Currency Portfolio of External Debt, Exchange Rate Cyclicality, and Consumption Volatility

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This version: October 2019

Abstract

Even though external debt can play a buffer's role against adverse shocks to assist consumption smoothing, it may also exert a volatility amplifying effect depending on the currency of denomination and the cyclicality of the borrower's exchange rate. We empirically investigate the nexus among the debt denomination portfolio, exchange rate cyclicality, and consumption volatility of low and middle-income countries. On constructing the debt-weighted effective exchange rates, we examine how the denomination portfolio affects the debtors' exchange rate cyclicality to influence the consumption response to transitory income shocks. We find that the portfolio concentration enhances the exchange rate pro-cyclicality, which makes the consumption more volatile when negative income shocks occur. Our results suggest that portfolio diversification is helpful to countries with original sin for hedging against bumpy consumption paths.

Keywords: *external debt, debt denomination, currency portfolio, original sin, effective exchange rates.*
JEL Classifications: F34, F31

Acknowledgements: This research is supported by JSPS KAKENHI Grant Number 18K01715. The author is grateful to the workshop participants at Université Catholique de Louvain and the Center for Risk Research of Shiga University for helpful comments.

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1. Introduction

Access to external capital is valuable for alleviating the effects of adverse income shocks, especially for countries in which markets for credit and insurance are underdeveloped. By borrowing abroad, they can generate a buffer against income shocks to smooth consumption with. However, if denominated in foreign currency, external debt also becomes a source of unwanted risk exposure. A common problem is the debt revaluation and balance sheet deterioration that the domestic currency depreciation induces. Moreover, theoretical studies suggest that foreign currency debt can generate far-reaching effects, including those on the borrower's macroeconomic volatility (Korinek, 2011), default risk (Gumus, 2013), and currency regimes (Bleaney and Ozkan, 2011).

For international debt, the choice of the denominating currency is crucial because it determines who to undertake the inherent exchange rate risk. Unless the borrowing country and its currency possess solid credibility and thick markets, it is more likely than not that the debt will be denominated in other currency than the borrower's. From this perspective, it is not surprising if "original sin" persists while a few major currencies of affluent economies dominate the international financial markets.[1]

For many developing countries resolving original sin is, even though desirable, unrealistic at least in the short run. If they continue to rely on foreign currency debt, it is imperative to look for means to attenuate the negative consequences and hedge against adverse incidents in the future. This is the motivation of this paper.

It is worth emphasizing that the choice of the debt-denominating currency is not mere binary in reality. Unlike the theoretical models assuming the domestic-or-foreign binary

[1] Original sin refers to the inability of a country to borrow abroad in its own currency (Eichengreen and Hausmann, 2005).

choice for simplicity, there are actually multiple foreign currencies in which a country can denominate its external debt. The importance of this is that, for a given amount of foreign currency debt, borrowers can adjust their risk exposure by altering the denominating currency portfolio. Thus, it is conceivable that countries sharing the same degree of original sin experience significantly different effects of the foreign currency debt by holding dissimilar portfolios. If so, it will provide us a clue in searching room for attenuating the undesirable consequences of original sin.

More specifically, we are interested in how the choices of the debt-denominating currency shape the cyclicality of the borrowers' exchange rates. As theoretically argued by Korinek (2011), the exchange rate cyclicality may translate into the consumption dynamics of the borrowers. If a debtor's exchange rate is pro-cyclical, foreign currency-denominated debt requires large (small) repayment in bad (good) economic states. Thus, the effect of output fluctuations can be amplified to make consumption more volatile than otherwise. The extent to which this effect arises depends on the denomination currency portfolio and the resulting exchange rate cyclicality.

This paper empirically examines the nexus among the debt denomination currency portfolio, exchange rate cyclicality, and consumption volatility for a large number of low and middle-income countries (LMICs). Using data on their public and publicly guaranteed (PPG) external debt for 1980-2017, we construct the debt-weighted effective exchange rate (DEER) indices to quantify the extents of debt-revaluation effects the borrowers were exposed to. We further investigate how the debt denomination portfolio relates to the exchange rate cyclicality which in turn affects the consumption volatility.

Our chief findings are summarized as follows. In general, the PPG external debt of the LMICs continues to be denominated primarily in foreign currency, particularly in US

dollar (USD). The general denomination trend over the four decades is characterized with not only a rise in the foreign currency share, but also portfolio concentration. The portfolio concentration is manifested especially in the period since the launch of euro.

Holding the share of foreign currency debt constant, we find that the portfolio concentration significantly contributes to the exchange rate pro-cyclicality. Furthermore, the pro-cyclicality makes households' consumption more volatile in responding to negative income shocks. Altogether our results imply that, even in the plague of original sin, there is room for mitigating its negative consequences via portfolio diversification.

The remainder of this paper is organized as follows. Section 2 presents a selective literature review. Section 3 quantifies the debt denomination by the currency share and portfolio measures. Section 4 constructs the DEER to gauge the extents of debt revaluation and exchange rate cyclicality. Section 5 estimates the effects of the debt denomination on the exchange rate cyclicality. Section 6 examines the consumption responses to transitory income shocks under cyclical exchange rate movements. An extended discussion is followed by concluding remarks in section 7.

2. Selective literature review

The recent literature on external debt has flourished with studies highlighting the prevalence of original sin, the inability of a country to borrow abroad in its own currency, and the danger it brings about to indebted countries (Hausmann and Panizza, 2003; Eichengreen and Hausmann, 2005; Eichengreen, Hausmann, and Panizza, 2007). The prime message they deliver is that accumulation of foreign currency-denominated debt eventually suppresses the debtor's economic activity, especially when the country does not possess sufficient foreign currency asset to match it with (Kourtellos, Stegnos, and

Tan, 2013; Panizza and Presbitero, 2014; Ranciere, Tornell, and Vamakidis, 2010; Reinhart and Rogoff, 2010, 2011).[2] Nonetheless, given the status quo of the international financial markets, it may not be feasible for many LMICs to resolve original sin in the short run. An imperative issue for them is to attenuate the negative consequences it may bring on and to hedge against adverse incidents in the future.

To consider the ramifications of foreign currency debt, it is necessary to take account of the cyclical behavior of the borrower's exchange rate. Let the exchange rate pro-cyclicality be defined a tendency of a borrower's currency to depreciate (appreciate) in unfavorable (favorable) states of its aggregate economy. If a borrower's exchange rate is pro-cyclical, foreign currency-denominated debt requires large repayments when output contracts as the domestic currency depreciates.[3] Thus, the impact of negative economic shocks will be aggravated. Conversely, the debt repayment will be small when output expands and the borrower's currency appreciates, which enhances the boom resulting from positive shocks. Thus, under the exchange rate pro-cyclicality, there is a volatility enhancing element to foreign currency debt.

