominated in foreign currencies constant, we find that currency concentration exacerbated exchange rate pro-cyclicality during the study period. Furthermore, pro-cyclicality renders household consumption more volatile in response to fluctuations in national income. Our results suggest that LMICs can potentially mitigate these negative consequences by diversifying the currencies that denominate their external debt.

The study proceeds as follows. Section 2 reviews the previous literature, while Section 3 describes data and quantifies the currency shares and portfolios of LMIC debt. Section 4 constructs the DEER index to gauge foreign exchange-related debt revaluation and exchange rate cyclicality. Section 5 examines how household consumption responds to changes in national income under cyclical exchange rate movement, and Section 6 concludes.

2. Literature Review

Many studies on international borrowing by emerging economies highlight the prevalence of original sin and its implied danger for indebted countries (Eichengreen *et al.*, 2005, 2007; Hausmann and Panizza, 2003). Studies mainly assert that accumulating debt in foreign currencies eventually suppresses the borrower's economic activity, especially without offsetting foreign currency assets (Panizza and Presbitero, 2014; Ranciere, Tornell, and Vamakidis, 2010; Reinhart and Rogoff, 2010).

Sources of original sin have been contentiously debated. Eichengreen *et al.* (2005) argue that original sin is exogenous to a borrowing country's fundamentals and is related to the international financial system. Conversely, Burger and Warnock (2006) argue that countries with stable inflation rates and substantial creditor rights have more developed local bond markets and rely less on foreign currency debt. Claessens, Klingebiel, and Schmukler (2007) find that economies with deeper domestic financial systems have larger domestic currency bond markets and issue less foreign currency debt. Caballero and Krishnamurthy (2003) attribute excessive dollar-denominated debt to limited financial development in emerging markets. A recent study by Engel and Park (2022) argues that original sin can be attributed mainly to a borrowing country's monetary indiscipline, even

though the endogenous relationship between inflation performance and the debt's currency composition is not straightforward.

Eichengreen *et al.* (2005) imply that there is little LMICs can do to resolve original sin within the status quo of the international financial system. An opposing view is that LMICs can reduce their reliance on foreign currency debt by improving macroeconomic policy conducts and undertaking legal reforms on domestic bond markets. In concrete terms, remedial means may include inflation targeting (Ogrokhina and Rodriguez, 2018), international reserve management (Alfaro and Kanczuk, 2009), deepening of domestic financial systems (Claessens *et al.*, 2007), and enhancing creditor rights (Burger and Warnock, 2006; La Porta, Lopez–De–Silanes, Shleifer, and Vishny, 1997). Provided foreign currency borrowing continues to be an essential instrument for LMICs, finding ways to attenuate its negative consequences is imperative.

External debt is crucial for smoothing absorption across periods of varying income (Eaton and Gersovitz, 1981). In this regard, the cyclicality of exchange rates can have significant implications for countries relying on foreign currency-denominated debt. Korinek (2011) uses a theoretical model of a small open emerging-market economy with a pro-cyclical exchange rate, finding that an output shock's impact on aggregate demand and volatility in consumption rise as sovereign borrowers denominate a greater percentage of their debt in foreign currencies. However, the positive correlation between the share of foreign currency debt and consumption volatility is not necessarily warranted.

Empirically, exchange rate cyclicality might vary from counter-cyclical to pro-cyclical among different LMICs. Furthermore, even in the case of a pro-cyclical exchange rate, Bengui and Nguyen (2016) show that non-tradable consumption baskets and domestic price rigidities reduce the effects of domestic currency depreciation. Thus, the

theoretical findings of Korinek (2011) must be situated in a specific empirical context before drawing implications.

This study contributes to the literature by empirically examining the implications of debt currency portfolios for volatility in domestic consumption. Specifically, we quantify LMICs' exchange rate cyclicality using currency-composition data on their external debt. We then examine if exchange rate pro-cyclicality exerts a volatility amplifying effect on consumption. Unlike previous literature, we consider the potentials and perils of foreign currency debt from the perspective of portfolio concentration and the resultant cyclicality in exchange rates. Unless denominated solely in one foreign currency, the share of debt denominated in foreign currencies (the standard theoretical measure) does not convey complete empirical information about fluctuations in a borrower's effective exchange rate.[2] Thus, we adopt a portfolio perspective in examining LMICs' debt.

3. Measuring Currency Composition

This section describes the data and presents two alternative measures to characterize the currency compositions of LMICs' external debt.

3.1. Data

The World Bank's International Debt Statistics (IDS) database reveals the currency composition of external long-term PPG debt. We examined 106 countries in the database from 1980 to 2017 based on data availability.[3] Shorter sample periods apply to some countries because of data limitations. Data are annual, and our Data Appendix provides further information.

[2] Several studies (Claessens, 1992; Dodd and Spiegel, 2005; Fujii 2017) endorse a portfolio perspective when considering the currency composition of indebtedness among emerging economies.
[3] For consistency and comparability of results, we limited our sample to countries with effective observations of currency denominations, exchange rates, and output for pre-EUR and EUR periods.

Regarding the 1980–2017 average, PPG debt constitutes 73% and 68% of all debt stock and service expenditures, respectively. The shares are higher pre-EUR (79% and 72 %) than in the EUR period (67% and 65%), presumably reflecting the gradual development of private bond markets. Overall, data indicate that PPG debt comprises the bulk of and is a reasonable proxy for LMICs' indebtedness.

IDS provides percentage shares for debt denominated in USD, EUR, Japanese yen (JPY), British pounds (GBP), and Swiss francs (CHF). Data for debt denominated in German marks (DEM) and French francs (FRF) are available for the pre-EUR period. IDS also reports debt denominated in special drawing rights (SDRs), multiple currencies, and all other currencies. SDRs are a basket of foreign currencies, and we treat SDR-denominated debt as foreign currency debt.[4] Furthermore, "multiple currencies" logically entails at least one foreign currency; thus, this category is also considered foreign currency debt. Given that IDS tallies prominent international currencies, the primary candidate for "all other currencies" is the borrowers' domestic currencies. Absent refining data, we assume that "all other currencies" indicates debt denominated in borrowers' domestic currencies.

3.2. Foreign currency share

As an empirical counterpart to conventional measures in theoretical studies, we first calculated the total share of debt denominated in foreign currencies for each sampled country as

$$TFS_{i,t} = \sum_{j} FS_{i,j,t} \ , \qquad (1)$$

[4] An exception is China during 2016 and 2017 when the Chinese yuan (CNY) comprised 10.92% of the SDR basket.

where *i* and *j* denote the borrower and debt-denominating foreign currencies, respectively. $FS_{i,j,t}$ is foreign currency *j*'s share of country *i*'s debt in year *t*.

Figure 1 displays average composition shares by currency. On average, foreign currency debt (i.e., all but "Others") constitutes approximately 80% of all PPG debt. Sub-period averages for 1980–2000 and 2001–2017 are 76% and 87%, respectively; these figures suggest that original sin was increasingly prevalent.

Approximately 50% of PPG debt among LMICs is denominated in USD. EUR's advent preceded a rise from 41% to 61% in USD-denominated debt in sub-period averages. The EUR is second to the USD, with an average share of 12%. Although the EUR exceeded the combined share for DEM- and FRF-denominated debt during the preceding era, its share is one-fifth of the USD for the corresponding period.[5]

Average debt shares denominated in JPY, GBP, and CHF are far smaller (approximately 5%, 2%, and 1%, respectively) during 1980–2017. The sub-period data reveal that the share of debt denominated in GBP and CHF eroded to below half a percent upon introducing the EUR.

