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CURRENCY DEPRECIATIONS IN EMERGING ECONOMIES: A BLESSING OR A CURSE FOR EXTERNAL DEBT MANAGEMENT?

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Currency Depreciations in Emerging Economies: A Blessing or a Curse for External Debt Management?

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Abstract:
We investigate the long-term effect of domestic currency depreciation on the external debt for a panel of 41 emerging economies over the years 1999-2019. Using heterogenous panel cointegration methods, we find that domestic currency depreciation leads to an increase in external debt to GDP ratio over the long-term and it reduces the sustainability of external debt. This is particularly the case for larger depreciations, while smaller depreciations might reduce the external debt burden over the long-term for more developed emerging economies. Poorer emerging economies face a greater increase in external debt burden following domestic currency depreciation. We also find that higher exchange rate volatility and the use of floating exchange rates contributes to an increase in external debt burden over the long-term. Consequently, our results suggest that for emerging economies, having more volatile and floating exchange rates reduces the sustainability of external debt. We find asymmetrical effects of exchange rate depreciation on external debt: higher central bank independence limits the effect of currency depreciation on external debt, while higher financial development and illicit financial flows augment the effect of depreciation on external debt.

JEL: E50, F31, F34
Keywords: external debt, exchange rate, currency depreciation, exchange rate volatility, exchange rate regime, DFE estimator, PMG estimator

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1 Introduction

Depreciated or undervalued currency has often been attributed to economic miracles of countries such as West Germany and Japan in the post-war era, or China and other East Asian countries over the past three decades (Dooley et al., 2004). To that end, predominantly during the 1980s and 1990s, the International Monetary Fund (IMF) had been advocating nominal depreciation for developing countries in order for them to 'buy' international competitiveness. Nonetheless, empirical studies studying the effectiveness of domestic currency depreciation in stimulating the economic growth often reach conflicting conclusions (Acevedo et al., 2015; Habib et al., 2017; Hausmann et al., 2005; Nouira and Sekkat, 2012). Therefore, the policy dilemma regarding the macroeconomic ramifications of domestic currency depreciation is far from resolved. While domestic currency depreciation, assuming that the conventional Marshall-Learner criteria are met, provides some macroeconomic payoffs by enhancing net exports and increasing output, there is also a fairly high level of risk associated with the increase of the level of foreign currency-denominated debt and domestic inflation. As argued in Bernoth and Herwatz (2019), domestic currency depreciation might have negative wealth effects and it might also increase the sovereign risk. Consequently, the overall impact of depreciation depends on whether the 'foreign exchange channel' of depreciation dominates over 'the net export channel'. Since the foreign exchange channel is likely to be particularly important in emerging economies, which are characterized by their high level of foreign-currency debt, it remains unclear whether and to what extent the depreciation of domestic currency might be an efficient tool of stimulating the convergence process in today's emerging economies.

The dynamics of external debt resulting from changes in the exchange rate of the domestic currency, as well as the associated exchange rate volatility have long been at the forefront of interest for economists, financial analysts and policymakers, theoretical and methodological controversies notwithstanding. As such, the issue of emerging countries relying on foreign currency-denominated debt, which refers to the debt a country incurs by borrowing in a foreign currency, has been described as the phenomenon of 'Original sin' (Eichengreen and Hausmann, 1999; Eichengreen et al., 2007). The 'Original sin' refers to the inability of a government to secure loans abroad in its own local currency. The central distinction between foreign currency-denominated debt and domestic currency-denominated debt is that the former is substantially exposed to a high risk resulting from swings in the exchange rate of the domestic currency. As a result, a depreciation of domestic currency will increase the domestic currency value of foreign currency-denominated debt (i.e., valuation effect), leading to an increase in external debt burden, as well as the external debt service. Since the financial markets in emerging economies are relatively underdeveloped, this increase in external debt burden may force the emerging economies to borrow more abroad to repay the older foreign-currency denominated debt – leading to an even greater increase in external debt, which could contribute to an increase in borrowing costs, which could then in turn further undermine the sustainability of external debt. Therefore, the increase in external debt due to domestic currency depreciation might not just be a temporary phenomenon, reversed by a subsequent domestic currency appreciation,

but it may have a more long-term character.