Using a theoretical model of small open emerging market economy, Korinek (2011) finds that the greater the fraction of debt denominated in foreign currency, the higher the impact of a given output shock on aggregate demand and the more volatile the consumption will be. A critical feature of the model is that the borrower's exchange rate is pro-cyclical. However, as we will show in section 4, empirically the extent of the exchange rate cyclicality varies significantly by country, ranging from counter-cyclical to

[2] For an alternative view, see Borensztein and Panizza (2010).
[3] Under the exchange rate pro-cyclicality, the local currency value of the foreign currency-denominated debt is counter-cyclical to the aggregate state of the economy.

pro-cyclical of various degrees. Thus, the theoretical finding needs to be placed in a specific empirical context for drawing useful implications.

For empirical analyses, it is crucial to measure the external debt denomination in portfolio terms. The share of foreign currency debt, the standard theoretical measure, does not fully convey the information regarding the borrower's effective exchange rate fluctuations unless its external debt is denominated entirely in a single foreign currency.

The importance of the portfolio perspective is demonstrated for instance by Claessens (1992). The author argued that developing countries can manage better their external exposure by pursuing the risk-minimizing currency composition of their debt. As examples, he finds that debt crisis-struck Mexico and Brazil could have lowered the currency exposure in the 1970s and 1980s by altering the denomination compositions.

By examining the currency compositions of external debt and international trade of numerous LMICs, Fujii (2017) finds that the extent of currency portfolio mismatch between debt and trade exerts significant negative effects on economic growth. Dodd and Spiegel (2005) extensively discuss the currency portfolio issues for developing countries. They proposed issuance of international debt denominated in multi-borrowers' currencies to manage the exposure. The aforementioned studies together suggest the significance of a portfolio perspective in considering the issues of external debt denomination.

3. Measuring the external debt denomination

3.1 Data

The World Bank's International Debt Statistics (IDS) database provides the currency composition information of the long-term PPG external debt. Of all countries listed in the database, we retained 123 countries for 1980-2017 by the data availability. Shorter sample

periods apply to some countries due to data limitations. Further information is provided in the data appendix.

Panel A of table 1 presents the average shares of the PPG debt in all debt. The PPG debt stock and service take up approximately seventy-two and sixty-eight percent, respectively, of all debt. The shares are higher in the pre-euro period (1980-2000) than in the euro period (2001-2017), reflecting the gradual development of the private bond markets. Overall, the data indicate that the PPG debt serves us as a reasonable proxy for the LMICs' external debt by comprising the major bulk.

The IDS provides the denominating shares of USD, euro, Japanese yen (JPY), British pound (GBP), and Swiss franc (CHF). For the pre-euro period, the shares of German mark (DM) and French franc (FF) are available. In addition, the IDS reports the shares of the three other categories: "SDR", "Multiple currencies", and "All other currencies". For the LMICs, SDR is a basket of foreign currencies. Thus, we regard the SDR debt to be foreign currency debt.[4] Because multiple currencies must include at least one foreign currency, we treat the debt in this category also as foreign currency debt.

Considering the fact that all the eminent international currencies are already tallied, the foremost candidate for "All other currencies" is arguably the domestic currencies of the borrowers. In the absence of further information, we assume that the share of "All other currencies" reflects the share of the debtors' domestic currencies.

3.2 Foreign currency share

As a counterpart to the standard binary measurement of the theoretical studies, we first calculate the total share of the foreign currency-denominated debt for each country

$$TFS_{i,t} = \sum_{j} FS_{i,j,t} \quad , \tag{1}$$

[4] An exception is China in 2016 and 2017 when 10.92 percent of the SDR was renminbi.

for which *i* and *j* denote a borrowing country and a debt denominating foreign currency, respectively. $FS_{i,j,t}$ is foreign currency *j*'s share of country *i*'s PPG debt in year *t*.

Panel B of Table 1 presents the average compositional shares by currency and in aggregate. When averaged across countries over 1980-2017, the foreign currency debt takes up approximately seventy-eight percent of all PPG debt. The sub-period averages are seventy-two and eighty-six percent in for 1980-2000 and 2001-2017, respectively.[5] The figures suggest that original sin is not just prevalent but increasingly so.

USD is by far the most dominant currency of the LMICs' external debt denomination. On average, the USD share is approximately forty-eight percent. Interestingly, the advent of euro is followed by a substantial rise in the USD share from the sub-period averages of thirty-nine to fifty-eight percent. Euro, second only to USD, has an average share of thirteen percent. Though greater than the combined share of DM and FF in the preceding era, euro's share is less than a quarter of USD's for the corresponding period.[6]

The shares of JPY, GBP, and CHF are far smaller and only approximately five, two, and one percent, respectively, in the 1980-2017 average terms. The sub-period statistics reveal that on the introduction of euro, the shares of GBP and CHF were eroded substantially plunging to less than half a percentage point.

Countries may increase or decrease their reliance on foreign currency debt over time. To identify the direction of the shifts, we fitted a linear time trend to the aggregate and individual currency shares.[7] Figure 2 visually summarizes the results reported in panel C

[5] As noted in the previous section, we include the shares of "multiple currencies" and "SDR" categories in the foreign currency aggregate.
[6] The "synthetic euro" share in table 1 connects the two series, the sum of DM and FF (1980-2000) and euro (2001-2017).
[7] We regressed the foreign currency shares on a constant and a time trend to check if the coefficient on the time trend is significantly positive or negative.

of Table 1. Over 1980-2017, seventy-nine countries increased the aggregate foreign currency share whereas only eighteen decreased it. As the other side of a coin, seventy-six countries reduced the share for "All other currencies", presumably the domestic currencies. The trends in the by-currency shares highlight the increasing presence of USD. Its share rose in ninety-five countries while declining in only eighteen countries.

The sub-period results reveal opposing trends between 1980-2000 and 2001-2017. The first period is characterized with rising shares in the foreign currency debt for which USD and JPY were the chief drivers. The second period witnessed for many countries a reduction of the foreign currency shares together with a rise in the domestic currency shares. Nonetheless, USD stands as an exception. Even for 2001-2017, the number of countries with increasing USD shares exceeds that with declining shares.

3.3 Foreign currency portfolio

A borrower may alter its risk exposure without changing the total share of foreign currency debt by diversifying or concentrating the denominating currency portfolio. Although the total foreign currency share may be suitable for theoretical analyses assuming the binary denomination choices, empirically it is insufficient because it conveys no information on the currency portfolio. We address the problem by constructing a Herfindahl-Hirschman index to gauge the extent of portfolio concentration/diversification

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

for which $FS_{i,j,t}$ and $TFS_{i,t}$ are as defined by (1). The index takes a value that $0 < HI_{i,t} \leq 1$ with a larger (smaller) value indicating a more concentrated (diversified) portfolio of country *i*'s foreign currency debt.

Because the SDR is composed by several foreign currencies, it is reasonable to decompose the share of SDR-denominated debt into the individual shares of the SDR-composing currencies by using the IMF's official weights.[8] We thus add the decomposed SDR shares to the shares of USD, euro, DM, FF, JPY, and GBP.