Countries may increase or decrease reliance on foreign currency debt over time. We fitted a linear time trend to aggregate and individual currency shares to identify the direction of those shifts.[6] Figure 2 displays the results. From 1980 to 2017, 67 countries showed significant uptrends in the aggregate share of debt denominated in foreign currencies, and 16 show downtrends. Moreover, 67 countries exhibit declining shares for debt denominated in "all other currencies," presumably domestic currencies. Trends in

[5] The "synthetic EUR" share in Figures 1 and 2 connects the two series, i.e., the sum of debt denominated in DEM and FRF for 1980–2000 and the EUR for 2001–2017.

[6] We regressed foreign currency shares along a constant and time trend to see if the time trend's coefficient is statistically significant at the 5% level (positive or negative).

by-currency shares highlight the escalation of USD-denominated debt in 84 sampled countries, whereas only 9 countries exhibit declines.

Sub-period results reveal opposing trends between 1980–2000 and 2001–2017; the former features rising shares in foreign currency debt, primarily USD and JPY. The latter period exhibits a reduction in debt denominated in foreign currencies among many countries alongside increases in debt denominated in domestic currencies. Nonetheless, the USD is an exception. Even between 2001 and 2017, the number of countries with escalating USD-denominated debt exceeds that of declining shares.

3.3. Foreign currency portfolio

Borrowers may alter risk exposure by diversifying or concentrating their portfolios' currency composition without changing the total share of foreign-currency debt. The share of total foreign currency debt might suffice for theoretical analyses assuming binary currency choices. However, it is an insufficient empirical measure because it conveys no information regarding other portfolio features. We address this problem by constructing a Herfindahl–Hirschman index to gauge portfolio concentration and diversification:

$$HI_{i,t} = \sum_{j} (FS_{i,j,t} / TFS_{i,t})^2 , \tag{2}$$

where $FS_{i,j,t}$ and $TFS_{i,t}$ are defined using Eq. (1). The index spans values between 0 and 1 ($0<HI_{i,t}\leq 1$), with larger (smaller) values indicating a more concentrated (diversified) portfolio for country i's foreign currency debt.

SDRs are baskets of several currencies; therefore, we decompose the share of SDR-denominated debt by currency using the International Monetary Fund's (IMF) official

weights.[7] We add the decomposed SDR shares to shares denominated in USD, EUR, DEM, FRF, JPY, and GBP.

Absent details about the actual content of "multiple currencies," we assume shares in this category are distributed over individual currencies according to their relative shares. Specifically, using SDR-inclusive shares and shares of CHF, we calculate the weights to decompose the share of "multiple currencies" into shares of USD, EUR, DEM, FRF, JPY, GBP, and CHF. We then add the decomposed shares before calculating $HI_{i,t}$.

Table 1 summarizes the concentration index for the constructed portfolio. The average concentration for the entire sample is 0.64, rising for sub-periods from 0.61 in 1980–2000 to 0.69 in 2001–2017. The standard deviations indicate reduced variability in the latter period; thus, portfolio concentration is evident from 2001 to 2017.

For further insight, we fitted a linear trend to $HI_{i,t}$. A significantly negative (positive) trend indicates portfolio diversification (concentration) over time. Insignificant trend estimates suggest that the level of portfolio diversification is largely stable over time. Figure 3 displays that the number of countries with currency-concentrated portfolios (66) far exceeds that of countries with diversified portfolios (18). Sub-period results reveal a trend in concentration, primarily from 2001 to 2017. The numbers of portfolio-concentrating (66) and portfolio-diversifying countries (12) during this period are less balanced than in the preceding period (36 and 27, respectively).

Figures 2 and 3 reveal greater currency concentration during 2001–2017 when many countries reduced percentages of total debt denominated in foreign currencies. During 1980–2000, many countries raised their total share of foreign currency debt and

[7] Until 1980, SDRs contained 16 currencies with weights changing annually. Their composition was revised during 1981 to feature the USD, DEM, FRF, JPY, and GBP with weights revised every 5 years. The EUR replaced the DEM and FRF during 1999, and CNY joined the basket during 2016. For 1980, we use the weights applicable in 1981.

diversified their portfolios by currency. Distinguishing changes in aggregate share from changes in currency composition highlights the effects of these alternative approaches to currency concentration.

4. Debt Revaluation and Exchange Rate Cyclicality

4.1. DEER

The currencies a borrower's debt is denominated in and any changes in the exchange rate determine the extent to which currency revaluations affect its indebtedness, as quantified in the borrower's domestic currency. Our DEER index captures the percentage of debt denominated by currency and the variability of exchange rates between domestic and denominating currencies.

$$DEER_{i,t} = \prod_j \left(\frac{S_{i,j,t}}{S_{i,j,2010}} \right)^{\gamma_{i,j,t}} \quad (3)$$

where $\gamma_{i,j,t}$ is the share of currency j among country i's total PPG debt during year t. $S_{i,j,t}$ is the nominal bilateral exchange rate between i's currency and currency j; currency j here includes i's home currency and all foreign currencies. The bilateral exchange rate is expressed in units of i's currency per currency j, indexed to 2010.[8] The DEER index indicates debt revaluation following changes in portfolios' currency composition or exchange rates. We use the first differences in logged DEER to measure the effective rate of debt revaluation. All exchange rate data, including SDR data, are from the IMF's International Financial Statistics (IFS).

To gauge changes in debt valuation in real terms, we calculated relative inflation and constructed a real DEER (RDEER) growth series:

[8] A rise in the value of DEER indicates effective depreciation in country i's currency.

$$\Delta \ln RDEER_{i,t} = \Delta \ln DEER_{i,t} - (\Delta p_{i,t} - \sum_{j} \gamma_{i,j,t} \Delta p_{j,t}) \quad (4)$$

where $\Delta p_{i,t}$ and $\Delta p_{j,t}$ are the borrower's inflation rates and countries whose currencies its debt is denominated, respectively.[9]

Panels A–C in Table 2 present descriptive statistics for average rates of DEER growth, relative inflation, and RDEER growth, respectively. In averaged terms across all countries from 1980 to 2017, LMIC debt was revalued by approximately 10% annually (Panel A). Average DEER growth rates exhibit discernible differences surrounding the advent of the EUR. Average rates of debt revaluation are approximately 20% for 1980–2000 and 1.5% for 2001–2017.

The decline in average rates of debt revaluation is better understood when combined with chronological information about relative inflation presented in Panel B. Massive inflation during 1980–2000 eroded the purchasing power of LMIC currencies. Debt crises in Latin America also marred the pre-EUR period during the 1980s.[10] Although inflation improved from 2001 to 2017, it averaged 6% higher in LMICs than in countries with major lending currencies. That higher inflation generated boosted values of RDEER, as indicated by the negative signs of means and medians in Panel C. RDEER appreciation implies erosion in the price competitiveness of LMICs' exports.

