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CURRENCY MISMATCHES IN EMERGING MARKET ECONOMIES: IS WINTER COMING?

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ABSTRACT

We develop a currency mismatch index and examine the causes of currency mismatches in emerging market economies. This study is based on a unique dataset on 22 economies from 2008 to 2017. We also construct the original sin index using granular data on international debt securities. We find Latin American countries, followed by Central European countries, suffer from the original sin and currency mismatch problems. The panel regression estimates show that country size, trade openness, and the level of economic and financial development explain cross-country variations in currency mismatches. Our empirical results suggest that unstable monetary and fiscal policies are the primary causes of currency mismatches. The results indicate that a better institutional environment reduces currency mismatches. These findings call for monetary independence, stable fiscal policy, and macroprudential policy measures to minimize currency mismatches.

Keywords: Foreign currency debt; Currency mismatch; Macroprudential policies; Monetary independence.
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I. INTRODUCTION

The open-economy macroeconomics literature shows that high-level Foreign Currency Denominated Debt (FCD) increases systematic risk and exacerbate currency and debt crisis in Emerging and Developing Economies (EDEs). In the event of exchange rate depreciation, the cost of FCD increases and causes a negative balance sheet effect. However, currency risk can be hedged by earning foreign currency assets. The EDEs with high foreign currency assets, like that of China, can sustain substantial levels of FCD. Therefore, measuring the net foreign currency position of a country uncovers the extent of the currency mismatch problem. Currency mismatch is defined as the mismatch between assets and liabilities in which the liabilities are denominated in foreign currency and assets are in local currency (Goldstein and Turner, 2004).

In this paper, we analyze the evolution of foreign currency exposure and currency mismatches in Emerging Market Economies (EMEs) and investigate the causes of currency mismatches. In international finance architecture, the US dollar plays a key role in transactions and debt contracts. In currency borrowings, the dollar is the dominant currency because the dollar credit to the non-banking sector outside the US rose from 9.5 percent in 2007 to 14 percent in 2018 of world Gross Domestic Product (GDP) (Bank for International Settlements (BIS), 2018). The dollar dominance is due to the inability of many EDEs to borrow from abroad in their own currency, and such inability often called "original sin" continues to be a source of concern (Eichengreen et al., 2005a; Acharya et al., 2015; Kuruc et al., 2016). The original sin problem can lead to an increase in the use of FCD and is likely to cause currency mismatches in EDEs. The recent currency and debt crisis in emerging economies indicate the importance of controlling the level of sovereign and corporate debt denominated in foreign currency (Du and Schreger, 2016; Pradhan and Hiremath, 2019).

Similarly, the measurement of currency mismatches is essential because mismatches increase the likelihood of a financial crisis. Eichengreen et al. (2005a, b; 2007), Goldstein and Turner (2004), Park (2010), and Chui et al. (2018) emphasize the need for a comprehensive method of measuring currency mismatches in EMEs. Hence, the original sin and currency mismatch indicators assume significance and have important implications for economic growth and macroeconomic policy.

We contribute to the literature on open economy macroeconomics in multiple ways. First, we develop an index to measure currency mismatches. This index helps to better understand foreign currency exposure by EMEs. The original sin hypothesis (Eichengreen et al., 2005a) and aggregate effective currency mismatch (Goldstein and Turner, 2004) are primary currency mismatch indicators. These indicators suffer from several drawbacks. The method for measuring external vulnerabilities should be based on data broken down by currency (nationality approach) rather than the residence principle because the domestic financial relations of the country are associated with the rest of the world (Tobal, 2018). We compare the original sin index with country-level data on the share of foreign currency debt in total debt outstanding. Besides, we explore the recent developments in foreign currency exposure. Gagnon (2014), Tobal (2018), and Chui et al. (2018) document that EMEs lengthened their foreign currency exposure during the recent period, and the literature on currency mismatches paid little

attention to these currency risks (Baek, 2013; Benetrix et al., 2015). In this context, the study assumes further importance.

Second, we employ diverse and comprehensive data sets on foreign currency exposure, and, thus, the results and implications of our study are robust. Specifically, we use balance sheet information to calculate the net asset position in foreign currency held by EMEs. Further, we construct a unique dataset to measure the currency mismatches in EMEs. We follow the methodology of Kuruc et al. (2016) and Chui et al. (2018) to develop the currency mismatch index. Third, we estimate the original sin index for the EMEs using granular data on international debt securities. We also use panel regression analysis to conduct an empirical analysis on currency mismatches, and this captures the heterogeneity across countries. The panel regression methodology accounts for time-varying and unobserved characteristics of the covariates of currency mismatches.

As our next contribution, we provide evidence on the role of effective monetary and fiscal policies in controlling currency mismatches. The first school of thought holds international factors, such as transaction costs, externalities, and global market imperfections, as causes of currency mismatches (Hausmann and Panizza, 2003; Eichengreen et al., 2005 a, b). In contrast, the second school emphasizes domestic factors, such as lack of monetary policy credibility, ineffective macroeconomic policy, and institutions, as the leading causes of financial instability and currency mismatches in EMEs (Goldstein and Turner, 2004; Özmen and Arinsoy, 2005). Fiscal policy also plays a crucial role in the management of external debt (Reinhart et al., 2003). However, no study empirically tests these propositions using a complete measure of currency mismatches.

Finally, to our knowledge, this study is the first to examine the role of macroprudential policy and monetary independence in controlling currency mismatches across EMEs. We examine a wide range of macroeconomic and institutional factors, which were not analyzed in the context of currency mismatches in previous studies. Macroprudential policy measures enhance exchange rate and financial system stability (Purnawan et al., 2015). Hence, our study has substantial research and policy implications for macroprudential frameworks.

We find that EMEs face severe financial fragilities and currency mismatch problems in the presence of a high value of the original sin. We show that both monetary and fiscal policies play a significant role in controlling currency mismatches. We also document the effects of monetary independence and macroprudential policy on currency mismatches.

The rest of the paper is organized as follows. The next section reviews the conceptual framework and analytical issues of currency mismatches. In Section III, we discuss the stylized facts of foreign currency exposure and currency mismatch measurements. We describe the data and methodology in Section IV. The results and discussions are presented in Section V, while Section VI concludes the paper with policy implications and suggestions.

II. CONCEPTUAL FRAMEWORK AND ANALYTICAL ISSUES

A. Conceptual Issues

Researchers view currency risk in three ways, namely debt intolerance, original sin, and currency mismatch. These three concepts focus on the open economy balance sheet effects with varied directions. Reinhart et al. (2003) define debt intolerance as the inability of many EDEs to handle external debt levels. Eichengreen et al. (2005b) develop the original sin hypothesis to explain the inability of EDEs to borrow in their own currencies. The term 'currency mismatch' introduced by Goldstein and Turner (2004) is the difference between the currency composition of liabilities and assets. Currency mismatch is the consequence of the original sin and debt intolerance problem. Eichengreen et al. (2007) argue that these three concepts are analytically distinct and focus on the problem of the structure of global financial markets. In light of these arguments, we emphasize the importance of measuring currency risk and investigate the factors determining currency mismatches.

B. Causes of Currency Mismatches: Theoretical and Empirical Framework

The theoretical framework of our study builds on the moral hazard and original sin hypotheses. The pegged exchange rate regime offers an implicit guarantee to the borrowers against foreign currency debt. Such a guarantee leads to a moral hazard problem by incentivizing excessive risk (Eichengreen and Hausmann, 1999). The fixed exchange rate regime increases the unhedged foreign currency debt[1]. Government bailouts and rescue packages of international financial institutions act as the implicit guarantees on external debts and lead to financial fragility. The original sin hypothesis shows that the flexible exchange rate regime lowers the FCD and enhances financial stability. Eichengreen and Hausmann (1999) suggest dollarization as an acceptable solution to control the moral hazard problem. However, Goldstein and Turner (2004) and Tobal (2013) refute the idea of dollarizing the economy. They argue that dollarization increases currency mismatches in EMEs.

Two schools of thought discuss the causes of currency mismatches in EMEs. The first school opines that currency mismatch occurs because of international factors, such as the imperfection in global capital markets, transaction costs, and network externalities, rather than inefficient domestic policies (Hausman and Panizza, 2003; Eichengreen et al., 2005a, b). In contrast, Goldstein and Turner (2004) and Özmen and Arinsoy (2005) argue that domestic factors are the primary causes of currency mismatches.