In the absence of concrete information on the content of the "multiple currencies" category, we make assumption that the share of this category is distributed over the individual currencies according to their relative shares. Specifically, using the SDR-inclusive shares and the shares of CHF, we calculate the weights by which we decompose the "multiple currencies" share into the shares of USD, euro, DM, FF, JPY, GBP, and CHF. The decomposed shares are then added to each currency's share prior to calculating $HI_{i,t}$.

Table 2 summarizes the constructed portfolio index. The full sample average is 0.63. For the sub-periods, the average rises from 0.61 for 1980-2000 to 0.67 for 2001-2017. Thus, there is an indication of portfolio concentration in the recent period.

To shed additional light, we also fitted a linear trend to $HI_{i,t}$. A significantly negative (positive) trend indicates portfolio diversification (concentration) over time. As reported in Table 2 and visualized by Figure 3, the number of portfolio concentrating countries exceeds by far the number of portfolio diversifying countries (70 versus 23). The sub-period results reveal that the portfolio-concentrating trend is manifested primarily in the 2001-2017 period. In the preceding period, the number of portfolio-concentrating countries and that of portfolio-diversifying countries are more balanced (41 versus 34).

[8] Until 1980 the SDR consists of sixteen currencies with their weights changing annually. The SDR composition was fundamentally revised in 1981 to a basket consisting of USD, DM, FF, JPY, and GBP with the weights to be revised every five years. In 1999, euro replaced DM and FF, and in 2016 Chinese renminbi became part of the basket. For 1980, we use the same weights as those for 1981.

From Tables 1 and 2, we notice that the foreign currency portfolio concentration is more commonly observed in 2001-2017 when many countries reduced the total foreign currency share. On the other hand, in 1980-2000 when numerous countries raise the aggregate foreign currency shares, a good number of the countries actually pursued portfolio diversification of their foreign currency debt. By making a clear distinction between the aggregate share and the portfolio, we highlight below the effects arising from the alternative aspects of the external debt denomination.

4. Debt revaluation and exchange rate cyclicality

4.1 The debt-weighted effective exchange rates

The extent to which a borrowing country experiences the debt revaluation depends not only on the denomination portfolio but also on the exchange rate changes. A relevant measure must reflect what percentages of the debt is denominated in which currency and how variable are the exchange rates between the domestic and denominating currencies.

As an index to capture the aforementioned factors, we construct the debt-weighted effective exchange rate indices

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

for which $\gamma_{i,j,t}$ is the share of currency *j* in country *i*'s total PPG debt in year *t*, and $S_{i,j,t}$ is the bilateral nominal exchange rate between *i*'s currency and currency *j*. Currency *j* in this case includes *i*'s domestic currency as well as all the foreign currencies. The bilateral nominal exchange rate is expressed in the domestic currency units per

currency *j* and indexed to its 2010 value.[9] An increase in the value of DEER indicates revaluation of the external debt due to changes in the denominating currency portfolio and the corresponding exchange rates. All exchange rate data including the SDR data come from IMF's International Financial Statistics (IFS).

Panel A of Table 3 summarizes the average growth rates of the DEER. They indicate the average rates of the debt revaluation the LMICs experienced. When averaged across all countries over 1980-2017, the debt revaluation occurred at approximately nine percent annually. When divided into the sub-periods, the DEER reveals a discernible difference between the pre-euro and euro periods. The average debt revaluation rate is nineteen percent for 1980-2000, whereas it is only two percent for 2001-2017. The debt revaluation pressure was substantially reduced in the recent years.

The apparent decline in the debt revaluation rate is driven potentially by a few factors. For instance, the 2008 world financial crisis and the deflationary environment put downward pressures on the interest rates and the currency values of the advanced economies. On the borrowers' side, the incidents of massive debt and currency crises, such as the ones in the Latin American countries, occurred mainly in the pre-euro era.

4.2 The cyclicality of the DEER

We stress that the use of the DEER is indispensable when empirically evaluating the extents of the exchange rate cyclicality. Unless a country's debt is denominated entirely in a single foreign currency, a bilateral exchange rate will be inadequate. A generally appropriate exchange rate is the effective exchange rate defined by (3) that is constructed by using the weights based on the debt denominating currency shares.

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

To gauge the extent of the exchange rate cyclicality by country, we calculate the correlations between the growth rates of DEER and output,

$$XCL_i = COR(\Delta \ln DEER_{i,t}, \Delta \ln Y_{i,t}), \quad (4)$$

for which $Y_{i,t}$ is the GDP of i in t. The GDP growth rate data are drawn from the World Bank's World Development Indicators (WDI) database.[10] A significantly negative (positive) value of XCL_i indicates the pro-cyclicality (counter-cyclicality) of i's DEER.

Panel B of Table 3 provides the summary statistics of XCL_i in percentage terms. The average as well as median correlations turn out to be negative, implying a general tendency of pro-cyclicality. However, the extent of the cyclicality differs widely by country as the large standard deviations indicate. For 1980-2017, XCL_i ranges from minus eighty-six percent (Syria) to sixty-two percent (Brazil) with a standard deviation of thirty-one percent. The sub-period statistics also suggest that the LMICs are diverse in their DEER cyclical properties. We also note that the average and median extents of pro-cyclicality rose in the second sub-period. These results suggest that the consumption effects of the foreign currency debt will not be unanimous across countries and over time.

5. Implications of debt denomination for exchange rate cyclicality

We are now poised to analyze the nexus among the debt denomination portfolio, exchange rate cyclicality, and consumption volatility. This section examines if a country's external debt denomination significantly determines the extents of its exchange rate cyclicality. We estimate a panel regression model of the income elasticity of the DEER

$$\left(\frac{\Delta \ln DEER}{\Delta \ln Y}\right)_{i,t} = \sum_i \alpha_i + \phi\, TFS_{i,t} + \lambda\, HI_{i,t} + Z_{i,t}\Gamma + \varepsilon_{i,t}, \quad (5)$$

[10] We use GDP is measured in constant local currency units.

for which $TFS_{i,t}$ and $HI_{i,t}$ are the share and portfolio measures of the foreign currency debt, respectively, defined in section 3. $Z_{i,t}$ and Γ are a vector of control variables and their coefficients, respectively, and α_i s are country-specific constants.

Exchange rate pro-cyclicality is the tendency that domestic currency depreciation coincides with output contraction (i.e., $\Delta \ln DEER > 0$ with $\Delta \ln Y < 0$), and/or appreciation coincides with output expansion (i.e., $\Delta \ln DEER < 0$ with $\Delta \ln Y > 0$). Therefore, a significantly negative (positive) coefficient on the explanatory variables is interpreted as a pro-cyclicality (counter-cyclicality) enhancing effect.