4.2. Exchange rate cyclicality

We correlated real output growth and exchange rate changes to measure exchange rate cyclicality by country.[11] In Table 3, a negative (positive) correlation indicates pro-cyclicality (counter-cyclicality) of country *i*'s exchange rates. Panel A correlates the

[9] We used GDP-deflator inflation rates from the World Development Indicators (WDI) database.
[10] Another contributing factor may be the dollarization that countries such as Ecuador and El Salvador adopted during the 2000s.
[11] See Cordella and Gupta (2015) for an analysis of nominal effective exchange rate cyclicality of advanced and emerging market economies.

growth rates of DEER and real output. From 1980 to 2017, the correlation spans −82% (Tajikistan) to 34% (Eritrea), with a standard deviation of 27%. For comparison, Panel B summarizes the cyclicality of bilateral USD exchange rates. To the extent that LMICs rely on USD debt, the DEER cyclicality resembles the USD cyclicality.

Panel C correlates the growth rates of RDEER and real output; large standard deviations indicate that RDEER cyclicality also differs widely by country. From 1980 to 2017, the correlation spans −57% (Russia) to 92% (Cambodia), with a standard deviation of 28%. The results suggest pro-cyclical tendencies in RDEER during 2001–2017 because mean and median correlations turned negative. The overall results highlight diverse exchange rate cyclicality among LMICs.

DEER and RDEER are tools for evaluating exchange rate cyclicality empirically. Unless a country's debt is denominated entirely in one foreign currency, bilateral exchange rates are inadequate measures. A broadly appropriate exchange rate is constructed by weighting the percentages of debt denominated in their respective currencies. In the Appendix, we further estimated the effects of the foreign currency share and the portfolio concentration index on the cyclicality of RDEER. The results indicate that portfolio concentration exacerbates pro-cyclicality of exchange rates.

5. Volatility in Consumption Under Cyclical Exchange Rates

5.1. Empirical model specifications

External debt may help LMICs stabilize domestic consumption by buffering fluctuations in national income; however, it may hinder consumption smoothing if changes in the borrower's effective exchange rate make debt service more burdensome when national income stagnates.

The literature generally contends that consumption may respond differently to expected and unexpected changes in income.[12] Separating expected from unexpected changes in national income is empirically complicated because data do not capture expectations. As a practical approach, given the data constraints, we decompose the national income into the trend and cycle components using the filter of Hamilton (2018). The cyclical component conceptualized by Hamilton (2018) is the difference in the value at date $t+h$ from the value that we would have expected to see based on its behavior through date t.[13] We treat the filtered trend component as the expected income path and the cycle components as unexpected deviations from the trend.

Domestic consumption responses to unexpected changes in national income may depend on the sign of the unexpected change. For instance, excess sensitivity of consumption to negative income shocks may arise from limited access to credit and insurance markets (Blundell, Pistaferri, and Preston, 2008).

Our benchmark specification permits asymmetry in the consumption response to positive and negative income surprises:

$$\Delta c_{i,t} = \alpha_i + \varphi \Delta \hat{y}_{i,t} + \beta_P \Delta \tilde{y}^P_{i,t} + \beta_N \Delta \tilde{y}^N_{i,t} + W_{i,t}\Phi + \varepsilon_{i,t} \quad (5)$$

where $\Delta c_{i,t}$ is the rate of growth in final household consumption expenditures. $\Delta \hat{y}_{i,t}$ is the expected national income growth. $\Delta \tilde{y}^P_{i,t}$ and $\Delta \tilde{y}^N_{i,t}$ are the unexpected positive and negative growths, respectively, in national income. $W_{i,t}$ captures the control variables, discussed as follows.

[12] The literature concerning this contentious topic is too voluminous to cite here. See Jappelli and Pistaferri (2010) for a comprehensive review.

[13] Highlighting the drawbacks of the Hodrik–Prescott filter, Hamilton (2018) proposes a better alternative that uses the linear population projection of y_{t+h} on a constant and p most recent values of y at date t. For the annual frequency data, we set the parameter values as h=2 and p=2, following the suggestions of Hamilton (2018).

If households can anticipate all national income shocks *ex ante*, as in a complete market model, consumption is perfectly smoothed and disregards changes in income, such that $\varphi = \beta_P = \beta_N = 0$. Generally, consumption responds less to fluctuations in income when markets are complete; imperfect smoothing yields $0 < \varphi, \beta_P, \beta_N$.

The buffer-stock models of saving (Carroll, 1992, 1994; Deaton, 1991) highlight the role of precautionary motives for consumption responses to unexpected income changes. Specifically, saving interacts with liquidity constraints to provide assets that can be used to buffer consumption. Our control variables included both lagged gross domestic savings and domestic credit provided to the private sector in ratios to gross domestic product (GDP).[14] *Ceteris paribus*, abundant accumulated assets and domestic credit means that resources are available to finance current consumption; thus, we conjecture positive effects.

A general equilibrium model of international fluctuations (Backus, Kehoe, and Kydland, 1992; Pakko, 1998) predicts that domestic consumption correlates perfectly with the global output when asset markets are complete and correlates perfectly with domestic output absent asset trade. Generally, global output fluctuations represent prime exogenous influences to which LMICs are commonly exposed. Therefore, we included world output growth as a control, expecting a positive coefficient less than unity.

Numerous LMICs experienced political turmoil during the sample period. To ensure these events did not drive our results, we included a dummy variable to capture the effects of *coups d'état*. The variable equals 1 if a successful or unsuccessful coup arose in a country, per the dataset in Powell and Thyne (2011). We expect a negative coefficient because social disorganization likely constrains consumption.

[14] Savings to GDP are lagged to avert simultaneity with consumption.

Access to external resources may also be relevant; thus, we included the debt stock relative to gross national income (GNI), current account balances relative to GDP, a capital account openness index (Chinn and Ito, 2006), and exchange rate regime classification (Ilzetzki, Reinhart, and Rogoff, 2017). We expect a negative effect concerning debt stock because debt accumulation can squeeze consumption. Improved current accounts generally reflect rising net exports, and we expect a positive correlation. The capital account openness index contains information that exchange rate regimes alone cannot capture, and its effect suggests another regime effect modifier. For a given exchange rate regime, less restricted cross-border capital transactions broaden households' market access and facilitate consumption smoothing. The Data Appendix provides details on the control variables.

The specification related to our chief scholarly interest elaborates upon Eq. (5) to allow additional asymmetry via exchange rate cyclicality:

$$\Delta c_{i,t} = \alpha_i + \varphi \Delta \hat{y}_{i,t} + (\rho_A A_{i,t} + \rho_D D_{i,t}) \Delta \tilde{y}^P_{i,t} + (\eta_A A_{i,t} + \eta_D D_{i,t}) \Delta \tilde{y}^N_{i,t} + W_{i,t} \Phi + \varepsilon_{i,t} \quad (6)$$

where $A_{i,t}$ and $D_{i,t}$ are dummies set equal to 1 if country i's RDEER appreciates and depreciates, respectively. This specification allows asymmetric reactions to positive and negative changes and varying responses, depending on whether changes in national income coincide with appreciation or depreciation in RDEER.

Pro-cyclical movement in exchange rates refers to the tendency for positive (negative) income deviations to coincide with appreciation (depreciation) in RDEER. Thus, ρ_A and η_D (ρ_D and η_A) are the relevant coefficients for pro-cyclicality (counter-cyclicality).

Given the endogeneity between consumption and income, we estimated Eqs. (5) and (6) by IV regression. The income growth is instrumented by growth in exports, government expenditures, and gross capital formation. These comprise income growth

not directly attributed to final growth in household consumption. We also instrumented credit, debt stock, current account balance, and capital account openness ratios using lagged terms. Data requirements increased in stringency as we adopted more instruments, and the effective number of countries empaneled declined to 86.[15]

5.2. Estimation results

Table 4 summarizes the estimation results. Column 1 presents the preliminary estimates imposing $\beta_P = \beta_N$ on Eq. (5). The estimates reveal that household consumption responded only to unexpected growth in national income. Approximately 42% of unpredicted national income changes do not smooth consumption fluctuations. The unresponsiveness to anticipated income changes is consistent with the predictions from models of certainty equivalence (Flavin, 1981) and precautionary saving (Carroll, 2009).