Empirically, Baek (2013) tests the determinants of currency mismatches using Lane and Shambaugh's (2010a) data on foreign currency exposure. Nevertheless, the data overestimates within-country foreign currency exposure and is inappropriate for partially dollarized economies. Further, the study does not show the influence of monetary and fiscal policies as well as exchange rate regimes on currency mismatches. Goldstein and Turner (2004) argue that these factors are significant causes of currency mismatches.

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[1] See Mishkin (1996) and Obstfeld (1998).

III. FOREIGN CURRENCY EXPOSURE AND CURRENCY MISMATCHES: STYLIZED FACTS

The measurement of foreign currency risk and currency mismatches in EMEs is challenging due to insufficient data. We select a group of 22 EMEs over the period of 2008 to 2017, and data availability dedicates the sample (see Table 1 for country coverage). We adopt the new methodology suggested by Kuruc et al. (2016) and Chui et al. (2018) to measure currency mismatches in EMEs. To achieve this objective, we collect the data from BIS, International Monetary Fund (IMF), and World Bank databases. We calculate aggregate effective currency mismatch ($AECM$) as follows:

$$AECM = \frac{NFCA}{M} \times FCTD \qquad if\ NFCA > 0 \tag{1}$$

$$AECM = \frac{NFCA}{X} \times FCTD \qquad if\ NFCA < 0 \tag{2}$$

where $NFCA$ denotes the net foreign currency assets.[2] M and X are, respectively, the country's imports and exports of goods and services; $FCTD$ represents foreign currency share of the total debt.[3] $AECM > 0$ indicates a net asset position in foreign currency of a country, whereas the AECM < 0 suggests a net liability position; $AECM = 0$ indicates no currency mismatch or that foreign currency liabilities equal assets.

$$OSIN = max\ (1 - \frac{Securities\ \ in\ currency\ i}{Securities\ issued\ by\ country\ i}, 0) \tag{3}$$

The original sin ($OSIN$) index ranges between 0 and 1. Values close to one imply a severe original sin position, and close to zero implies a secure position. Eichengreen et al. (2007) argue that a greater value of original sin leads to high currency mismatches. We present the computed $OSIN$ values for a sample of 20 EMEs in Table 2. The original sin index shows that Latin American economies have a greater original sin problem followed by the Central European countries. The higher level of original sin in these economies indicates an increase in foreign currency risk. For example, Indawan et al. (2015) show that the foreign currency liabilities in Indonesia are increasing, which, in turn, increase the risk of domestic currency depreciation. In contrast, giant economies in Asia, such as China, Chinese Taipei, and India, have the least original sin problem. The development of the domestic bond market led to a drop in original sin value in these economies.

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[2] The positive $NFCA$ denotes net asset position in foreign currency, and negative value implies net liability position in foreign currency. The negative $NFCA$ leads to negative currency mismatches in EDEs. The $NFCA$ includes net foreign assets of monetary authorities and deposits of money banks, and foreign currency assets of non-banks held with BIS reporting banks minus foreign currency liabilities of non-banks to BIS reporting banks and international debt securities outstanding.

[3] The $FCTD$ denotes the composite of liabilities of nonbanks and non-banks to BIS reporting, domestic credit to the private sector, international and domestic debt securities outstanding.

Table 1.
Region-wise Sample

This table presents the region-wise distribution of 22 EMEs.

Latin America (7)	Central Europe (3)	Asia (8)	Other EMEs (4)
Argentina	Czech Republic	China	Russia
Brazil	Hungary	Chinese Taipei	Israel
Chile	Poland	India	Turkey
Colombia		Indonesia	South Africa
Mexico		Malaysia	
Peru		Philippines	
Venezuela		South Korea	
		Thailand	

Table 2.
Original Sin Index

This table provides the estimates of original sin index values based on a sample of 20 EMEs for the period 2008 to 2018. The original sin index is defined in Eq. (3). We calculate the index employing the data on international debt securities of Bank of International Settlements (BIS). The original sin value closer to one indicates serious original sin problem implying that the country has little ability to issue international debt in its own currency.

Country/Region	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Latin America	0.83	0.86	0.87	0.85	0.86	0.86	0.87	0.91	0.91	0.91	0.92
Argentina	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Brazil	0.72	0.75	0.71	0.65	0.67	0.67	0.68	0.77	0.73	0.75	0.80
Chile	0.96	0.96	0.94	0.92	0.91	0.93	0.95	0.97	0.97	0.97	0.98
Colombia	0.79	0.80	0.78	0.74	0.76	0.77	0.80	0.86	0.89	0.88	0.87
Mexico	0.66	0.75	0.79	0.81	0.83	0.81	0.83	0.86	0.90	0.89	0.88
Venezuela	0.84	0.94	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Central Europe	0.49	0.55	0.63	0.70	0.77	0.81	0.82	0.86	0.86	0.85	0.85
Czech Republic	0.00	0.00	0.22	0.37	0.49	0.61	0.63	0.71	0.72	0.73	0.73
Hungary	0.89	0.92	0.93	0.95	0.97	0.97	0.98	0.98	0.97	0.96	0.95
Poland	0.58	0.72	0.75	0.79	0.85	0.86	0.86	0.90	0.90	0.88	0.88
Asia	0.84	0.80	0.75	0.65	0.63	0.67	0.69	0.70	0.73	0.76	0.78
China	0.63	0.50	0.38	0.01	0.00	0.00	0.00	0.00	0.11	0.37	0.47
Chinese Taipei	0.85	0.76	0.75	0.86	0.89	0.94	0.94	0.96	0.97	0.98	0.98
India	0.98	0.98	0.97	0.90	0.86	0.87	0.85	0.76	0.73	0.59	0.54
Indonesia	0.85	0.86	0.78	0.68	0.72	0.78	0.81	0.84	0.86	0.87	0.89
Malaysia	0.86	0.83	0.81	0.78	0.78	0.83	0.87	0.92	0.93	0.95	0.96
Philippines	0.99	0.99	0.97	0.92	0.91	0.91	0.91	0.92	0.93	0.93	0.94
Thailand	0.74	0.67	0.60	0.39	0.27	0.34	0.48	0.50	0.58	0.62	0.70
Other EMEs	0.55	0.59	0.57	0.57	0.55	0.57	0.60	0.68	0.69	0.68	0.72
Israel	0.85	0.91	0.90	0.92	0.95	0.96	0.97	0.97	0.98	0.97	0.98
Russia	0.79	0.80	0.78	0.72	0.66	0.71	0.75	0.83	0.85	0.82	0.85
South Africa	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.17	0.11	0.11	0.21
Turkey	0.55	0.64	0.61	0.63	0.57	0.61	0.69	0.77	0.81	0.82	0.83

Many of the EMEs reduced the original sin problem in their aggregate balance sheets because of constraints imposed by domestic financial distress on their ability to borrow. This evidence contradicts the view that EMEs are successful in converting FCD into local currency-denominated debt and developed their bond market (Gagnon, 2014; Chui et al., 2018). Although India, Indonesia, Malaysia, and Thailand began to develop their local bond markets but are still in the early stages of development (Park, 2010; and Indawan et al., 2015).

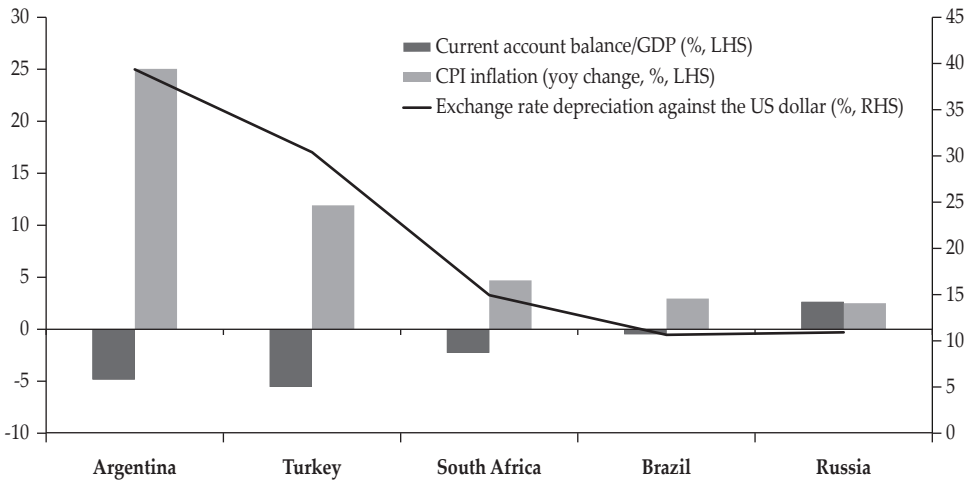
IV. DATA AND METHODOLOGY

A. Data

The data covers 22 EMEs in Latin America, Asia, and Central Europe for the period of 2008 to 2017. The data coverage have some crucial advantages. First, the EMEs are under stress during the post-global financial crisis (GFC) period.[4] Second, the recent currency depreciation of EMEs against the US dollar is due to high inflation and current account deficit, which possibly lead to an increase in the currency mismatch problem. The exchange rate depreciation is a good barometer to measure the stress in EMEs (Figure 1). Third, the series of events occurred in EMEs throughout the study period, such as the taper tantrum crisis, currency devaluation, and a slowdown in China, trade tensions escalation, and Lira and peso crises, which created financial stress in these markets, as shown in Figure 1.