The control variables include the exchange rate regime categories, PPG debt share in all debt, debt stock to gross national income (GNI), net foreign asset, current account balance, reserves to debt, capital account openness and trade openness.[11] In addition, we include a dummy variable to control for the effect of coups d'état because political turmoil often jolts the economic performances of LMICs. The variable is set equal to unity when a coup attempt was observed in the corresponding country and year.[12]

While $TFS_{i,t}$ and $HI_{i,t}$ may affect the debt revaluation, the borrowing country may adjust the debt denomination currency shares and portfolio on observing the extents of the debt revaluation and output growth. This reaction may occur in a concurrent fashion

[11] The magnitude of exchange rate changes needs to be conditioned on the flexibility of the regimes. The share of PPG debt in all debt is included because the DEER is constructed using the denomination information only of the PPG debt. The remaining variables indicate the external account conditions that may relate to the debt revaluation and/or the output growth. They are included in order to isolate the effects of the key explanatory variables *TFS* and *HI*. The exchange rate regime index (Ilzetzki, Reinhart and Rogoff, 2017) are downloaded from http://www.carmenreinhart.com/data/. We use the coarse classifications. Capital account openness is measured by the index of Chinn and Ito (2003). Data on the other control variables are drawn from the WDI and IFS.

[12] We use "Dataset 2: Coup Attempts, 1950-Present" of Powell and Thyne (2011).

in the annual frequency data we use. Thus, we treat $TFS_{i,t}$ and $HI_{i,t}$ as endogenous regressors. The control variables on the external account conditions may also possibly be endogenous to the exchange rate changes and output growth. To avoid the simultaneity bias, we conduct the instrumental variables (IV) estimations. The instruments we adopt include the lagged terms of the endogenous variables, country-specific constants, exchange rate regime categorical dummies, regional dummies, and coups d'état dummies.

The entries in the first two columns of table 4 are the IV estimates with and without the coups d'état dummy, respectively. The estimates indicate that the portfolio concentration exerts a highly significant negative effect. The coefficient estimates of the foreign currency share are also negative but statistically insignificant. Holding constant the total share of foreign currency debt and the various factors of the control variables, a more concentrated portfolio of the foreign currency debt enhances the pro-cyclicality of the DEER. The *J*-statistics for the over-identifying restrictions test corroborate the exogeneity of the instruments.[13]

For comparison, we additionally report the OLS estimates in the remaining columns. In general, the OLS estimates are qualitatively similar. Quantitatively, the portfolio effect appears smaller in magnitude by the point estimates.

6. Consumption smoothing under cyclical exchange rate movements

By playing a role as a buffer against income fluctuations, external debt can help the LMICs stabilize consumption. However, if the borrower's effective exchange rate

[13] The coefficients are over-identified in the first specification and just identified in the second specification. The panel is unbalanced due to data limitations.

behaves in the manner that the burden of the debt grows heavier as income stagnates, the external debt may also possess a hindering effect for the consumption smoothing.

To extract transitory components of the income growth, we regress $\Delta \ln Y_{i,t}$ on a constant and a time trend to denote the residuals by $\Delta\tilde{y}_{i,t}$. We use $\Delta\tilde{y}_{i,t}$ as our measure of the transitory income shocks as it captures the deviations from the growth trend.

Households may not react to positive and negative income shocks in a symmetric fashion. For instance, without well-developed credit and insurance markets, it would be more difficult not to reduce consumption when faced by an unexpected income decline than not to boost consumption at a surprise income rise. Our benchmark specification allows the asymmetry in the consumption response to positive and negative shocks

$$\Delta c_{i,t} = \sum_i \alpha_i + \beta_P \Delta\tilde{y}_{i,t}^P + \beta_N \Delta\tilde{y}_{i,t}^N + W_{i,t}\Phi + \varepsilon_{i,t} \qquad (6)$$

for which $\Delta c_{i,t}$ is the households' final consumption expenditure growth rate, $\Delta\tilde{y}_{i,t}^P$ and $\Delta\tilde{y}_{i,t}^N$ are positive and negative income shocks, respectively. $W_{i,t}$ consists of the control variables including the exchange rate regime dummies and the external account variables such as debt stock to GNI, foreign reserves, capital account openness and trade openness. When consumption is perfectly smoothed, it does not respond to the transitory income shocks so that $\beta_P = \beta_N = 0$. Imperfect smoothing should result in $0 < \beta_P, \beta_N$. If the consumption responds asymmetrically to positive and negative shocks, then $\beta_P \neq \beta_N$.

The specification of our chief interest elaborates on (6) to allow additional asymmetry by the exchange rate cyclicality

$$\Delta c_{i,t} = \sum_i \alpha_i + (\rho_A A_{i,t} + \rho_D D_{i,t})\Delta\tilde{y}_{i,t}^P + (\eta_A A_{i,t} + \eta_D D_{i,t})\Delta\tilde{y}_{i,t}^N + W_{i,t}\Phi + \varepsilon_{i,t} \qquad (7)$$

for which $A_{i,t}$ and $D_{i,t}$ are dummy variables that are set equal to unity if *i*'s DEER appreciates and depreciates, respectively. This specification allows not only asymmetric reactions to positive and negative shocks, but also varying responses depending on whether the income shocks coincide with the DEER depreciation or appreciation.

Pro-cyclical exchange rate movements refer to the tendency that positive income shocks coincide with appreciation and/or negative income shocks occur with depreciation. Thus, ρ_A and η_D are the relevant coefficients. Counter-cyclical exchange rates refer to the cases where the DEER depreciation (appreciation) coincides with positive (negative) income shocks. The relevant coefficients in this case are ρ_D and η_A.

Because of the endogeneity between consumption and output, we estimate equations (6) and (7) by the IV regression. The borrower's output growth is instrumented by its governments consumption expenditure growth, export growth, and gross fixed capital formation growth. We also instrument the external account variables by their lagged terms.

Table 5 presents the IV estimates. As a starting point, column 1 presents the preliminary estimates when we impose $\beta_P = \beta_N$ on (6) so that no asymmetry is allowed. The coefficient estimate of this restricted model suggests that approximately forty-four percent of the income shocks are not smoothed to result in the consumption fluctuations. In other words, slightly more than one-half of the income shocks are smoothed.

In column 2 we present the estimates of (6). The point estimate of the consumption response to negative income shocks is approximately seventy-five percent and highly significant. On the other hand, the response to positive shocks is twenty percent and statistically insignificant. It appears that the households are indeed more inclined to reduce consumption when faced with a surprise income loss than they are to increase

consumption with a surprise income rise. The result is consistent with the view that households in the LMICs are generally not well equipped with insurance and credit means to deal with a surprise dent in the income.

Column 3 presents the estimates of (7) that additionally differentiates the shocks under the pro-cyclicality and the counter-cyclicality. Once differentiating the income shocks also by the directions of the concurrent exchange rate movements, we find that the consumption significantly responds to negative income shocks coinciding with the DEER depreciation. In other words, in the face of negative income shocks, consumption smoothing is significantly hindered by the exchange rate pro-cyclicality. More specifically, when a surprise dent of the income growth coincides with depreciation, the consumption shrinks by approximately seventy-five percent of the income shrinkage. That is, the DEER depreciation, hence the debt revaluation, makes the consumption path more volatile when the income growth unexpectedly falls below the trend.