Additionally, apart from effects of changes of the exchange rate, the potential detrimental macroeconomic consequences of exchange rate volatility have also attracted attention from several prior studies (Aghion et al., 2007; Huchet-Bourdon and Korinek, 2011; Schnabl, 2007). However, the effect of exchange rate volatility on external debt remains, to the best of our knowledge, as yet unexplored. Nevertheless, from a policy perspective, this is an important issue because exchange rate volatility makes it harder to predict the sustainability of external debt and thus increases the likelihood of sovereign debt crisis. This is particularly important in the context of emerging and developing countries with remarkable degree of dependency on foreign currency-denominated debt as their domestic currencies are largely non-convertible to other currencies and are hence subject to the phenomenon of 'Original Sin' and subsequent debt crises resulting from high exchange rate volatility. Furthermore, Hausmann et al. (2006) found that the exchange rate volatility in emerging countries was three times higher than in advanced economies. Moreover, higher volatility of the domestic currency might also lead to an increase in borrowing costs – as foreign lenders perceive the economy in question as more risky, leading to a further increase in the likelihood of a debt crisis. In this regard, there is a large body of literature, which examines the impact of debt crisis on economic growth resulting from debt overhang, crowding out effects and uncertainties, which all combined together turn debt sustainability into challenging task to accomplish (Borensztein and Panizza, 2008; Carrera and Vergara, 2012; Krugman, 1988; Reinhart and Rogoff, 2010; Sachs, 1986).

The objective of this study is to examine whether and to what extent the depreciation of domestic currency and its volatility could influence the level of external debt and its sustainability over the long-term in the case of a panel of emerging economies. That is, we do not aim to study just the short-term valuation effect of exchange rate depreciation on external debt, which might be reversed by a subsequent appreciation, but we instead aim to investigate, whether the depreciation of domestic currency might have a more long-term effect on the sustainability of the country's external debt. Debt sustainability is generally understood as a situation in which the ratio of debt to GDP ratio is stationary (Bohn, 1991; Carrera and Vergara, 2012). Then, the external debt is deemed sustainable if the external debt to GDP ratio is mean-reverting over the medium- and long-term (Lukkezen and Rojas-Romagosa, 2013). This is the approach that we follow in this paper, as we equate the long-term increase in external debt to GDP ratio with a decrease in external debt sustainability.

While there is a rich body of empirical and theoretical literature, which studied the effects of exchange rate on external debt, our study extends the existing findings by i) using the most recent data for a relatively broad set of emerging economies, ii) focusing specifically on the long-run relationship between the exchange rate and the external debt relying on panel cointegration methods, iii) investigating the effect of exchange rate volatility on external debt, iv) considering the heterogeneity in the long-term responses of external debt to exchange rate on several country-level characteristics, including the exchange rate regime, central bank independence and capital flows, and v) studying the asymmetrical long-term effects of domestic

currency depreciation on external debt.

We find robust evidence that the depreciation of the domestic currency leads to an increase in external debt over the long-term and thus, the depreciation undermines the external debt sustainability. However, our results for the entire panel of emerging economies indicate that only larger depreciations of domestic currency, with the rate of depreciation exceeding 15 %, lead to a long-term increase in external debt to GDP ratio. Smaller depreciations might actually reduce the external debt to GDP ratio slightly, presumably owing to improved economic performance due to higher international competitiveness associated with weaker domestic currency. However, only more developed of the emerging economies from our sample exhibited a long-run decrease in external debt to GDP ratio following small depreciations – the poorer of the emerging economies in our sample experienced a long-term increase in the external debt to GDP ratio even at lower rates of domestic currency depreciation and consequently, they do not seem to have benefited from weaker domestic currency at all. While the effect of depreciation on external debt sustainability seems to be relatively small on average, we find that higher exchange rate volatility and use of the (more volatile) floating exchange rate regimes seem to lead to a more substantial long-term increase in external debt. Therefore, we find some evidence that in poorer emerging economies with more volatile floating exchange rates, the depreciation of domestic currency may lead to a more significant increase in external debt over the long-term. Finally, we find robust evidence that higher degree of central bank independence limits the long-term increase of external debt following a depreciation of domestic currency, while higher susceptibility to the issue of illicit capital flows enhances the long-term increase. Consequently, we find that the degree of central bank independence and illicit capital flows might play an important role in external debt management.

The remainder of the paper is organized as follows. Section 2 outlines the most relevant previous theoretical and empirical studies. Section 3 discusses our empirical approach followed by Section 4, which presents our dataset. Section 5 reports the results and Section 6 summarizes the policy implications of this study and open issues for further research.

2 Literature Review

The existence of only a few internationally competitive currencies in the contemporary global monetary order and the dominant role they play in international transactions and external debt financing have posed various challenges to developing and emerging economies. In such an asymmetric international monetary arrangement, developing and emerging economies have been constrained by numerous challenges, including but not limited to higher proportion of their external debt denominated in foreign currencies(Faudot and Ponsot, 2016). Unlike advanced economies with large and highly liquid financial markets and internationally convertible currencies, which are able to issue external debt in domestic currencies, developing and emerging economies with their thin and often illiquid financial markets are doomed to borrow overseas predominantly in foreign currencies (Miller, 1997). Even though there was slight shift in recent years towards issuing foreign debt denominated in domestic currencies (Dell'Erba et al., 2013).