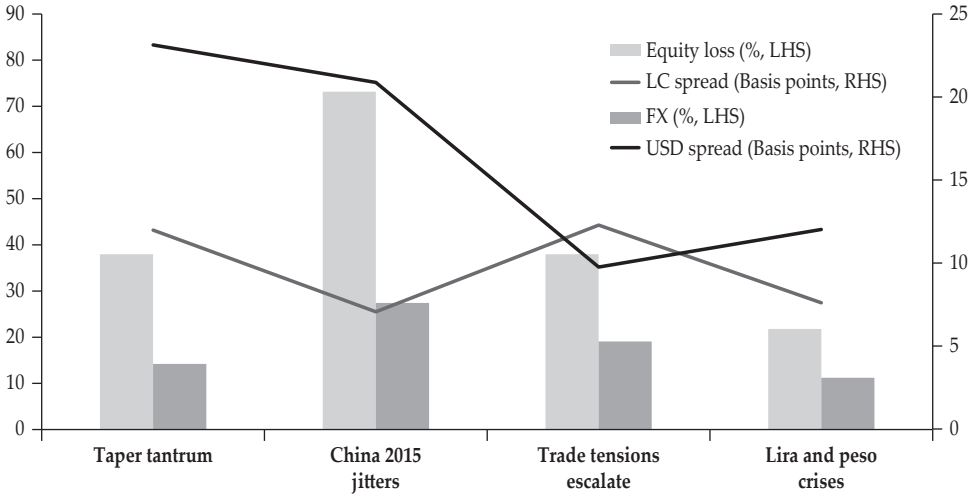
Figure 1.
EMEs Stress and Macroeconomic Vulnerabilities

The figure presents recent financial stress and vulnerabilities in EMEs. The left-hand panel shows that macroeconomic vulnerabilities of EMEs generate high exchange rate depreciation against the US dollar (31 July 2018 to 12 September 2018). The right-hand panel corresponds to the financial stress of the EMEs in a series of events such as taper tantrum crisis (May to September 2013), China's currency devaluation and slowdown (August 2015 to January 2016), trade tensions escalate (March to July 2018) and Lira and peso crises (August to September 2018). Equity loss measured with the MSCI EMEs index (in $). Foreign currency depreciation (FX) based on the trade-weighted $ index. LC and USD represent the local currency and US dollar-denominated spreads, respectively. Data is taken from the Bank of International Settlements (BIS) reports.



[4] See, BIS Quarterly review, September 2018.

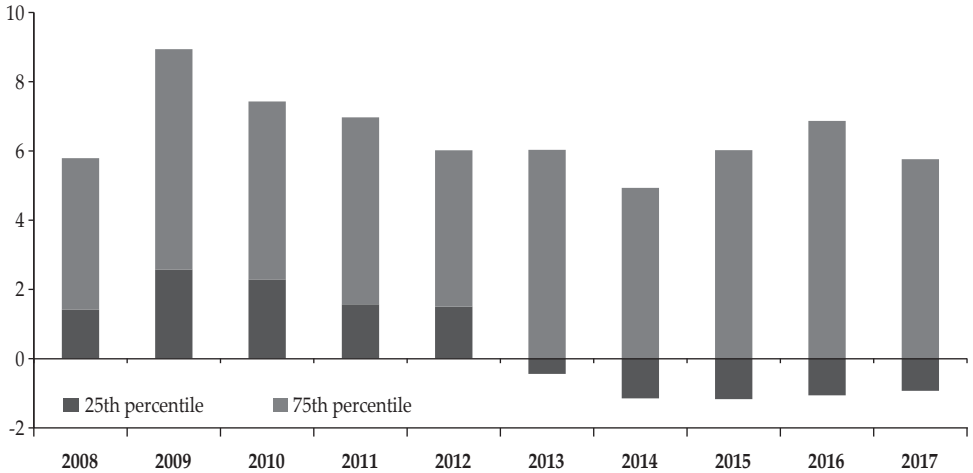
Figure 1.
EMEs Stress and Macroeconomic Vulnerabilities (Continued)



Furthermore, tight financial conditions, such as equity loss and currency depreciation, create pressure on EMEs, and lower their ability to borrow in domestic currency in international markets. The focus on data after 2008 ensures that complete currency mismatch indicators are available after this period. Moreover, our *AECM* estimates confirm the net liability position of these EMEs in foreign currency since 2013 (Figure 2). Such liability indicates that *AECM* has significantly moved from positive to negative position.

Figure 2.
Cross-Sectional Distribution of *AECM* (%)

This figure shows the cross-sectional distribution of the 25th and 75th percentile of aggregate effective currency mismatch (*AECM*) for 22 EMEs from 2008 to 2017. The figure indicates that the first quartile of *AECM* has significantly moved from a favourable position to a negative position. Data Source: Authors' own calculations.



B. Empirical Model

We use panel regression models to investigate the effects of global and country-specific macroeconomic factors on currency mismatches. Goldstein and Turner (2004), Eichengreen et al. (2007), Baek (2013), and Benetrix et al. (2015) suggest an association of monetary credibility, exchange rate volatility, country size, trade openness, institutional quality, and financial development with currency mismatches. The other important policy factors—monetary independence, macroprudential measures, original sin, and debt intolerance—are relevant for liability position in foreign currency. We describe the variables and data sources in Table 3. We estimate the following panel regression model:

$$CM_{i,t} = \alpha_i + \beta_1 Size_{i,t} + \beta_2 INF_{i,t} + \beta_3 ERV_{i,t} + \beta_4 TO_{i,t} + \beta_5 Quality_{i,t} + MII_{i,t} + \varepsilon_{i,t} \quad (4)$$

where the dependent variable is $CM_{i,t} \in \{(AECM_{i,t} * (-1)), (MAECM_{i,t} * (-1))\}$; $AECM_{i,t}$ is the aggregate effective currency mismatch computed using Eq. (1) or (2); $MAECM_{i,t}$ denotes the modified currency mismatch indicator for country i at time t. The $MAECM_{i,t}$ includes the domestic bank loans and bonds that are denominated in foreign currencies.[5] To facilitate the comparison, we convert *AECM* and *MAECM* into *CM* and *MCM*, respectively, and, therefore, a high value of *CM* indicates a high currency mismatch (net liability position in foreign currency). α_i is a country-specific fixed-effect, which controls the time-invariant unobserved characteristic of country *i*. $Size_{i,t}$ is the country size measured as the log levels of GDP; $INF_{i,t}$ denotes the inflation rate; $ERV_{i,t}$ refers to the standard deviation of the first log difference of quarterly local currencies against the US dollar rate over the current and the past year; $TO_{i,t}$ and $Ka\_open_{i,t}$ are the indicators of trade openness (trade as a percentage of GDP) and capital openness (Chinn-Ito's capital account openness index). The institutional quality index ($Quality_{i,t}$), comprising 12 indicators, ranges between 0 and 100; $MII_{i,t}$ is the monetary independence index constructed by Aizenman et al. (2013). $\varepsilon_{i,t}$ is the error term. The panel regression approach uses the cross-sectional and time-variation of information on currency mismatches across the countries. In this empirical framework, some covariates overlap, but such variables are measured differently.

Previous studies find monetary policy as a significant determinant of currency mismatches in EDEs (Eichengreen et al., 2005b; Goldstein and Turner, 2004; Jeanne, 2005; Tobal, 2013). The lack of effective monetary policy exposes the EDEs to systemic risk, and, in turn, adversely affecting the domestic borrowers holding FCD. Therefore, foreign and domestic investors insist on lending in domestic currencies because of higher inflation and lesser protection in the domestic market. Specifically, Goldstein and Turner (2004), and Jeanne (2005) hold monetary policy credibility—a measure of inflation volatility—as a leading cause of currency mismatch. Thus, countries with high and volatile inflation have a greater tendency to issue debt in foreign currencies. Empirically, Baek (2013) find a positive association between inflation and currency mismatches.