Note that our results are not unconditional corroboration of the hypothesis that the exchange rate pro-cyclicality leads to consumption volatility. Instead, they attest to a refinement that the consumption volatility effect is specific to negative income shocks.

7. Extended discussion and conclusions

On observing the results in the preceding sections, one may presume that the LMICs' bilateral exchange rates vis-à-vis USD co-move closely with those vis-à-vis the other major currencies. If so, portfolio diversification among the currencies will make little difference to the debt revaluation. As a general observation, the bilateral exchange rates indeed exhibit strong positive correlations. However, they look different when we focus on the countries whose debt-denominating currency portfolio is highly concentrated.

Table 6.A presents the correlations between the LMICs' bilateral USD rate changes and those in the other currencies for 2001-2017, the period for which the portfolio concentration prevailed. For the general sample, the correlations of the bilateral exchange rate changes are high at approximately ninety-seven percent. However, when the sample is limited to the observations for which the portfolio concentration index is within the highest quantile, the correlations decline noticeably for all currencies. When the sample is sub-grouped according to the exchange rate regimes, the correlations decline further for the pegged regime sub-sample and even further for the float regime sub-sample. For instance, the correlations are approximately sixty-five percent for euro and JPY, and fifty-two percent for GBP. Thus, for these countries portfolio diversification is relevant in affecting the magnitude of the debt revaluation.

What about the exchange rate cyclicality? Table 6.B displays the correlations between the income growth deviations and the bilateral exchange rate changes. A negative correlation indicates pro-cyclicality of the exchange rate fluctuations. For the full sample, the income correlation is negative for all bilateral exchange rates among which USD has the largest coefficient size. For all sub-samples, the USD shares negative correlations with the income shocks. The size of its correlation coefficient is in most cases the largest in absolute terms, implying relatively strong pro-cyclicality regardless of the sample.

Focusing on the observations with the highly concentrated portfolios, we observe that the borrowers' exchange rates against the other currencies are not as pro-cyclical as the USD rates as table 6.C shows. In fact, the euro and GBP exchange rates exhibit counter-cyclicality. The borrowers with highly-concentrated-portfolios also have a high USD share. Their average share is eighty-four percent, which is more than twenty percent higher than the general average. The USD share is particularly high for the float regime

sample, exceeding ninety percent. These observations imply a hidden cost of the immoderate reliance on the USD debt. If the seemingly excessive USD debt results from financial market underdevelopment (Caballero and Krishnamurthy, 2003), it would be difficult to pursue a solution by conversion into the domestic currency debt. Portfolio diversification among the international currencies is a more feasible option that helps the borrowers keep their consumption path less volatile by attenuating the extents of debt revaluation and exchange rate pro-cyclicality.

In this study, we have examined the currency compositional trends in the external debt of the LMICs over the last four decades. The data reveal that not all debtors with original sin are alike in their borrowing behavior. The differences provide useful information to help us understand the implications of the external debt denomination.

Although it is not necessary common in the literature to analyze the issues of foreign currency debt from a perspective of multi-currency portfolios, empirically the portfolio perspectives turned out important. We find that the cyclical property of the LMICs' currency values is significantly associated with the denominating foreign currency portfolio, rather than the mere foreign currency share. A more concentrated foreign currency portfolio is associated with a more pro-cyclical movement of the borrower's effective exchange rate. Theoretically, the exchange rate pro-cyclicality is expected to have a boosting effect on consumption volatility. Empirically, we find that the consumption volatility effect of the exchange rate pro-cyclicality is significant only with negative income shocks.

Altogether, our results suggest that the ramifications of the external debt denomination are not limited merely to the debt revaluation. They encompass the cyclical properties of the borrowers' exchange rates and consumption volatility. An important

implication to draw from our findings is that, even though original sin continues to prevail, there is room for the borrowers to attenuate the negative consequences it may bring about. Diversifying the portfolio will help the borrowers keep their consumption less volatile by attenuating the extents of debt revaluation and exchange rate pro-cyclicality.

Of course, the overall welfare of the borrowers depends also on the specific debt structures defined by the maturity and interest rates. In the absence of the detailed data on those, we only point to the potential role of the denomination currency portfolio to provide room for hedging against adverse ramifications.

For the foreseeable future, foreign-currency-denominated debt is likely to continue to be an important instrument for many LMICs. Unfortunately, it is also likely to remain a potential source of financial havoc such as a debt crisis. In this regard, our findings contribute to the literature by shedding some light on the covert cost of the foreign currency debt and suggesting room where the borrowers can re-consider their borrowing practices to hedge against inauspicious developments in the future.

Data Appendix

Sources

Currency composition of external debt: World Bank's *International Debt Statistics*.
Exchange rate regime indicators: Ilzetzki, Reinhart and Rogoff (2017).
Index of capital account openness: Chinn and Ito (2006).
Incidents of coups d'état: Powell and Thyne (2011).
Other macroeconomic and external account variables: World Bank's *World Development Indicators,* and International Monetary Fund's *International Financial Statistics*.

Sample periods

The primary sample period is 1980–2017. Depending on data availability, some countries have shorter samples.
Euro: exchange rate 1999–2017; currency composition 2001–2017.
Deutsche mark and French franc: exchange rate 1973–1998; currency composition 1973–2000. The exchange rates for 1999 and 2000 are set to 1 euro = 1.95583 DM and 1 euro = 6.55957 FF.
Synthetic Euro: 1980–2017, of which 1980–2000 is calculated by the weighted sum of DM and FF denominated debt.

Sample countries

Our sample consists of all low income, lower middle income, and upper middle income countries in the WDI for which data on external debt currency composition are available. The MIC and LIC samples, respectively, consist of ninety-one and thirty-three countries listed below. For the analyses in sections 3 and 4, the number of countries in the samples is further reduced because of limited data availability.

Income stratification

Low-income countries (29 countries): Afghanistan, Burundi, Benin, Burkina Faso, Central African Republic, Comoros, Eritrea, Ethiopia, Guinea, Gambia, Guinea-Bissau, Haiti, Liberia, Madagascar, Mali, Mozambique, Malawi, Niger, Nepal, Rwanda, Senegal, Sierra Leone, Somalia, Chad, Togo, Tanzania, Uganda, Dem. Rep. Congo, Zimbabwe.

Lower middle-income countries (47 countries): Armenia, Bangladesh, Bolivia, Bhutan, Cote d'Ivoire, Cameroon, Rep. Congo, Cabo Verde, Djibouti, Egypt, Georgia, Ghana, Guatemala, Guyana, Honduras, Indonesia, India, Kenya, Kyrgyz Republic, Lao, Sri

Lanka, Lesotho, Morocco, Moldova, Myanmar, Mauritania, Nigeria, Nicaragua, Pakistan, Philippines, Sudan, Senegal, Solomon Islands, El Salvador, Sao Tome and Principe, Swaziland, Syrian Arab Republic, Tajikistan, Ukraine, Uzbekistan, Vietnam, Vanuatu, Samoa, Yemen, Zambia.