Although the effect of credit is insignificant, the lagged saving exhibits a significantly positive effect, as expected. Holding all else constant, the availability of a larger amount of accumulated assets tends to enhance consumption. Coefficients of world output growth and *coups d'état* bear the expected signs; however, only the latter is statistically significant, showing a consumption-suppressing effect of political turmoil.

Only the capital account openness index is statistically significant among external account variables. With all else constant, the negative coefficient suggests that a rise in capital account openness mitigates the consumption response. After controlling for differences in exchange rate regimes, we interpret this finding as the enhanced consumption smoothing effect of freer cross-border financial transactions.[16] *J*-statistics for testing over-identification corroborate the instruments' exogeneity.

[15] See the Data Appendix for the list of sampled countries.
[16] If perfectly smoothed, consumption is constant and the intercepts are 0. The effect of capital account openness reduces the positive intercepts of exchange rate regimes.

Estimates of Eq. (5) in Column 2 reveal that unexpected negative changes in national income prompt changes in household consumption. Unresponsiveness to positive income surprises implies that households are generally prudent. When faced with a negative income surprise, they show a 58% marginal propensity to reduce consumption. The sensitivity of consumption to negative income surprises supports the findings of a micro survey data study by Bunn, Le Roux, Reinold, and Surico (2018).

Estimates using Eq. (6) provide additional insight. After we differentiated unexpected changes in national income by the direction of movement in the exchange rate, Column 3 reveals that consumption responses vary significantly with cyclicality in exchange rates. Consumption responds significantly to negative income deviations that coincide with depreciation in RDEER. That is, unexpected negative changes in national income render household consumption volatile when RDEER exhibits pro-cyclicality. More specifically, 54% of unexpected income decline does not level consumption fluctuations.

The above results indicate that the amplifying effect on volatility in consumption is specific to pro-cyclical RDEER, as hypothesized. More precisely, the consumption volatility effect of exchange pro-cyclicality materializes when RDEER depreciation coincides with unexpected negative income changes. When RDEER exhibits counter-cyclicality, consumption responds mutedly to positive or negative deviations in national income. The findings present a more nuanced picture of consumption reaction to unexpected income changes under the cyclical behavior of exchange rates.

5.3 Robustness and discussion

This sub-section evaluates the results' robustness and extends the discussion in two ways. First, we examine if alternative modeling of income expectations significantly

alters the results. Second, we replace RDEER with the standard real effective exchange rate (REER) series to draw implications on the usefulness of RDEER.

We modeled income growth as an autoregressive process as an alternative method to capture expectations. By fitting an AR(1) model, we used predicted values and residuals as expected and unexpected income growth, respectively. This approach accommodates varying persistence in macroeconomic growth and incorporates it into expectations.

Column 1 of Table 5 presents the estimates of Eq. (6) using the AR(1) income decomposition. The main difference from Table 4 is that the effect of a positive income surprise with RDEER appreciation also attains significance, suggesting two-directional volatility amplification. Nonetheless, the results affirm that significant consumption responses are specific to pro-cyclical RDEER changes.

Although domestic currency depreciation makes foreign currency debt more burdensome, it can also boost LMICs' export price competitiveness to earn more foreign currency to repay the debt. While RDEER reflects the varying debt burden, the trade-weighted REER better represents the export price competitiveness. Determining which affects the consumption of households faced with income changes is an empirical question. Thus, we estimated Eq. (6) by replacing RDEER with REER. Unfortunately, the lack of REER data produced a sample of only 37 LMICs, as listed in the data appendix.

Column 2 of Table 5 presents the estimates using REER with the Hamilton-filtered income series.[17] Unlike the RDEER results, the estimates reveal significant consumption responses only to unexpected positive income changes under REER depreciation. That is, when income rises unexpectedly with improving export price competitiveness, households consume approximately 74% of the unexpected increase in income.

[17] Unlike RDEER, a rise in REER indicates real appreciation for domestic countries.

Conversely, consumption does not respond to a negative income surprise that coincides with REER depreciation; in other words, we found no REER pro-cyclicality effects.

It is unclear if the differences in the estimates above are due to using REER or the reduced data sample. Thus, we re-estimated Eq. (6) with RDEER on the same 37-country sample used for the REER estimates. Column 3 indicates that consumption significantly responds to a negative income surprise with RDEER depreciation, similar to Table 4. Again, approximately 50% of an unexpected income decline under RDEER depreciation translates into reduced household consumption.

The REER and RDEER estimates imply multi-faceted interactions of LMICs' household consumption, national income, and exchange rate cyclicality. To the extent that LMICs rely on external debt as a consumption buffer, their repayment burden becomes a constraint. In particular, the pro-cyclical nature of fiscal policy in LMICs (Talvi and Végh, 2005; Kaminsky, Reinhart, and Végh, 2004) can generate a significant link between household consumption and the burden of sovereign debt.

Although REER depreciation helps LMICs to earn foreign currency for debt repayment, households consume part of the positive income surprises that depreciation may cause. The definition of exchange rate cyclicality depends on how effective exchange rates are constructed. Interestingly, RDEER, an effective measure of external debt burden, proved empirically consistent with the hypothesis of consumption volatility amplifying the effect of exchange rate pro-cyclicality (Korinek, 2011).

6. Conclusions

This study examined the tendency for LMICs to borrow funds denominated in foreign currencies since 1980. Data reveal that LMICs differ in borrowing behavior. Quantifying

their differences clarifies the implications of sovereign debt denominated in foreign currencies.

Previous studies seldom model multicurrency portfolios when analyzing international borrowing in foreign currencies. However, our portfolio perspective reveals that concentrating debt in a few foreign currencies exacerbates pro-cyclicality in the effective exchange rate of the borrower's currency. Furthermore, we found that exchange rate pro-cyclicality renders household consumption more volatile when national income fluctuates.

Our findings revealed the possibilities and perils of concentrating a currency portfolio of external debt. Sovereign borrowers can attenuate the negative consequences of original sin even as it prevails, which is an important policy implication. Diversifying portfolios situate LMIC borrowers on a less-volatile consumption path by attenuating debt revaluation and exchange rate pro-cyclicality. In addition to converting debt into a home currency, an alternative option would be diversifying among international currencies.

Of course, the borrowers' overall welfare also depends on their debt's term structure. Additionally, the dominance of USD in trade invoicing (Gopinath and Stein, 2021) may affect the calculations. Thus, we point only to the potential role of the denomination portfolio as a hedge against adverse consequences of a foreign currency debt.

Debt denominated in foreign currencies will likely remain important for many LMICs throughout the foreseeable future. Unfortunately, that likelihood portends potential for financial havoc (e.g., debt crises), a concern that intensifies amid today's rising indebtedness (Kose, Nagle, Ohnsorge, and Sugawara, 2019). Accordingly, our findings extend the literature by illuminating the hidden cost of foreign currency debt and suggesting how indebted countries can reconfigure their borrowing to buffer inauspicious developments.