[5] We assume that domestic bonds and loans are denominated in domestic currencies in all EMEs, while computing $CM_{i,t}$.

Table 3.
Variables Definition and Sources

This table defines variables and cite sources of data. Authors' calculations are based on data obtained from BIS: Bank for International Settlements; IFS: International Financial Statistics, IMF; World Bank; and National sources. Other variables are sourced from WDI: World Development Indicators. PRS Group, ICRG: International Country Risk Guide; IIF: Institute of International Finance.

Acronym	Variable Name	Exp. Sign	Description	Source
CM	Currency mismatch	NA	*CM* > 0 indicates liability position in foreign currency (%). $CM_{i,t} = (AECM_{it})*(-1)$; *AECM* denote aggregate effective currency mismatch constructed in Eq. (1) and (2).	Authors' own calculations
MCM	Modified currency mismatch	NA	Revised CM estimates include the domestic bank loans and domestic bonds denominated in foreign currency. In CM, we assume that domestic bonds and loans are denominated in domestic currency in all EMEs.	Authors' own calculations
Size	Country size	(±)	GDP in log levels (current, millions of US dollars).	IFS
INF	Inflation	(+)	Percentage change, end of period consumer prices (%).	WDI
ERV	Exchange rate volatility	(+)	The standard deviation of the first log difference of quarterly local currency against the US dollar rate over the current and the past year, annualized (%).	IFS
TO	Trade openness	(−)	Trade (% of GDP).	WDI
Quality	Institutional quality index	(−)	Index value ranges between 0 and 100; it comprises 12 indicators, namely government stability, socioeconomic conditions, investment profile, internal conflict, external conflict, corruption, military in politics, religious tensions, law and order, ethnic tensions, democratic accountability, and bureaucracy quality.	PRS Group, ICRG
MII	Monetary independence index	(−)	Calculated as the reciprocal of the annual correlation between the monthly interest rates of the home country and the base country.	Aizenman et al. (2013)
Ka_open	Capital openness	(+)	The index measures the country's degree of capital account openness. *Ka_open* is the binary dummy variable that codifies the tabulation of restrictions on cross-border financial transactions reported in IMF's annual report on exchange rate arrangements and exchange rate restrictions.	Chinn and Ito (2006)
Peg	Hard peg exchange rate regime	(+)	Binary dummy hard peg = 1 (includes categories of 1-2 Coarse classification) of exchange rate regime of Ilzetzki et al., 2018) otherwise 0.	Ilzetzki et al. (2018)
FC	Limits on foreign currency loans	(−)	The macroprudential policy of limits on foreign currency loans. It reduces the vulnerability to foreign currency risk (index value 0 and 1)	Cerutti et al. (2017)
DTI	Limits on debt to income ratio	(−)	The macroprudential policy constrains the household indebtedness by enforcing or encouraging a limit (index value 0 and 1)	
INFV	Inflation volatility	(+)	The standard deviation of the first log difference of quarterly consumer price index over the current and past year, annualized (%).	IFS
POP	Population	(±)	Total Population in log levels (in millions)	WDI
EXP	Exports	(−)	Exports of goods and services (% of GDP)	WDI

Table 3.
Variables Definition and Sources (Continued)

Acronym	Variable Name	Exp. Sign	Description	Source
Regime	Exchange rate regimes	(−)	Coarse classification starts from rigid regime to a more flexible exchange rate regime (index value 1 to 6)	Ilzetzki et al. (2018)
LD	Level of development	(−)	GDP per capita in log levels (current, US dollars)	WDI
M2	Financial development	(−)	Broad money supply (% of GDP).	WDI
OSIN	Original sin	(+)	The original sin index is defined in Eq. (3).	Authors' own calculations
DI	Debt intolerance	(−)	Total external debt (% of GDP).	IIF

Besides, the extant literature shows fiscal policy as a prominent cause of currency mismatches. Weak government policies (debt management) compel monetary officials to devalue the domestic currencies to lower the real value of debt obligations. Goldstein and Turner (2004) opine that fiscal prudence helps to reduce currency mismatches; they argue that neither the local government nor international financial institutions have an effective policy on public debt management. In a similar vein, Reinhart et al. (2003) find fiscal policy as a critical factor in the management of external debt. Moreover, Hausmann and Panizza (2003) predict that governments address the fiscal solvency issues through a rising inflation rate and FCD. Hence, larger share of sovereign debt and high inflation pose a severe threat to borrowing in domestic currencies, this is the vicious circle of domestic original sin. However, they find no relationship between the original sin and fiscal policy.

The exchange rate policy is closely related to the monetary policy of an economy; and the policy is an essential determining factor of high currency mismatches. Exchange rate depreciation can raise the value of FCD and increase currency mismatches. Baek (2013) finds a positive association between exchange rate volatility and currency mismatches, and shows that higher exchange rate volatility raises the FCD and hedging cost. Nonetheless, Eichengreen et al. (2005a) find no such relationship. In fixed exchange rate regimes, firms are unable to internalize their exchange rate risk, whereas flexible exchange rate regimes can reduce currency risk and mismatches (Martínez and Werner, 2002). For example, Mexico had a currency mismatch problem because of its fixed exchange rate regime. Using the *de-facto* exchange rate regime, Hausmann and Panizza (2003) empirically show a positive association between the original sin and exchange rate regimes.

Trade and capital account openness also influence currency mismatches. Trade openness increases domestic consumption and foreign currency assets through imports and exports. The foreign currency assets in the domestic markets can increase the credit facilities and decrease the FCD, which lowers the currency mismatches. Empirically, Eichengreen et al. (2005a) and Baek (2013) document

the role of trade openness in reducing currency mismatches. Countries with a free capital account hold substantial debt in foreign currencies, and, hence, have higher currency mismatches (Barajas and Morales, 2003). In EMEs, capital account openness increases the volatility in all levels of investment, such as Foreign Direct Investment (FDI), portfolio investment, and loans. Park and An (2012) investigate the effect of capital account openness in economies with and without the original sin. They show how capital account openness tends to increase capital volatility and the original sin problem in EMEs. They caution EMEs about capital account openness because their currencies are not internationalized. However, Hausmann and Panizza (2003) opine that capital controls may discourage a foreign investor from investing in the domestic market in local currency. Baek (2013) estimates the relationship between currency mismatches and capital account openness and finds an inverse relationship between capital account liberalization and currency mismatches.

The literature discusses how weak domestic institutions in EDEs lower local currency denominated debts, resulting in borrowing in foreign currencies. Countries with high-quality institutions can issue debt in domestic currencies and generate more foreign currency assets. Thus, the strength of local institutions is a crucial factor in reducing currency mismatches. In an influential paper, Lane and Shambaugh (2010b) investigate the determinants of foreign currency exposure in cross-country balance sheets. They document an inverse association between institutional quality and currency mismatches.

Nonetheless, Baek (2013) finds a positive relationship between institutional quality and currency mismatches. Better institutions induces the domestic agents to borrow in foreign currencies. Moreover, larger economies can limit foreign currency exposure due to cost advantage. These economies can borrow in domestic currencies, compared to small economies (see Lane and Milesi-Ferrentti, 2001; Hausmann and Panizza, 2003; and Eichengreen et al., 2005a, b).

In the aftermath of the GFC, many EDEs opted for macroprudential policy measures to limit external shocks, in addition to lowering capital controls. The pertinent literature emphasizes the importance of macroprudential policy in controlling currency mismatches (Goldstein and Turner, 2004; Dell' Ariccia et al., 2012; Tobal, 2018). In EDEs, monetary independence allows the central banks to freely operate and maintain the stability of the economy to limit currency mismatches. Financial depth is an important cause of currency mismatches in EDEs. The lack of financial development in EDEs dries up the available liquidity. Theoretically, Caballero and Krishnamurthy (2003) illustrate how lower financial depth in the domestic market results in more considerable dollar-denominated debt in EMEs. Hausmann and Panizza (2003) and Baek (2013) consider financial depth as an outstanding credit to the private sector as a share of GDP. They find a higher propensity for currency mismatches when the level of domestic credit to the private sector is lower.

C. Descriptive Statistics and Correlation Analysis

The summary statistics and correlations for all the variables are presented in Tables 4 and 5, respectively. Negative value of *CM* and *MCM* imply net asset

position in foreign currency in EMEs. The currency mismatch indicators reveal Argentina, Chile, Hungary, Poland, and Turkey as the countries with an average net liability position in foreign currencies, whereas Chinese Taipei, Peru, Russia, and Venezuela are economies with the net asset position in foreign currencies in our sample. The countries with an average original sin of 0.76 are still unable to issue debt in their currencies. Likewise, many EMEs have external debts higher than their GDP (i.e. up to 156.1 percent higher), leading to the debt intolerance. The correlation analysis confirms weak correlation among the explanatory variables, indicating weak evidence of multicollinearity.