Upper middle-income countries (45 countries): Angola, Albania, Azerbaijan, Bulgaria, Bosnia and Herzegovina, Belarus, Belize, Brazil, Botswana, China, Colombia, Costa Rica, Dominica, Dominican Republic, Algeria, Ecuador, Fiji, Gabon, Grenada, Iran, Jamaica, Jordan, Kazakhstan, Lebanon, St. Lucia, Maldives, Mexico, Macedonia, Montenegro, Mongolia, Mauritius, Malaysia, Panama, Peru, Paraguay, Romania, Serbia, Thailand, Turkmenistan, Tonga, Tunisia, Turkey, St. Vincent and the Grenadines, South Africa.

Regional stratification

East Asia and the Pacific (15 countries): China, Fiji, Indonesia, Cambodia, Lao PDR, Myanmar, Mongolia, Malaysia, Philippines, Solomon Islands, Thailand, Tonga, Vietnam, Vanuatu, Samoa

Europe and Central Asia (20 countries): Albania, Armenia, Azerbaijan, Bulgaria, Bosnia and Herzegovina, Belarus, Georgia, Kazakhstan, Kyrgyz Republic, Moldova, Macedonia, Montenegro, Romania, Russia, Serbia, Tajikistan, Turkmenistan, Turkey, Ukraine, Uzbekistan

Latin America and the Caribbean (24 countries): Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, Grenada, Guatemala, Guyana, Honduras, Haiti, Jamaica, St. Lucia, Mexico, Nicaragua, Panama, Peru, Paraguay, El Salvador, St. Vincent and the Grenadines, Venezuela

Middle East and North Africa (10 countries): Djibouti, Algeria, Egypt, Iran, Jordan, Lebanon, Morocco, Syrian Arab Republic, Tunisia, Yemen

South Asia (8 countries): Afghanistan, Bangladesh, Bhutan, India, Sri Lanka, Maldives, Nepal, Pakistan

Sub-Saharan Africa (44 countries): Angola, Burundi, Benin, Burkina Faso, Botswana, Central African Republic, Cote d'Ivoire, Cameroon, Dem. Rep. Congo, Congo, Comoros, Cabo Verde, Eritrea, Ethiopia, Gabon, Ghana, Guinea, Gambia, Guinea-Bissau, Kenya,

Liberia, Lesotho, Madagascar, Mali, Mozambique, Mauritania, Mauritius, Malawi, Niger, Nigeria, Rwanda, Sudan, Senegal, Sierra Leone, Somalia, Sao Tome and Principe, Swaziland, Chad, Togo, Tanzania, Uganda, South Africa, Zambia, Zimbabwe.

Figure Appendix

Figure 1.

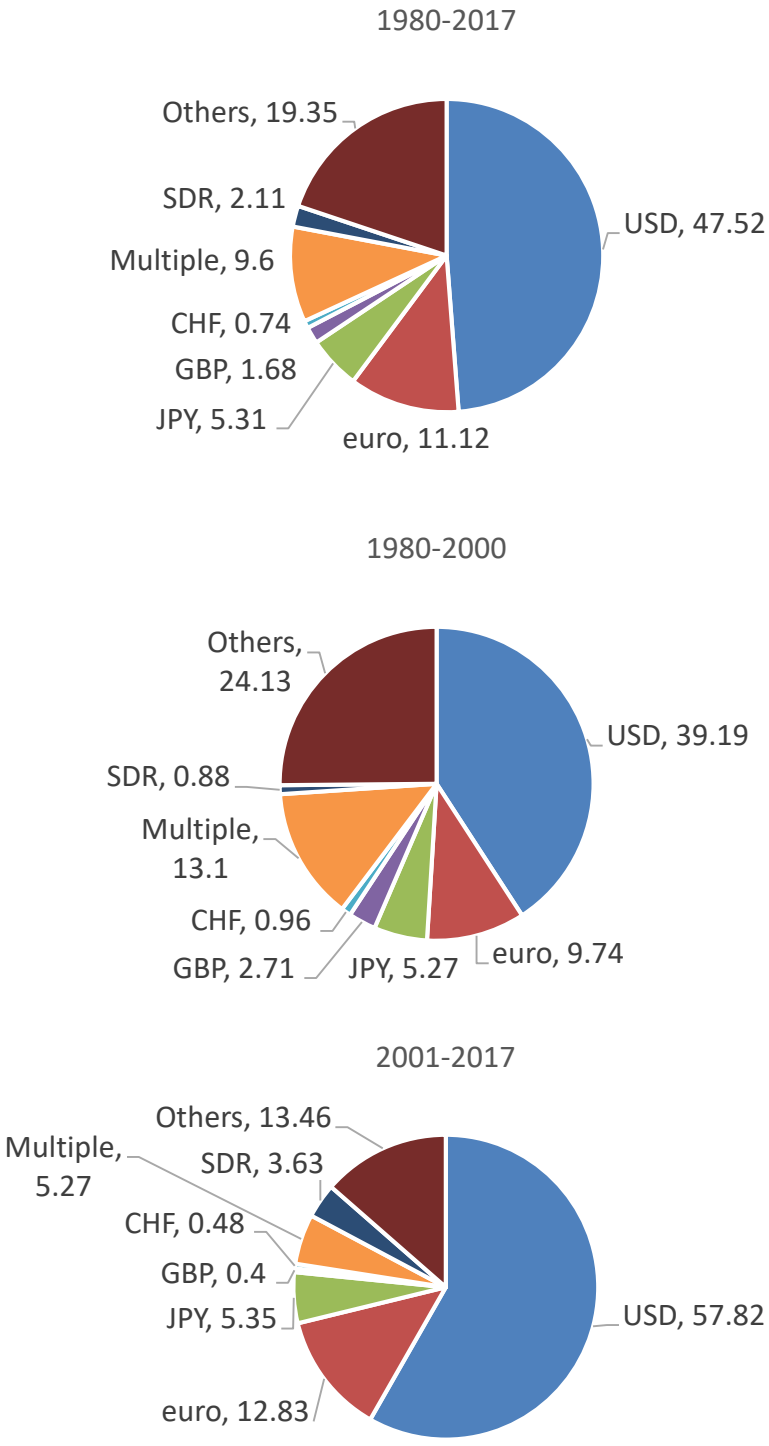

Figure 2. The numbers of countries with increasing/decreasing trends in the currency shares