Data Appendix

Sources

Currency composition of external debt: World Bank's *International Debt Statistics*

Exchange rate regime indicators: Ilzetzki, Reinhart, and Rogoff (2017) [a]

Index of capital account openness: Chinn and Ito (2006)[b]

Incidents of *coups d'état*: Powell and Thyne (2011)[c]

Other macroeconomic and external account variables: World Bank's *World Development Indicators* and International Monetary Fund's *International Financial Statistics*

Notes:

[a] We downloaded the regime index, available up to 2016, from http://www.carmenreinhart.com/data/. We use coarse classifications.

[b] The index is based on binary dummy variables that codify restrictions on cross-border financial transactions reported in IMF's Annual Report on Exchange Arrangements and Exchange Restrictions. It is the first principal component of the original variables on regulatory controls over current or capital account transactions, the existence of multiple exchange rates, and requirements of surrendering export proceeds.

[c] We use "Dataset 2: Coup Attempts, 1950–Present" in Powell and Thyne (2011). Coups are illegal and overt attempts by the military or other elites within the state apparatus to unseat a sitting executive. Our dummy variable equals 1 for successful and unsuccessful coup attempts because they indicate political instability.

Frequency

Annual for all series

Sample periods

The primary sample period is 1980–2017. The pre-EUR and EUR sub-periods are 1980–2000 and 2001–2017, respectively. Depending on data availability, some countries have smaller samples.

Euro: exchange rate 1999–2017; currency composition 2001–2017

Deutsche mark and French franc: exchange rate 1973–1998; currency composition 1973–2000; Exchange rates for 1999 and 2000 are set to €1 = 1.95583 DEM and €1 = 6.55957 FRF.

Synthetic EUR: 1980–2017, of which the 1980–2000 period is calculated by the weighted sum of DEM- and FRF-denominated debt.

Sampled countries

Our sample consists of low-, lower-middle-, and upper-middle-income countries listed in the WDI, for which data for the currency composition of external debt, exchange rates, and GDP growth rates are available for pre-EUR and EUR periods. The primary sample includes 106 countries (24 low-income and 82 middle-income countries) listed in the income stratification section.

The Section 5 analyses reduce the effective number of sampled countries through limited data to construct variables for estimations. More specifically, for the estimates in Table 4 and Column 1 of Table 5, the effective number of countries is 86. The following countries were dropped for data constraints: Angola, Central African Republic, China, Dominica, Ethiopia, Fiji, Gambia, Grenada, Guyana, St. Lucia, the Maldives, Malaysia, Panama, Papua New Guinea, the Solomon Islands, Tonga, Vanuatu, Samoa, Yemen, and Zambia.

For the estimates in Columns 2–3 of Table 5, the sample consists of the following 37 countries whose REER data are available: Albania, Armenia, Burundi, Bulgaria, Bolivia, Brazil, Bhutan, Cote d'Ivoire, Cameroon, the Democratic Republic of the Congo, Colombia, Costa Rica, Dominican Republic, Algeria, Gabon, Georgia, Ghana, Iran, Lesotho, Morocco, Moldova, Mexico, Malawi, Nigeria, Nicaragua, Pakistan, the Philippines, Paraguay, Romania, Russia, Sierra Leone, Togo, Tunisia, Uganda, Ukraine, St. Vincent and the Grenadines, and Venezuela.

Income stratification

Low-income countries comprise the following 24 countries: Burundi, Benin, Burkina Faso, Central African Republic, the Democratic Republic of the Congo, Comoros, Eritrea, Ethiopia, Guinea, Gambia, Guinea-Bissau, Haiti, Madagascar, Mozambique, Malawi, Niger, Nepal, Rwanda, Senegal, Sierra Leone, Chad, Togo, Tanzania, and Uganda.

Lower-middle-income countries comprise the following 42 countries: Angola, Armenia, Bangladesh, Bolivia, Bhutan, Cote d'Ivoire, Cameroon, Republic of the Congo, Cabo Verde, Egypt, Georgia, Ghana, Guatemala, Honduras, Indonesia, India, Jordan, Kenya, Kyrgyz Republic, Cambodia, Lao, Sri Lanka, Lesotho, Morocco, Moldova, Mongolia, Mauritania, Nigeria, Nicaragua, Pakistan, the Philippines, Papua New Guinea, Sudan, the Solomon Islands, El Salvador, Tajikistan, Tunisia, Ukraine, Vietnam, Vanuatu, Yemen, and Zambia.

Upper-middle-income countries comprise the following 40 countries: Albania, Azerbaijan, Bulgaria, Belarus, Belize, Brazil, Botswana, China, Colombia, Costa Rica, Dominica, Dominican Republic, Algeria, Ecuador, Fiji, Gabon, Grenada, Guyana, Iran, Jamaica, Kazakhstan, Lebanon, St. Lucia, the Maldives, Mexico, Mauritius, Malaysia, Panama, Peru, Paraguay, Romania, Russia, Serbia, Thailand, Tonga, Turkey, St. Vincent and the Grenadines, Venezuela, Samoa, and South Africa.

Figure Appendix

Figure 1. Average shares by currency (%)