Table 4.
Summary Statistics

This table summarizes the descriptive statistics of currency mismatch indicators and all other covariates employed in the empirical model. The estimation period is from 2008 to 2017. Variables and data are as defined in Table 3. The mean, median, standard deviation, percentile distribution, skewness, and kurtosis statistics are presented. We include the log values of GDP (*size*), Population (*POP*), and GDP per capita (*LD*); Standard deviation of CPI and Exchange rate in our regressions. Therefore, the values in descriptive statistics are presented in log levels and Standard deviation values.

Variables	N	Mean	Median	St.Dev	Min	p25	p75	Max	Skewness	Kurtosis
CM	220	-3.74	-3.00	8.39	-33.31	-5.32	-0.63	24.91	-0.49	4.94
MCM	220	-5.91	-4.07	14.04	-55.78	-9.96	-0.77	38.20	-0.72	5.28
Size	220	13.22	12.95	0.99	11.70	12.54	13.91	16.30	0.93	3.63
INF	220	5.42	3.62	6.06	-1.51	2.02	6.49	30.90	2.39	8.74
ERV	220	12.52	10.85	8.17	0.00	6.39	16.40	42.43	1.08	4.09
TO	220	74.29	59.24	40.12	22.11	46.80	96.96	176.67	0.98	2.84
Quality	220	65.65	64.27	8.84	44.00	59.95	74.31	80.62	-0.13	2.38
MII	220	0.51	0.52	0.17	0.04	0.40	0.63	0.97	-0.21	3.00
Ka_open	210	0.50	0.45	0.32	0.00	0.17	0.72	1.00	0.25	1.81
Peg	220	0.31	0.00	0.47	0.00	0.00	1.00	1.00	0.80	1.65
FC	210	0.30	0.00	0.46	0.00	0.00	1.00	1.00	0.85	1.72
DTI	210	0.32	0.00	0.47	0.00	0.00	1.00	1.00	0.78	1.60
INFV	200	1.64	1.22	1.79	0.18	0.65	1.98	20.35	6.18	61.56
POP	220	4.10	3.89	1.33	1.99	3.37	4.79	7.24	0.80	3.35
EXP	210	36.97	29.71	21.77	10.71	22.57	45.34	99.50	1.14	3.17
Regime	220	2.71	3.00	0.73	1.00	2.00	3.00	5.00	0.86	5.58
LD	220	9.12	9.26	0.75	6.90	8.71	9.56	10.60	-0.65	3.28
M2	210	73.92	67.00	39.71	23.49	42.89	82.93	208.46	1.25	4.23
OSIN	210	0.76	0.85	0.27	0.00	0.70	0.96	1.00	-1.70	5.13
DI	200	42.24	34.00	26.93	8.22	26.80	47.00	156.10	2.14	8.11

Table 5.
Pairwise Correlations

This table presents pairwise correlation coefficients between currency mismatch and all covariates employed in the empirical model. The variables are as defined in Table 3. * denotes significance at the 5 % level. '+' indicates that the variables in the model are alternative proxies and ensure robustness. The estimation period is from 2008 to 2017.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
(1) CM	1																			
(2) MCM	0.97*+	1																		
(3) Size	-0.03	-0.12*	1																	
(4) INF	-0.02	0.03	0.06*	1																
(5) ERV	0.30*	0.30*	-0.11*	0.16*	1															
(6) TO	0.08*	0.11*	-0.46*	-0.40*	0.02	1														
(7) Quality	0.13*	0.10*	-0.23*	-0.54*	0.06*	0.53*	1													
(8) MII	-0.13*	-0.15*	0.18*	0.06*	-0.04	-0.18*	-0.07*	1												
(9) Ka_open	-0.00	-0.02	-0.39*	-0.47*	0.06*	0.35*	0.54*	-0.08*	1											
(10) Peg	0.05*	0.05*	0.06*	0.08*	-0.01	0.07*	0.02	-0.09*	0.06*	1										
(11) FC	0.35*	0.31*	0.22*	0.04	0.09*	-0.19*	0.06*	0.07*	-0.05*	-0.00	1									
(12) DTI	0.35*	0.29*	0.10*	-0.24*	0.03	0.01	0.22*	0.03	0.20*	-0.04	0.50*	1								
(13) INFV	-0.04	-0.04	-0.04	0.43*+	0.15*	-0.11*	-0.29*	-0.05	-0.22*	-0.01	-0.16*	-0.13*	1							
(14) POP	-0.03	-0.08*	0.83*+	0.07*	-0.14*	-0.50*	-0.42*	0.11*	-0.55*	0.11*	0.03	-0.09*	0.07*	1						
(15) EXP	0.13*	0.17*	-0.45*	-0.39*	0.05*	0.99*+	0.51*	-0.16*	0.35*	0.12*	-0.19*	0.01	-0.11*	-0.48*	1					
(16) Regime	0.01	-0.02	0.01	0.19*	-0.03	-0.18*	-0.23*	0.16*	-0.10*	-0.73*+	-0.01	-0.04	0.17*	-0.02	-0.17*	1				
(17) LD	0.02	-0.01	-0.15*	-0.05*	0.10*	0.28*	0.44*	0.04	0.45*	-0.12*	0.25*	0.31*	-0.18*	-0.68*	0.26*	0.05*	1			
(18) M2	0.01	-0.06*	0.41*	-0.39*	-0.16*	0.30*	0.19*	0.14*	-0.16*	-0.04	0.08*	0.29*	-0.13*	0.27*	0.33*	-0.04	0.06*	1		
(19) OSIN	-0.02	0.03	-0.29*	0.18*	-0.04	0.04	0.11*	0.01	0.25*	-0.11*	0.13*	0.06*	0.11*	-0.30*	0.01	0.10*	0.17*	-0.36*	1	
(20) DI	0.18*	0.20*	-0.50*	0.05*	0.11*	0.57*	0.26*	-0.07*	0.30*	0.13*	-0.04	0.09*	-0.04	-0.61*	0.53*	0.08*	0.40*	-0.14*	0.28*	1

D. Model Specification Tests

The cross-section dependence test (Pesaran, 2015) examines the null hypothesis of cross-sectional independence in the data. The preliminary results reject the null hypothesis, suggesting that all factors are cross-sectional dependent (Table 6). In the presence of cross-sectional dependence, the standard errors of panel regressions do not produce reliable and unbiased estimates due to the occurrence of the multi-factor structure of the error term. Moreover, we test the random-effects (vs. pooled OLS), heteroscedasticity, and autocorrelation in panel regression models. The test statistics reject the null hypothesis for the estimated baseline regression models (1-5).

Table 6.
Cross-Sectional Dependence Test

This table presents estimates of the cross-sectional dependence test of Pesaran (2015). *** denote the rejection of null about parameters at 1% significance level. The variables are as defined in Table 3.

Variable	CD
CM	10.43***
MCM	10.26***
Size	48.06***
INF	38.95***
ERV	39.95***
TO	47.73***
Quality	48.01***
MII	43.82***
Ka_open	40.96***
Peg	05.94***
FC	05.46***
DTI	04.99***
INFV	34.13***
POP	48.06***
EXP	45.31***
Regime	46.38***
LD	48.06***
M2	45.64***
OSIN	41.67***
DI	42.02***

The fixed-effect and random-effect estimators are consistent, but the estimated standard errors are biased in the presence of cross-sectional dependence, heteroscedasticity, and serial correlation (Table 7). Therefore, we estimate the panel regression models with Driscoll and Kraay (1998) standard errors[6], which are robust in the presence of a serial correlation, heteroscedasticity, and cross-

[6] Estimation of the standard errors with Newy and West or cluster–robust standard errors instead Driscoll and Kraay (1998) are not relevant in the presence of cross-sectional dependence because the correlations across panels of cross-sections take non-zero values.

sectional dependence. Further, these estimates are suitable for short panel data models, where *N* is large and *T* is small. Finally, the results of the Sargan-Hansen and Hausman specification statistics reject the random-effects in favor of the fixed-effect models.

Table 7.
Model Specification Tests

This table presents model specification test statistics and regression diagnostic checks such as random-effects, heteroscedasticity, and autocorrelation. The Breusch-Pagan Lagrangian multiplier (1980) test is suitable for random-effects vs. pooled OLS regression.