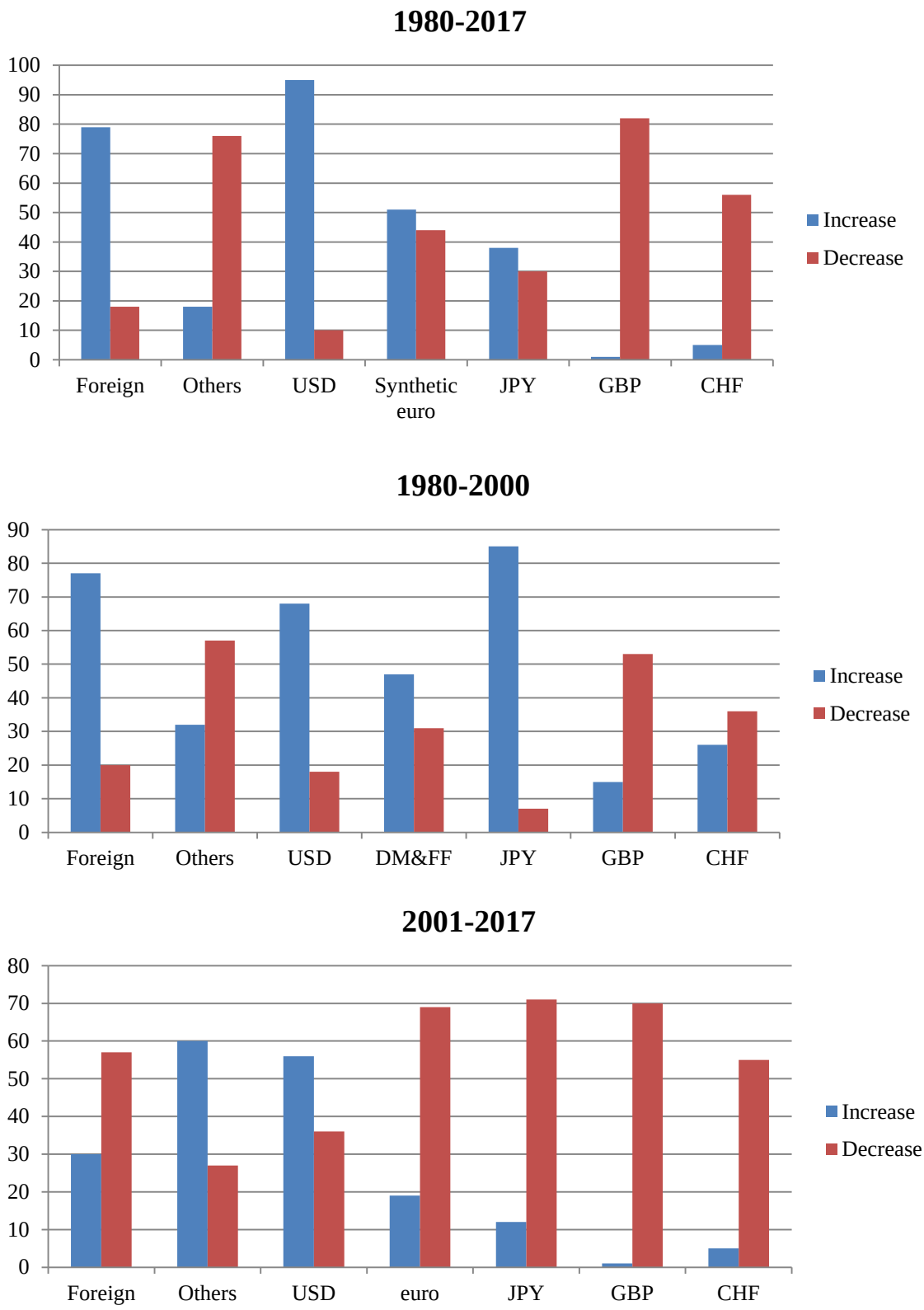

Figure 3. The numbers of countries with concentrating/diversifying portfolio

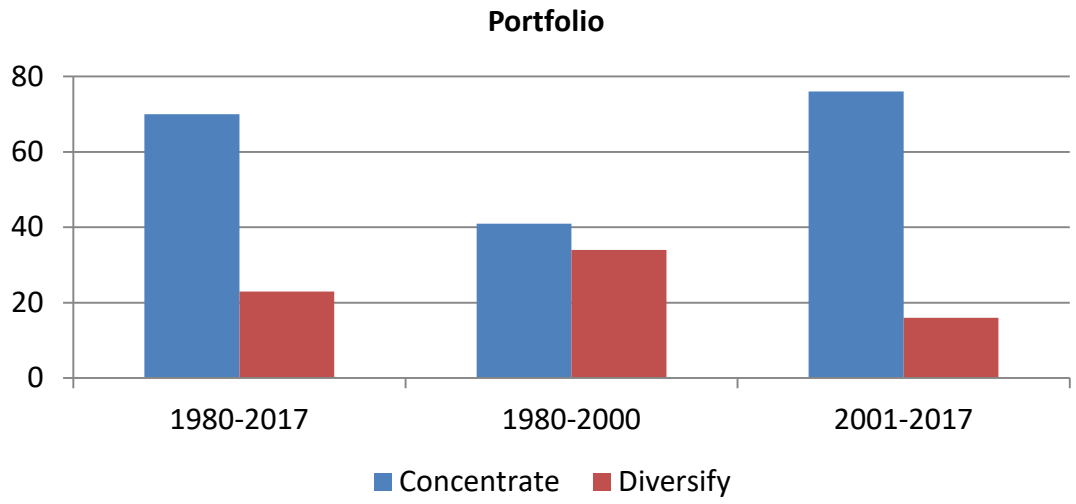

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Table 1. Descriptive statistics of the external debt denomination

	1980-2017	1980-2000	2001-2017
A. PPG debt share (%)			
PPG/Total debt stock	72.34	78.54	66.54
PPG/Total debt service	68.03	72.01	64.95
B. By-currency share (%)			
US dollar	47.52	39.19	57.82
Euro	-	-	12.83
German mark	-	3.93	-
French franc	-	5.81	-
Synthetic euro	11.12	9.74	12.83
Japanese yen	5.31	5.27	5.35
British pound	1.68	2.71	0.40
Swiss franc	0.74	0.96	0.48
Multiple currencies	9.60	13.10	5.27
SDR	2.11	0.88	3.63
Other currencies	19.35	24.13	13.46
Total minus other currencies	78.08	71.85	85.78
C. Trends in the shares			
Foreign currencies aggregate	+79, −18	+77, −20	+30, −57
US dollar	+95, −10	+68, −18	+56, −36
Synthetic euro	+51, −44	+47, −31	+19, −69
Japanese yen	+38, −30	+85, −7	+12, −71
British pound	+1, −82	+15, −53	+1, −70
Swiss franc	+5, −56	+26, −36	+5, −55
Other currencies	+18, −76	+32, −57	+60, −27

Notes: The entries in Panels A and B are in percentage terms. The sample period is 1980–2017 except for the euro (2001–2017), German mark (1980–2000), and French franc (1980–2000). Synthetic euro is constructed by connecting the summed shares of German mark and French franc for 1980-2000 and the share of euro for 2001-2017. “Foreign currencies aggregate” denotes the aggregated share of US dollar, synthetic euro, Japanese yen, British pound, and Swiss franc.