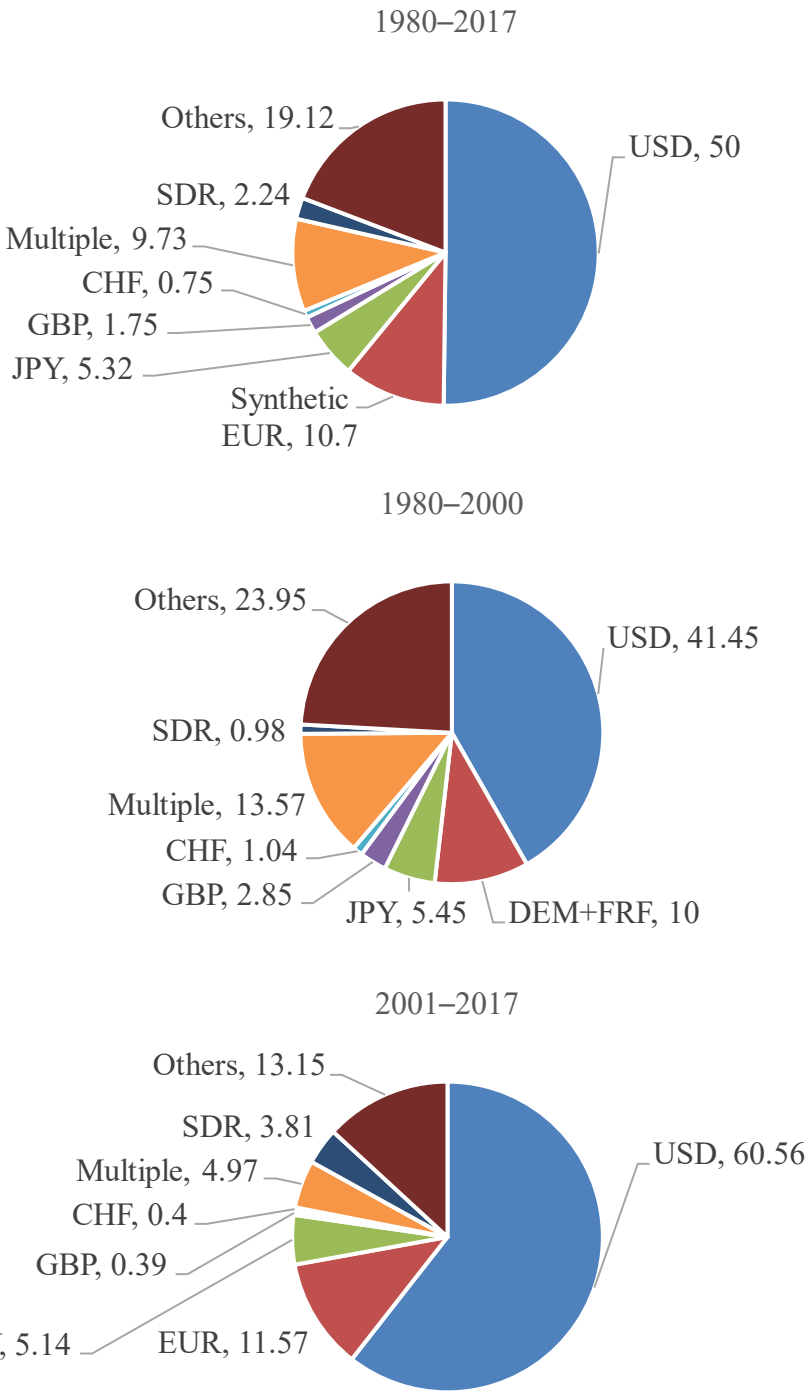

Figure 2. Countries with increasing/decreasing trends in currency shares

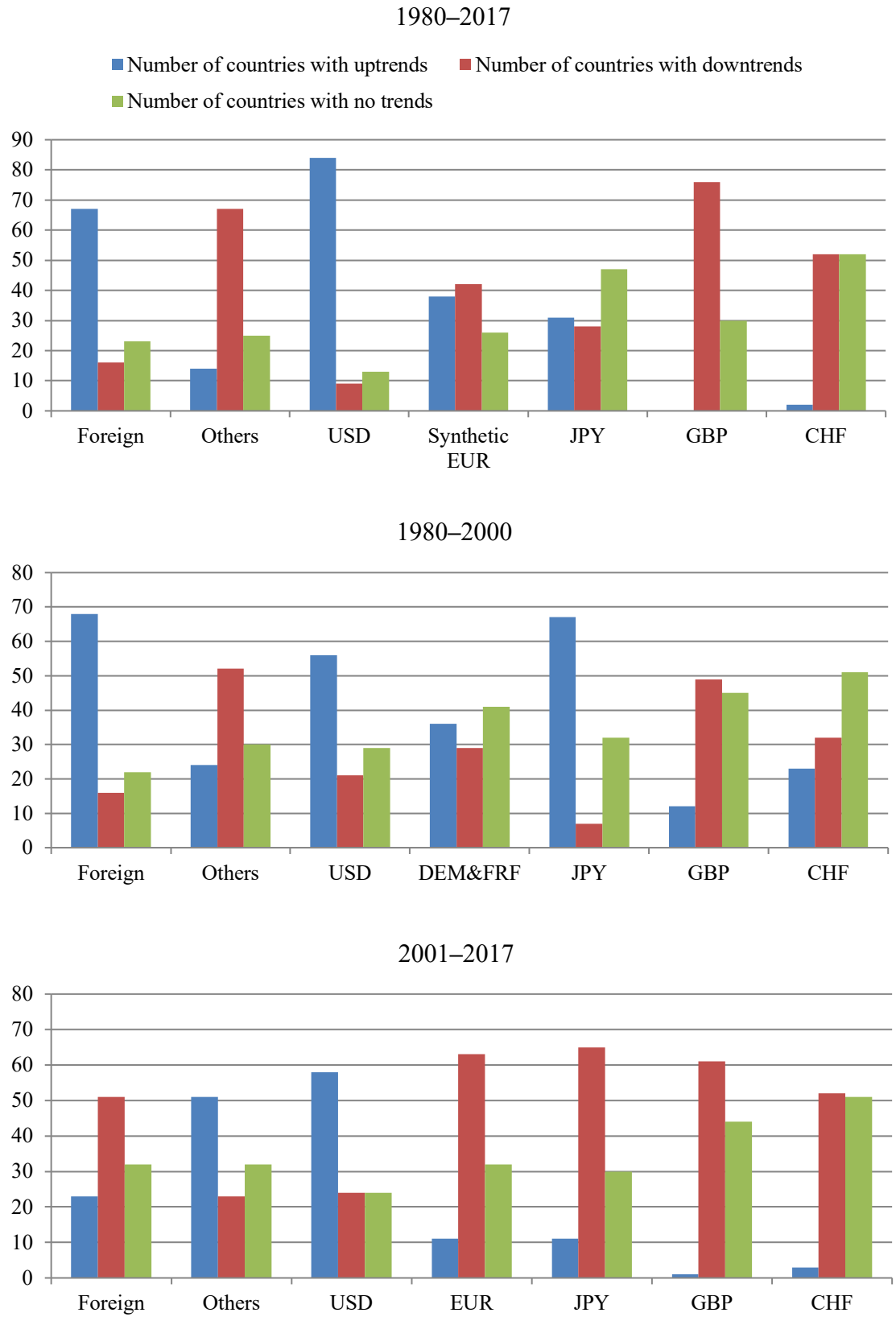

Figure 3. Countries with concentrating/diversifying trends in portfolios

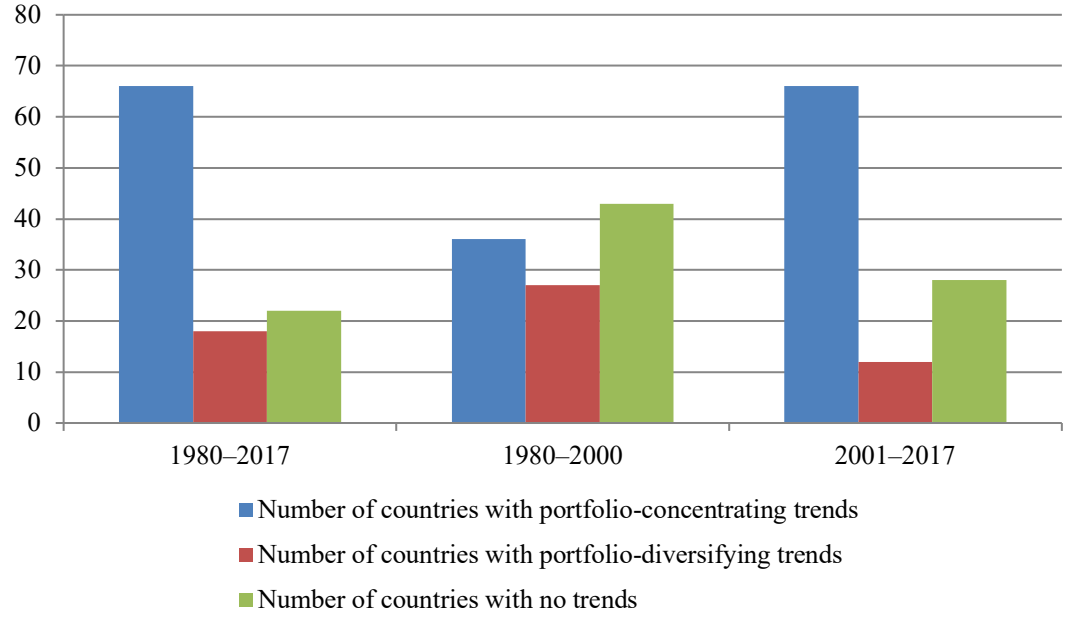

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Table 1. Index of portfolio concentration/diversification

	1980–2017	1980–2000	2001–2017
Mean	0.64	0.61	0.69
Standard deviation	0.14	0.17	0.15

Notes: Means and standard deviations of the Herfindahl–Hirschman index of portfolio concentration appear in the top two rows. The index is calculated for the foreign currency portfolio of external PPG debt using Eq. (2) in the main text.