Tests	Model 1	Model 2	Model 3	Model 4	Model 5
Breusch-Pagan LM	497.23***	310.71***	303.87***	203.35***	266.60***
Modified Wald	6444.64***	5004.30***	2140.46***	1526.69***	1546.82***
Wooldridge Autocorrelation	26.09***	21.85***	32.09***	21.74***	13.62***

V. RESULTS AND DISCUSSION

A. Baseline Regression Results

We present estimates of the baseline regression (i.e. Eq. 4) in Table 8. In the first model (i.e. column 2), we examine whether the currency mismatches are associated with high inflation, exchange rate volatility, trade openness, institutional quality, monetary independence, and country size. We find a positive relationship between currency mismatch and country size. The result shows that large EMEs (in terms of GDP) hold liability position in foreign currencies. This finding contrasts the one documented by Lane and Milesi-Ferrentti (2001), Hausmann and Panizza (2003), and Eichengreen et al. (2007).

A stronger monetary policy framework can lower the incentives to borrow in foreign currencies and reduce the currency mismatch problem. Thus, lower inflation that results from stronger monetary policy is associated with the greater use of domestic currency debts. The results suggest a positive and statistically significant effect of inflation on currency mismatches. This positive association is consistent with the idea that countries with higher inflation have a greater tendency to issue FCD, which causes currency mismatch problem. The association between currency mismatch and trade openness is negative and significant in the fifth model (column 6). This evidence suggests that a country with high imports and exports has a low currency mismatch problem. For instance, high trade openness increases foreign currency earnings and reduces the liability position in foreign currency. Moreover, more open countries (in terms of trade) have better access to foreign currency assets and international financial markets compared to closed countries.

We also investigate the role of institutional and policy factors in the currency mismatch problem. High-quality institutions can provide the appropriate microeconomic incentives, pursue good macroeconomic and exchange rate policies, and nurture confidence in the economy (Goldstein and Turner, 2004). We expect that EMEs with better institutions can control currency mismatches. To test this argument, we employ the institutional quality index developed by the PRS Group. The index is the sum of 12 indicators, namely government stability,

socio-economic conditions, and others.[7] The index vary from zero to 100; higher value implies better quality institutions in the country. We find strong evidence that institutional factors are relevant determinants of currency mismatches. Specifically, the results indicate that a country with high-quality institutions can issue debts in its own currency and, thus, limit the currency mismatch problem. Therefore, Asian economies with high-quality institutions are associated with low levels of currency mismatches. This finding supports the theoretical prediction and refutes Baek's (2013) finding that good institutional quality aggravates the FCD and currency mismatches in EMEs.

One of the critical contributions of our study is to analyze the impact of monetary independence on currency mismatches. Bianchi and Mondragon (2018) argue that the lack of monetary independence in EMEs aggravates the sovereign debt crisis and increases their vulnerability to roll over debt crisis. Therefore, we examine the association between currency mismatches and monetary independence in EMEs. We use the index of monetary independence developed by Aizenman et al. (2013). The index is "the reciprocal of annual correlation between monthly interest rates of the home country and the base country." The estimated coefficient on monetary independence is negative and significant, which implies that lack of monetary independence in EMEs aggravates the currency mismatch problem. However, this effect is insignificant after adding the other explanatory variables in the model (3) and (5). This result is driven by an association between interest rates and choice of exchange rate regimes.

In the second model, we include the capital openness index (Chinn and Ito, 2006), exchange rate pegs (Ilzetzki et al., 2018), the macroprudential policy indices developed by Cerutti et al. (2017), and inflation volatility to examine whether these factors cause the currency mismatches in EMEs. The index of capital openness measures the country's degree of capital account openness. *Ka_open* is a binary dummy variable and denotes the tabulation of restrictions on cross-border financial transactions reported in IMF. The coefficient of *Ka_open* is positive, implying a higher degree of currency mismatch problem for financially liberalized countries. The greater financial openness increases the volatility in all levels of investment, such as FDI, portfolio investment, and loans, in EDEs. Therefore, countries pursuing capital account liberalization hold more foreign currency debt because of better access to loans. This finding supports the work of Barajas and Morales (2003) on the dollarization of liabilities in Latin America.

In fixed exchange rate regimes, low incentives to hedge foreign currency risk create currency mismatches in EMEs. Dell'Ariccia et al. (2012) argue that countries with fixed exchange rate regimes do not have an effective monetary policy instrument and have limited scope for supervising foreign currency exposure. In model (2), we find the coefficient of the *peg* positive but statistically insignificant, meaning that there is no strong evidence on the effect of pegged exchange rate regimes on currency mismatches. In model (3), we examine whether the choice of exchange regimes affects currency mismatches by employing an index prepared by Ilzetzki et al. (2018). The index is based on coarse classification from pegged to a more flexible exchange rate regime, and its values lie between one and six. We find

[7] See Howell (2011) for the discussion on the methodology.

that economies with flexible exchange rate policies reduce the currency mismatch problem. This evidence is in line with that of Goldstein and Turner (2004) and Baek (2013).

Recently, macroprudential measures are assuming importance as the best policy to mitigate external shocks and systemic risks. Unlike the existing literature, this study empirically tests the role of macroprudential policy in controlling currency mismatches. We include two instruments of prudential policies in baseline regression—limits on foreign currency loans (*FC*) and debt to income ratio (*DTI*). These are binary variables, which take one for a country with limits on the *FC* and *DTI*, and zero otherwise. Cerutti et al. (2017) find limits on *FC* and *DTI* reduce the vulnerability to foreign currency risk and household indebtedness.

Our estimates confirm that greater limitations on foreign currency loans and debt-income ratio reduce the net liability position in foreign currencies. The coefficient on *DTI* is economically and statistically significant across all models. Moreover, *FC* is inversely associated with currency mismatches, and only significant in fifth model (column 6). The limits on *FC* loans reduce countries' vulnerability to foreign currency risk. Similarly, enforcing the constraints on household debt to income ratios lower their indebtedness. These results are in line with Dell'Ariccia et al. (2012), who found a significant impact of macroprudential policy instruments on credit booms in Central and Eastern European countries.

In model (3), we use alternative proxies to check the robustness of the baseline results. The results are significant and in line with the models (1) and (2). In model (4), we control for the levels of economic and the financial development measured by GDP per capita and broad money supply (*M2*), respectively.[8] We find a negative association between the level of economic development and currency mismatches. This finding suggests that well-developed EMEs can control currency mismatches. Although the coefficient of *M2* is statistically insignificant, it is negative and may indicate that high liquid assets is associated with low currency mismatches. This appears to be consistent with Goldstein and Turner (2004), who argue that the development of the domestic bond market plays a vital role in limiting currency mismatches in EMEs.

Finally, we examine whether the debt-related variables, namely the original sin and debt intolerance, in the baseline model (5) determine the level of currency mismatches. In this model, we exclude the levels of economic and financial development because they may be plausibly correlated with the original sin. The estimates show a positive association of the original sin index with currency mismatches, implying that the greater the FCD, the higher the original sin, and, in turn, the severe the problem of currency mismatches. This finding supports the view of Tobal (2018).

The relationship between external debt levels and sovereign risks are documented in Reinhart et al. (2003) and Reinhart and Rogoff (2011). We find the coefficient of debt intolerance negative and significant suggesting that the share of total external debt in GDP determines the extent of currency mismatch. This evidence indicates that high debt intolerant economies are not even able to access

[8] We use broad money supply (M2) as a proxy for financial development, consistent with Goldstein and Turner (2004), and Baek (2013).

loans in foreign currencies. Therefore, they do not have the liability position in foreign currencies. Earlier, Reinhart et al. (2003) argue that the consequence of debt intolerance results in slower growth and higher macroeconomic volatility. However, "constrained access to international capital markets is best viewed as a symptom, not a cause, of the disease."

B. Robustness Tests and Endogeneity Issues

First, we use alternative covariates of the benchmark regression to evaluate the robustness of our findings. Second, we repeat the econometric analysis with a modified currency mismatch measure. Third, we address potential endogeneity problem.

We further investigate the issue by including variables, such as $POP_{i,t}$, $INFV_{i,t}$, $EXP_{i,t}$, and $Regime_{i,t}$, to assess the effect of country *size*, inflation, trade openness, and exchange rate regimes, respectively, on currency mismatches. $POP_{i,t}$, $INFV_{i,t}$,$EXP_{i,t}$, and $Regime_{i,t}$, denote population, inflation volatility, exports and exchange rate regimes, respectively. The results presented in Table 8 confirm that large EMEs (in terms of the population) have a currency mismatch problem.