Table 2. The index of portfolio concentration/diversification

	1980-2017	1980-2000	2001-2017
Mean	0.63	0.61	0.67
Standard deviation	0.14	0.17	0.15
Portfolio-concentrating countries	70	41	76
Portfolio-diversifying countries	23	34	16

Notes: The mean and the standard deviation of the Herfindahl-Hirschman index of portfolio concentration are reported in the top two rows. The index is calculated for the foreign currency portfolio of the external PPG debt by (2) in the main text. The entries in the remaining rows indicate the number of countries that significantly concentrated/diversified the debt-denominating currency portfolio during the corresponding sample periods.

Table 3. Debt revaluation and exchange rate cyclicality (%)

	Mean	S. deviation	Minimum	Median	Maximum
A. Debt revaluation					
1980-2017	9.41	13.54	−8.21 (Ecuador)	5.08	70.22 (Angola)
1980-2000	18.83	26.85	−15.00 (Ecuador)	9.75	155.90 (Angola)
2001-2017	2.02	6.83	−12.98 (El Salvador)	1.14	43.35 (Argentina)
B. Exchange rate cyclicality					
1980-2017	−13.76	30.83	−86.06 (Syria)	−13.08	62.48 (Brazil)
1980-2000	−11.31	34.33	−88.71 (Azerbaijan)	−5.33	59.31 (Swaziland)
2001-2017	−14.48	34.14	−87.17 (Ukraine)	−14.34	84.22 (Argentina)

Notes: Average changes in the debt weighted effective exchange rates *with the decomposed multiple currency share added data*. For the minimum and maximum countries for 1980-2017, we considered only the countries that have effective observations for both 1980-2000 and 2001-2017 periods. For instance, panel A, 1980-2017: −11.29 (Montenegro but it existed only since 2006)
Panel B 1980-2017: 84.22 (Argentina).

Table 4. The exchange rate cyclicality

	1) IV	2) IV	3) OLS	4) OLS
Portfolio concentration	−1.04**	−1.07**	−.67**	−.68*
	(.21)	(.21)	(.17)	(.17)
Foreign currency share	−.38	−.366	−.34	−.34
	(.26)	(.261)	(.22)	(.22)
PPG share	.72**	.73**	.69*	.70*
	(.20)	(.21)	(.17)	(.17)
Debt stock to GNI	.28**	.29**	.43**	.43**
	(.09)	(.09)	(.04)	(.04)
Current account	−2.44**	−2.38**	−1.63**	−1.63**
	(.57)	(.57)	(.32)	(.32)
Net foreign asset	4.61**	4.63**	3.48**	3.48**
	(.17)	(.17)	(.08)	(.08)
Reserves	−2.51*	−2.54*	.28	.26
	(1.09)	(1.09)	(.34)	(.34)
Trade openness	−.31	−.35	−.48**	−.50**
	(.21)	(.21)	(.13)	(.13)
Capital account openness	−13.33	−14.67	−2.48*	−2.51*
	(8.84)	(8.52)	(1.05)	(1.05)
Coups d'état dummy	-	−22.40	-	−19.61
		(11.72)		(12.08)
F-statistics	12.48**	12.39**	18.21**	18.12**
J-statistics	1.83	0	-	-
Adjusted R^2	.53	.53	.45	.45
N	2858	2858	2925	2925

Notes: Country-specific fixed effects model estimates are reported. ** and * indicate the statistical significance at 5 and 10 percent levels, respectively.In all estimates, the country-specific constants, the exchange rate regime dummies, and the region dummies are allowed. The *J*-statistic is reported for the over-identifying restrictions for the instrumental variables estimations.

Table 5. IV estimates of consumption responses to the income shocks

	1	2	3	4	5
Income shocks	.44**	-	-	-	-
	(.10)				
Positive income shocks (β_P)	-	.20	-	-	-
		(.19)			
Negative income shocks (β_N)	-	.75**	-	-	-
		(.24)			
Positive income shocks with appreciation (ρ_A)	-	-	.10	.10	.10
			(.20)	(.20)	(.20)
Positive income shocks with depreciation (ρ_D)	-	-	.46	.46	.44
			(.25)	(.25)	(.25)
Negative income shocks with appreciation (η_A)	-	-	.83	.85	.74
			(.58)	(.59)	(.57)
Negative income shocks with depreciation (η_D)	-	-	.75**	.75**	.72**
			(.28)	(.28)	(.27)
Deb stock to GNI	.02**	.02**	.02**	.02**	.02**
	(.006)	(.006)	(.007)	(.007)	(.007)
Capital account openness	−1.45**	−1.56**	−1.67**	−1.68**	−1.75**
	(.510)	(.54)	(.58)	(.56)	(.56)
Reserves	.39**	.37**	.35**	.36**	.30**
	(.11)	(.11)	(.11)	(.12)	(.11)
Current account	-	-	-	−.009	-
				(.03)	
Trade openness	-	-	-	-	.02
					(.01)
Exchange rate regime	Included	Included	Included	Included	Included
J-statistic	.77	.71	.66	.66	.71
N	2225	2225	2225	2199	2199

Notes: Country-specific fixed effects model estimates are reported. ** and * indicate the statistical significance at 5 and 10 percent levels, respectively. In all estimates, the country-specific constants, and the exchange rate regime dummies are allowed. The entries for GDP per capita is pre-multiplied by 1000.

Table 6. Features of the highly concentrated portfolio cases

A. The USD bilateral exchange rate correlations with other currencies

	All	Highly concentrated portfolio cases			
		All regimes	Peg	Middle	Float
EUR	.97	.72	.68	.74	.65
JPY	.96	.68	.66	.70	.64
GBP	.98	.77	.77	.78	.51
CHF	.98	.82	.79	.85	.72
N	2091	516	209	268	31

B. Correlations between the income growth deviations and the bilateral exchange rates

	All	Highly concentrated portfolio cases			
		All regimes	Peg	Middle	Float
USD	−.18	−.26	−.20	−.35	−.19
EUR	−.15	−.06	−.01	−.15	.17
JPY	−.17	−.17	−.10	−.24	−.29
GBP	−.14	−.02	.03	−.09	.14
CHF	−.16	−.11	−.04 †	−.21	−.08

C. Denomination shares by currency

	All	Highly concentrated portfolio cases			
		All regimes	Peg	Middle	Float
USD	62.41	83.62	83.74	82.29	91.11
EUR	13.82	2.40	2.47	2.20	4.00
JPY	5.88	.89	.62	1.15	.56
GBP	.45	.07	.09	.05	.18
CHF	.53	.01	.003	.01	.009

Notes: All entries are for 2001-2017 observations. The highly concentrated portfolio cases consist of the observations for which the Herfindahl index of the denomination portfolio is within the highest quantile. The exchange rates are measured in the growth rate terms. In panel A, the entries denote the correlations between the LMICs' bilateral USD exchange rates and their bilateral rates vis-à-vis the other foreign currencies. In panel B, the entries denote the correlations between the income growth deviations and the bilateral exchange rate changes. The entries in the first column of panel C denote the adjusted shares after distributing the shares of the SDR and multiple currency debt in the original data. Thus, the figures differ from the by-currency shares reported in Table 1.