Table 2. Debt revaluation and relative inflation (%)

	Mean	S. deviation	Minimum	Median	Maximum
A. DEER growth					
Full sample period	9.80	13.62	−8.18 (Ecuador)	5.25	70.26 (Angola)
Pre-EUR period	19.93	27.56	−14.97 (Ecuador)	10.00	155.90 (Angola)
EUR period	1.53	4.89	−12.83 (El Salvador)	1.03	15.35 (D. R. Congo)
B. Relative inflation					
Full sample period	60.75	167.64	−0.74 (Belize)	8.48	1079.89 (D. R. Congo)
Pre-EUR period	131.76	375.41	−4.52 (Ecuador)	10.19	2557.59 (Georgia)
EUR period	6.38	6.02	−0.22 (Belize)	5.50	34.27 (Angola)
C. Real DEER growth					
Full sample period	−35.22	133.52	−1018.32 (D. R. Congo)	−3.01	3.98 (Romania)
Pre-EUR period	−68.07	258.09	−1881.68 (D. R. Congo)	−1.62	44.94 (Serbia)
EUR period	−4.83	3.25	−19.42 (Angola)	−4.25	0.22 (Belize)

Notes: A positive value of DEER and RDEER growth indicates debt revaluation (i.e., effective depreciation of LMIC currency) in nominal and real terms, respectively. S. deviation is standard deviation, and D. R. Congo is the Democratic Republic of Congo. The reported statistics are based on effective observations of all countries during the corresponding periods, and the sample comprises 106 countries listed in the Data Appendix. The maximum sample period is 1980–2017; some countries have shorter sample periods due to limited data availability.

Table 3. Exchange rate cyclicality (%)

	Mean	S. deviation	Minimum	Median	Maximum
A. DEER cyclicality					
Full sample period	−15.86	27.38	−82.47 (Tajikistan)	−14.26	34.12 (Eritrea)
Pre-EUR period	−12.24	32.77	−88.91 (Azerbaijan)	−5.48	50.67 (Eritrea)
EUR period	−15.76	32.11	−85.79 (D. R. Congo)	−15.50	65.96 (Togo)
B. USD cyclicality					
Full sample period	−20.88	29.86	−85.64 (Tajikistan)	−18.22	37.86 (Eritrea)
Pre-EUR period	−16.15	35.19	−81.01 (Ukraine)	−12.53	85.37 (Serbia)
EUR period	−24.23	31.24	−83.89 (Ukraine)	−26.30	62.27 (Yemen)
C. Real DEER cyclicality					
Full sample period	3.59	27.64	−57.04 (Russia)	3.85	91.86 (Cambodia)
Pre-EUR period	6.97	33.92	−66.96 (Thailand)	5.97	97.85 (Cambodia)
EUR period	−14.58	33.32	−77.09 (Ukraine)	−14.76	65.58 (Togo)

Notes: The correlation between real output growth and exchange rate changes are summarized. A negative (positive) correlation indicates pro-cyclicality (counter-cyclicality) in a sovereign borrower's exchange rate. In Panels A, B, and C, exchange rate changes are those of DEER, bilateral USD, and RDEER, respectively.

Table 4. Consumption responses to changes

	1	2	3
Growth trend: $\Delta\hat{y}_{i,t}$	0.254	0.165	0.212
	(0.148)	(0.172)	(0.183)
Growth deviations: $\Delta\tilde{y}_{i,t}$	0.423**	-	-
	(0.087)		
$\Delta\tilde{y}_{i,t}>0$	-	0.237	-
		(0.203)	
$\Delta\tilde{y}_{i,t}<0$	-	0.584**	-
		(0.182)	
$\Delta\tilde{y}_{i,t}>0$ with appreciation: ρ_A	-	-	0.204
			(0.209)
$\Delta\tilde{y}_{i,t}>0$ with depreciation: ρ_D	-	-	0.331
			(0.232)
$\Delta\tilde{y}_{i,t}<0$ with appreciation: η_A	-	-	0.687
			(0.362)
$\Delta\tilde{y}_{i,t}<0$ with depreciation: η_D	-	-	0.542**
			(0.200)
Credit to GDP	−0.007	−0.010	−0.008
	(0.016)	(0.016)	(0.017)
Lagged saving	0.202**	0.160**	0.156**
	(0.038)	(0.029)	(0.029)
World income growth	0.268	0.197	0.215
	(0.142)	(0.159)	(0.165)
Coups d'état dummy	−2.701**	−2.699**	−2.681**
	(1.028)	(1.030)	(1.040)
Deb stock	−0.874	−0.824	−0.846
	(0.690)	(0.692)	(0.695)
Current account balance	−0.068	−0.072	−0.064
	(0.045)	(0.046)	(0.047)
Capital account openness	−1.617**	−1.548**	−1.580**
	(0.310)	(0.318)	(0.322)
Over-identifying restriction	0.868	0.861	0.883
N	1988	1988	1988

Notes: Estimates of Eqs. (5) and (6) in the main text are reported. Income growth is decomposed into trend and deviation components. The entries in parentheses are standard

errors. In all estimates, country-specific constants and exchange rate regime dummies are allowed. (The coefficient estimates are not displayed for brevity.) ** and * represent statistical significance at 1% and 5%, respectively. Entries for the debt stock-to-GNI ratio are pre-multiplied by 100.

Table 5. Robustness: Alternative income decomposition and real effective exchange rate

	1 AR(1)	2 REER	3 RDEER
$\Delta\hat{y}_{i,t}$	0.359	0.234	0.146
	(0.240)	(0.178)	(0.209)
$\Delta\tilde{y}_{i,t}$ >0 with appreciation: ρ_A	0.560*	0.340	0.384
	(0.217)	(0.176)	(0.198)
$\Delta\tilde{y}_{i,t}$ >0 with depreciation: ρ_D	0.422	0.738**	0.400
	(0.254)	(0.201)	(0.239)
$\Delta\tilde{y}_{i,t}$ <0 with appreciation: η_A	−0.576	0.244	−0.254
	(0.490)	(0.241)	(0.328)
$\Delta\tilde{y}_{i,t}$ <0 with depreciation: η_D	0.652*	0.274	0.500*
	(0.245)	(0.211)	(0.218)
Credit	−0.009	−0.029	−0.027
	(0.017)	(0.023)	(0.024)
Lagged saving	0.157**	0.191**	0.186**
	(0.028)	(0.033)	(0.034)
World income growth	0.227	0.180	0.070
	(0.156)	(0.202)	(0.234)
Coups d'état dummy	−2.383*	−4.219*	−4.785**
	(1.039)	(1.677)	(1.791)
Deb stock	−0.154	−0.038**	−0.034**
	(0.650)	(0.012)	(0.012)
Current account balance	−0.082	−0.050	0.019
	(0.045)	(0.065)	(0.064)
Capital account openness	−1.574**	0.204	−0.307
	(0.500)	(0.199)	(0.214)
Over-identifying restriction	0.715	0.766	0.877
N	1968	885	814

Notes: Estimates of Eq. (6) in the main text are reported. Column 1 reports the estimates when income growth is decomposed into predicted and unpredicted components by fitting an AR(1) model. The estimates in Column 2 are obtained by using REER data. Those in Column 3 are RDEER-based estimates for the same sample of 37 countries as for the REER-based estimates in Column 2. The entries in parentheses are standard errors. In all estimates, country-specific constants and exchange rate regime dummies are allowed. (The coefficient estimates are not displayed for brevity.) ** and * indicate statistical

significance at 1% and 5%, respectively. Entries for the debt stock-to-GNI ratio are pre-multiplied by 100.