Table 8.
Baseline Regression Results

The table shows the estimates (fixed effect) of the baseline regression Eq. (4). The Driscoll-Kraay standard errors are in parentheses. The statistical significance levels are denoted as *** $p<0.01$, ** $p<0.05$, * $p<0.1$. The dependent variable is the currency mismatch. The variables definition and data sources presented in Table 3.

Currency Mismatch	(1)	(2)	(3)	(4)	(5)
Size	3.977***	4.240**		36.056***	5.505***
	(0.808)	(1.385)		(6.152)	(1.293)
INF	0.348**			0.303**	0.256*
	(0.116)			(0.111)	(0.116)
ERV	0.129***	0.115***	0.093***	0.127***	0.112**
	(0.027)	(0.027)	(0.025)	(0.029)	(0.037)
TO	-0.046	-0.069		-0.043	-0.071**
	(0.027)	(0.042)		(0.033)	(0.023)
Quality	-0.199***	-0.383***	-0.391***	-0.140	-0.316***
	(0.039)	(0.023)	(0.043)	(0.105)	(0.054)
MII	-3.385**	-1.546*	-0.890	-1.406*	1.612
	(1.126)	(0.743)	(0.510)	(0.717)	(2.232)
Ka_open		0.924	1.503	3.606*	1.975
		(1.946)	(1.367)	(1.717)	(1.780)
Peg		0.956		-1.518	-3.164*
		(1.106)		(1.057)	(1.480)
FC		-2.352	-2.162	-1.294	-2.513**
		(1.353)	(1.209)	(1.217)	(1.010)
DTI		-3.020**	-3.183**	-3.712**	-2.595*
		(1.005)	(1.092)	(1.305)	(1.273)
INFV		0.594***	0.621**		
		(0.144)	(0.218)		

Table 8.
Baseline Regression Results (Continued)

Currency Mismatch	(1)	(2)	(3)	(4)	(5)
POP			17.328***		
			(2.109)		
EXP			-0.122**		
			(0.039)		
Regime			-1.254*		
			(0.664)		
LD				-34.003***	
				(6.967)	
M2				-0.017	
				(0.030)	
OSIN					7.465***
					(1.643)
DI					-0.078*
					(0.042)
Constant	-41.559***	-30.235	-42.904***	-159.947***	-54.022**
	(11.542)	(20.925)	(10.654)	(24.331)	(22.563)
Observations	220	200	200	210	190
Number of countries	22	20	20	21	19
Hausman test	10.50	474.47***	19.34**	94.94***	200.20***
Sargan-Hansen statistic	20.06***	54.42***	78.68***	87.04***	33.07***
R-squared	0.173	0.272	0.268	0.292	0.349

We find that inflation volatility has a positive association with currency mismatches in the model (2) and (3). This finding is consistent with earlier studies, including Baek (2013), Lane and Shambaugh (2010b), and Benetrix et al. (2015). In terms of the currency risk, measured by the exchange rate volatility, we find a link between volatility in the bilateral exchange rate and liability position in foreign currencies. Exchange rate volatility accounts for both currency risk and domestic instability. Exchange rate volatility has a positive coefficient and statistically significant in all models. This supports the view that currency risk can raise foreign currency debt and raise the liability position in foreign currencies. As an alternative measure of trade openness, we include exports, and the estimates are identical to those of the benchmark. The results confirm a negative and significant relationship between currency mismatch and exports.

The currency mismatch ($CM_{i,t}$) method assumes that domestic bank loans and bonds are denominated in domestic currencies. Nevertheless, few country's private bank loans and bonds are issued in foreign currencies. Therefore, we include "the share of foreign currency in domestic bank loans to the private sector, and the share of exchange rate linked instruments in domestic public debt" in the modified version of currency mismatch index following Goldstein and Turner (2004). As expected, the inclusion of these two instruments increases the share of foreign currency in total debt and the size of currency mismatch in our sample.

To examine the robustness of the estimates to this modification, we re-estimate Eq. (4) using an alternative version of currency mismatch ($MCM_{i,t}$) as the dependent variable. We present the same set of model specifications and regressors as in the benchmark models in Table 9. The modification of the assumption slightly changes the statistical significance of the regressors, although the results are qualitatively similar to the benchmark estimates. The coefficient of monetary independence is significant in model (1). In contrast, we fail to find the significant effect of capital openness and pegged exchange rate on the modified currency mismatch measure, but the coefficient on the flexible exchange rate regime index is significant in model (3).

Table 9.
Modified Currency Mismatch: Robustness Checks

This table presents the estimates of robustness tests. We re-estimate Eq. (4) using an alternative version of currency mismatch ($MCM_{i,t}$). We include "the share of foreign currency in domestic bank loans to the private sector and the share of exchange rate linked instruments in domestic public debt" in the modified version of currency mismatch. The Driscoll-Kraay standard errors are in parentheses. The statistical significance levels are denoted as *** p<0.01, ** p<0.05, * p<0.1. The variables definition and data sources presented in Table 3.

Modified Currency Mismatch	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Size	8.357***	8.533***		52.956***	9.481***
	(0.833)	(1.795)		(7.109)	(1.314)
INF	0.602***			0.579**	0.528**
	(0.181)			(0.209)	(0.215)
ERV	0.215***	0.206***	0.144**	0.215***	0.165**
	(0.053)	(0.059)	(0.053)	(0.054)	(0.063)
TO	-0.036	-0.110		-0.082	-0.111**
	(0.041)	(0.061)		(0.050)	(0.037)
Quality	-0.132***	-0.430***	-0.520***	-0.146	-0.459***
	(0.034)	(0.048)	(0.050)	(0.117)	(0.086)
MII	-6.965***	-2.834	-1.259	-2.247	2.987
	(1.078)	(1.916)	(1.412)	(1.651)	(2.867)
Ka_open		0.147	1.601	4.899	1.331
		(3.971)	(2.717)	(2.946)	(3.585)
Peg		3.196		-0.393	-3.706
		(1.935)		(1.485)	(2.287)
FC		-4.041*	-3.799*	-2.025	-4.143**
		(2.112)	(1.867)	(1.916)	(1.478)
DTI		-3.757*	-3.957*	-4.541**	-5.205*
		(1.837)	(1.979)	(1.833)	(2.449)
INFV		0.808***	0.933**		
		(0.222)	(0.340)		
POP			31.555***		
			(5.582)		
EXP			-0.248**		
			(0.082)		
Regime			-3.550**		
			(1.174)		

Table 9.
Modified Currency Mismatch: Robustness Checks (Continued)

Modified Currency Mismatch	(1)	(2)	(3)	(4)	(5)
LD				-46.512***	
				(8.067)	
M2				-0.092*	
				(0.048)	
OSIN					12.743***
					(2.484)
DI					-0.164**
					(0.067)
Constant	-107.448***	-83.243**	-84.780**	-265.609***	-97.332***
	(14.131)	(29.076)	(28.378)	(26.307)	(25.423)
Observations	220	200	200	210	190
Number of countries	22	20	20	21	19
Sargan-Hansen statistic	26.67***	37.49***	36.97***	71.34***	29.47***
Hausman test	21.42***	51.19***	117.61***	246.66***	127.29***
R-squared	0.167	0.255	0.284	0.291	0.404

To address endogeneity, we re-estimate all benchmark specifications using one-year lagged values of all country-specific factors except country size as instruments, following prior studies (Baek, 2013; Park and Mercado, 2014; Gadanecz et al., 2018). Tables 10 and 11 report the estimates; the tables confirm the robustness of our estimates. When explanatory variables are lagged by one-year, the sign and significance of coefficients remain broadly unchanged. Nonetheless, the coefficients of the lagged peg exchange rate, limits on foreign currency loans, inflation volatility, and the level of economic development become statistically insignificant in all specifications.

Table 10.
Endogeneity Check: Baseline Regression Results

This table shows the findings of baseline regression models with lagged explanatory variables. To avoid endogeneity, we re-estimate all benchmark specifications using one-year lagged values of all country-specific factors except variable country size as instruments to correct for the possible endogeneity. The Driscoll-Kraay standard errors are in parentheses. The statistical significance levels are denoted as *** p<0.01, ** p<0.05, * p<0.1. The variables are as defined in Table 3. The variables definition and data sources presented in Table 3.