Appendix

Implications of Currency Denomination for Exchange Rate Cyclicality

We estimated a panel regression for the income elasticity of RDEER to determine whether currency composition influences cyclicality in exchange rates:

$$\left(\frac{\Delta \ln RDEER}{\Delta \ln Y}\right)_{i,t} = \alpha_i + \phi\, TFS_{i,t} + \lambda\, HI_{i,t} + Z_{i,t}\Gamma + \varepsilon_{i,t} \qquad \text{(A1)}$$

where $\Delta \ln Y_{i,t}$ is the growth rate of real GDP. $TFS_{i,t}$ and $HI_{i,t}$ are the share and portfolio measures of foreign currency debt, respectively, defined in Eqs. (1) and (2) in Section 3 of the main text. $Z_{i,t}$ and Γ denote the vector of control variables and their coefficients, respectively; α_i is a country-specific constant.

Exchange rate pro-cyclicality is the tendency for depreciation (appreciation) of a home currency to coincide with contraction (expansion) in output (i.e., $\Delta \ln RDEER > 0$ with $\Delta \ln Y < 0$ and $\Delta \ln RDEER < 0$ with $\Delta \ln Y > 0$, respectively). Therefore, significantly negative (positive) coefficients for explanatory variables indicate that they stimulate pro-cyclicality (counter-cyclicality).[18]

We chose measures related to a country's external account for control variables. To measure assets, we calculated gross foreign assets by adding total external debt to net foreign assets.[19] Gross foreign assets denominated in a country's home currency reflect fluctuations in the value of assets denominated in foreign currencies. We chose official

[18] Note that the regression of Eq. (A1) in the form of elasticity differentiates pro-cyclical from counter-cyclical effects by detecting whether changes in exchange rates and output bear opposing or identical signs. Other measures, such as differences between (not ratios of) exchange rates, and output growth rates do not identify cyclicality.

[19] Ideally, we would gauge foreign asset positions in portfolio terms; however, currency composition data for LMICs' foreign assets are unavailable.

reserves as a narrower measure of sovereign assets. We gauged both measures relative to GDP.

We included current account balances relative to GDP and debt stock-to-GNI. Current account balances are said to drive exchange rates. Debt relative to GNI assesses the relative importance of external debt, which can vary by country and over time.

Countries also vary in openness to trade and capital account transactions. We used trade-to-GDP ratios and the capital account openness index in Chinn and Ito (2006) to control for those effects. Magnitudes of changes in exchange rates are conditioned on the flexibility of a country's currency regimes; therefore, we included dummy variables for regimes in Ilzetzki, Reinhart, and Rogoff (2017).[20] Limited data for control variables resulted in an unbalanced panel of 101 countries, with 2016 as the most recently observed year.[21] Unless otherwise specified, data for control variables are from WDI and IFS.

$TFS_{i,t}$ and $HI_{i,t}$ may affect debt revaluation; however, nations can alter the currencies they borrow and the portfolio composition of debt denominated in foreign currencies by observing debt revaluation and macroeconomic output. Their adjustments may coincide with our annual frequency data, so we treated $TFS_{i,t}$ and $HI_{i,t}$ as endogenous regressors. To avoid simultaneity bias, we performed two-stage least squares estimations using lags of endogenous variables as instruments. The control variables for external account conditions are presented in lagged terms because they may also be endogenous to changes in exchange rates and output.[22]

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[20] We downloaded the regime index, available up to 2016, from http://www.carmenreinhart.com/data/. We use coarse classifications.

[21] Ethiopia, Malaysia, Panama, Papua New Guinea, and Yemen lack data for estimating Eq. (A1).

[22] For instance, Cordella and Gupta (2015) found that countries with procyclical *nominal* effective exchange rates tend to restrict their capital accounts.

Table A1 summarizes estimates. Entries in the initial columns indicate results from including all control variables and indicate that portfolio concentration exerts highly significant negative effects. The coefficient of foreign currency share is statistically insignificant. Holding constant the total share of foreign currency debt and other controls, concentrating debt denominated in foreign currencies render RDEER more pro-cyclical.

The remaining columns in Table A1 report the estimates after excluding some control variables. Column 2 excludes the reserve-to-GDP ratio because it is insignificant in the presence of gross foreign assets, Column 3 excludes variables for trade and capital account openness, and Column 4 presents parsimonious estimates. The portfolio concentration effect is significantly negative in all cases. The overall results show that portfolio concentration contributes to exchange rate pro-cyclicality.

The above results suggest that LMICs can potentially attenuate the extent of RDEER pro-cyclicality without lowering the share of foreign currency debt. The significance of this finding in terms of policy implications rests on whether or not RDEER pro-cyclicality renders household consumption more volatile in the face of national income fluctuations. Section 5 addresses the issue.

Table A1. Output elasticity of real debt-weighted effective exchange rates

	1	2	3	4
Portfolio concentration	−0.613**	−0.621**	−0.503*	−0.424*
	(0.223)	(0.223)	(0.211)	(0.191)
Foreign currency share	0.501	0.480	0.334	0.213
	(0.302)	(0.301)	(0.268)	(0.234)
Gross foreign assets	−0.560**	−0.560**	−0.565**	−0.576**
	(0.107)	(0.107)	(0.107)	(0.104)
Reserves	−0.488	-	-	-
	(0.412)			
Current account	−0.367	−0.462	−0.349	-
	(.398)	(0.390)	(0.350)	
Debt stock	−1.004**	−0.980**	−0.943**	−0.736**
	(0.055)	(0.051)	(0.049)	(0.042)
Trade openness	−0.024	−0.057	-	-
	(0.167)	(0.165)		
Capital acc. openness	−0.303	−0.202	-	-
	(1.358)	(1.355)		
Regime 1	78.244	83.384	69.214*	62.185*
(De facto peg)	(43.495)	(43.228)	(30.371)	(26.322)
Regime 2	79.271	83.418*	69.825*	66.806*
(De facto crawling peg)	(42.784)	(42.603)	(30.015)	(26.107)
Regime 3	84.445*	88.887*	74.847*	66.578**
(De facto crawling band)	(42.342)	(42.133)	(29.387)	(25.501)
Regime 4	97.831	101.461	89.604*	78.405*
(Free floating)	(52.513)	(52.392)	(42.703)	(38.931)
Regime 5	81.163	85.493*	73.652*	64.923*
(Free falling)	(41.811)	(41.609)	(30.007)	(25.948)
Regime 6	91.157	95.434*	88.767*	89.204**
(Dual market)	(47.070)	(46.894)	(35.550)	(29.420)
N	2797	2797	2942	3279

Notes: Estimates for Eq. (A1) are reported. The entries in parentheses are standard errors. In all estimates, country-specific constants are allowed. Endogenous regressors are instrumented by their lagged values, and coefficients are exactly identified. ** and * indicate statistical significance at 1% and 5%, respectively. Entries for gross foreign assets are pre-multiplied by 10^3.