Currency mismatch	(1)	(2)	(3)	(4)	(5)
Size	5.749***	4.261***		9.983***	8.179***
	(0.884)	(1.238)		(2.944)	(0.708)
INF_1	0.445**			0.444*	0.363*
	(0.173)			(0.216)	(0.190)
ERV_1	0.153***	0.147***	0.109***	0.151***	0.151***
	(0.032)	(0.031)	(0.024)	(0.024)	(0.027)
TO_1	-0.028	-0.042		-0.043	-0.047*
	(0.020)	(0.038)		(0.033)	(0.023)
Quality_1	-0.177***	-0.297***	-0.328***	-0.239***	-0.278***
	(0.046)	(0.050)	(0.055)	(0.042)	(0.075)

Table 10.
Endogeneity Check: Baseline Regression Results (Continued)

Currency mismatch	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
MII_1	-4.471***	-1.654**	-0.594	-2.806***	0.144
	(0.567)	(0.624)	(0.656)	(0.812)	(0.551)
Ka_open_1		2.736	2.615	3.922**	2.423**
		(2.030)	(1.457)	(1.615)	(1.051)
Peg_1		0.978		0.117	-2.090
		(1.979)		(1.692)	(1.620)
FC_1		-1.842	-1.698	-1.341	-1.246
		(1.049)	(0.995)	(1.233)	(1.411)
DTI_1		-3.956***	-4.110**	-3.641***	-3.548***
		(1.143)	(1.266)	(0.731)	(0.922)
INFV_1		0.184	0.389		
		(0.211)	(0.246)		
POP			17.473***		
			(2.701)		
EXP_1			-0.096*		
			(0.042)		
Regime_1			-1.828*		
			(0.948)		
LD_1				-3.923	
				(2.749)	
M2_1				0.012	
				(0.041)	
OSIN_1					9.124***
					(1.276)
DI_1					-0.088***
					(0.022)
Constant	-68.083***	-38.618*	-47.379***	-85.312***	-95.861***
	(11.365)	(20.041)	(11.495)	(16.043)	(12.042)
Observations	220	200	200	210	190
Number of countries	22	20	20	21	19
Sargan-Hansen statistic	27.62***	54.40***	59.44***	139.43***	86.99***
Hausman test	10.04	23.88***	50.48***	46.85***	44.35***
R-squared	0.239	0.249	0.281	0.312	0.412

Table 11.
Endogeneity Check: Modified Currency Mismatch

This table shows the findings of modified currency mismatch regression with lagged explanatory variables. To avoid endogeneity, we re-estimate all benchmark specifications using one-year lagged values of all country-specific factors except variable country size as instruments to correct for the possible endogeneity. The Driscoll-Kraay standard errors are in parentheses. The statistical significance levels are denoted as *** p<0.01, ** p<0.05, * p<0.1. The variables definition and data sources presented in Table 3.

Modified Currency Mismatch	(1)	(2)	(3)	(4)	(5)
Size	10.783***	8.558***		17.809***	12.995***
	(1.712)	(2.194)		(4.546)	(1.140)
INF_1	0.685**			0.714**	0.571**
	(0.214)			(0.302)	(0.250)
ERV_1	0.240***	0.235***	0.158***	0.238***	0.208***
	(0.058)	(0.044)	(0.038)	(0.042)	(0.037)
TO_1	-0.030	-0.083		-0.086	-0.085*
	(0.033)	(0.068)		(0.059)	(0.045)
Quality_1	-0.076	-0.278**	-0.348***	-0.213**	-0.436***
	(0.066)	(0.101)	(0.087)	(0.075)	(0.125)
MII_1	-8.565***	-2.299	-01	-3.919*	1.786
	(1.874)	(1.805)	(1.313)	(2.091)	(1.259)
Ka_open_1		4.599	4.243	6.625*	2.436
		(4.527)	(3.406)	(3.181)	(2.999)
Peg_1		3.008		1.819	-2.523
		(2.797)		(1.955)	(1.659)
FC_1		-2.737	-2.419*	-1.840	-1.867
		(1.712)	(1.267)	(1.922)	(2.169)
DTI_1		-6.002**	-6.230**	-5.475**	-6.914**
		(2.370)	(2.588)	(1.701)	(2.277)
INFV_1		0.216	0.635		
		(0.331)	(0.361)		
POP			35.715***		
			(4.968)		
EXP_1			-0.172**		
			(0.062)		
Regime_1			-4.067***		
			(1.216)		
LD_1				-6.314	
				(4.830)	
M2_1				04	
				(0.056)	
OSIN_1					15.028***
					(3.150)
DI_1					-0.216***
					(0.045)
Constant	-143.678***	-97.065**	-116.154***	-170.164***	-148.532***
	(25.144)	(34.813)	(25.712)	(23.691)	(18.034)
Observations	220	200	200	210	190
Number of countries	22	20	20	21	19
Sargan-Hansen statistic	36.07***	31.28***	32.27***	214.90***	74.33***
Hausman test	6.80	10.41	418.52***	228.60***	144.82***
R-squared	0.200	0.231	0.290	0.300	0.481

VI. CONCLUSION AND POLICY IMPLICATIONS

We measure the original sin and currency mismatches in 22 EMEs for the period of 2008 to 2017. We find that Latin American economies have greater original sin problem than other economies. We identify weaknesses in domestic macroeconomic policy and institutions as the primary factors causing currency mismatches. Our empirical results confirm that fiscal and monetary policy factors are critical to control currency mismatches. In our panel regression analysis, we find that global and country-specific characteristics, such as country size, trade openness, and the levels of economic and financial development, explain the cross-country variation in currency mismatches.

Our findings suggest that EMEs can make significant progress in reducing their net liability positions in foreign currencies by pursuing monetary independence and by following stable monetary and fiscal policies. Unlike the original sin hypothesis, our results prove that the floating exchange rate policy is a necessary condition to limiting currency mismatches in EMEs. Our empirical results suggest that EMEs should create a better institutional environment to reduce currency mismatches. Such a quality environment will also contribute to macroeconomic stability and to the development of the domestic bond market. Moreover, the empirical analysis suggests that effective macroprudential policy measures can curb currency mismatches. Therefore, EMEs should introduce further limits on foreign currency loans and debt to income ratios to reduce systemic risk and currency mismatches.

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Appendix

A1. Model Specification and Expected Outcome.

We extend the baseline regression (Eq. 4) by incorporating the following variables. $Peg_{i,t}$ - the dummy variable which takes the value of one for the countries following peg exchange rate regime (Ilzetzki et al., 2018); the macroprudential policy indicators - limits on foreign currency loans and limits on debt to income ratio are denoted as ($FC_{i,t}$) and ($DTI_{i,t}$). $LD_{i,t}$, and $M2_{i,t}$ are the GDP per capita in log levels and broad money supply as a percentage of GDP respectively; We include additional variables such as original sin hypothesis ($OSIN_{i,t}$) and debt intolerance ($DI_{i,t}$) in regression.

Based on the theoretical literature, the expected relationships are as follows. Country size is the global factor or important control variable of currency mismatch, and its sign of the coefficient is ambiguous. The large size countries in terms of either GDP or total population may lower the FCTD, and hence they reduce the currency mismatches. However, large size countries also issue more foreign currency debt leading to a net liability position in foreign currency (Benetrix et al., 2015). The sign of the coefficient on inflation is expected to be positive, implying higher currency mismatches or perceived currency risk due to the greater level of inflation (Reinhart et al., 2003; Goldstein and Turner, 2004; Baek, 2013).

The expected sign of exchange rate volatility is positive. The exchange rate volatility can raise the value of foreign currency debt and increases the liability position in foreign currency (Baek, 2013). Further, economies with a higher degree of trade openness have better access to foreign currency assets and international financial markets than the closed economies (Eichengreen et al., 2005b; Baek, 2013). Therefore, the expected association between currency mismatch and trade openness is negative. The institutional quality and monetary independence aggravate the currency mismatches because a country with better institutional quality lowers the FCD and increases the share of domestic currency in foreign debt (Lane and Shambaugh, 2010b).

In EMEs, financial openness increases the volatility in all levels of investment, such as FDI, portfolio investment, and loans. Thus, countries with an open capital account hold debt in foreign currency, which increases the currency mismatches (Barajas and Morales, 2003; Park and An, 2012). Therefore, we expect a positive sign of the coefficient. Further, the effect of the exchange rate regime on currency mismatches is ambiguous –the floating exchange rate regime entails the hedging facility and lowers the currency risk but increases the currency risk through the inflationary economy (Martínez and Werner, 2002; Hausmann and Panizza, 2003).

The macroprudential policies are designed to limit the external shocks and systemic risks, which are frequently used in EMEs. Thus, we expect a drop in the currency mismatches with better policy measures. Countries with a high level of development and financial development are expected to have lower currency mismatches. Finally, the original sin hypothesis and debt intolerance have a positive and negative influence on currency mismatches, respectively (Eichengreen et al., 2005b; Reinhart et al., 2003).

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