There are generally two fundamental questions addressed by the contemporary literature regarding the issue of external debt or the 'Original sin'. First, what motivates emerging economies to borrow overseas in a foreign currency? Second, what are the broader macroeconomic ramifications of the phenomenon of original sin on external debt sustainability? The literature around development economics emphasizes the demand for external debt denominated in a foreign currency to be associated with the well-known three-gap models (saving-investment gap, fiscal gap and foreign-exchange gap). In the absence of the saving, investment and fiscal gaps, an emerging or developing economy would still be under pressure to issue external debt denominated in a foreign currency in order to match the foreign-exchange gap mainly due to the inconvertibility of its domestic currency (Bacha, 1990). Other studies emphasize the lack of monetary and fiscal discipline (Corsetti and Mackowiak, 2004; Jeanne, 2003) and less credible monetary policy (Engel and Park, 2018) as drivers of demand for external debt that is denominated in a foreign currency. The general assumption is that countries with higher level of financial development, institutional strength and monetary credibility are more likely to issue external debt denominated in local currency. Nevertheless, Eichengreen et al. (2004) found rather unconvincing empirical evidence to support the hypothesis that these economies' level of external debt, which is denominated in a foreign currency, is driven by their level of development, institutional quality, and monetary credibility. Their evidence rather indicates that emerging economies are doomed to borrow overseas in a foreign currency due to their difficult initial conditions, inherited from past governments, to which they refer as the 'Mystery of Original Sin' (Eichengreen et al., 2004). This mystery suggests the exogenous monetary policy environment, where governments in the emerging and developing world are positioned predominantly as policy takers and not policy makers (Dell'Erba et al., 2013).

There is also a bulk of literature, which investigates the role of exchange rate depreciation in promoting the export sector and eventually helping the emerging and developing countries to better manage their balance of payments and reduce their external debt burden (Bird and Rajan, 2004; Krueger, 1979; Mehl and Reynaud, 2005; Nunnenkamp and Schweickert, 1990; Tovar, 2006). In this regard, during 1980s and 1990s, many of the developing economies have been under pressure to devalue their domestic currencies and this was in conjunction with the World Bank's adjustment program – with the aid being delivered only to those countries that were willing to devalue their currencies to receive the external aid. These adjustment programs have been largely considered ineffective. This is mainly due to the volume effect[1] following depreciation remaining largely insufficient to compensate for the price effect[2] due to the failure of the Marshall Learner criterion. Hence, while depreciation may have helped those emerging economies to increase the volume of their exports, net export revenues declined, leading to rising demand for external debt. As a result, we argue that the domestic currency depreciation largely resembles a global price discount in the presence of lower price elasticity.

Further studies also emphasize that the type of exchange rate regime has substantial implications for external debt sustainability. While acknowledging the difficulties of prescribing

[1] I.e., an increase in the volume of exports due to weaker domestic currency.
[2] I.e., an increase in prices of imports.

any universal optimal exchange rate regime, such studies argue that the 'credibility-flexibility' trade off of monetary policy objectives determines the size of external debt denominated in a foreign currency (Barajas and Morales, 2003; Bleaney and Ozkan, 2011). Proponents of a fixed exchange regime assert that foreign currency denominated debt can serve as a 'self-discipline mechanism' to those borrowers who cannot be trusted to follow a credible monetary policy (Calvo, 2001). As argued in Calvo (2001), unlike the domestic-currency denominated debt, the governments are unlikely to 'eliminate' the value of foreign-currency denominated debt through domestic currency devaluation/depreciation. Along this line, Eichengreen (1994) argues that a fixed exchange rate regime can enhance excessive foreign exchange borrowing due to its false signalling effect about future exchange rate shifts.

In contrast, others argue that the level of credibility in the direction monetary policy and the resulting uncertainty that emerges are the main drivers of the phenomenon of original sin. As emphasized by Jeanne (2003), the external debt denominated in foreign currency itself is 'dangerous' mainly following large scale depreciation. In this aspect, there is a broader consensus that if emerging or developing economy's external debt is largely denominated in a foreign currency, a flexible exchange regime would lead to a more severe shock in the level of its external debt stock following the depreciation of the currency in which the external debt is denominated (Bleaney and Ozkan, 2007; Honig, 2009; Mehl and Reynaud, 2005). In contrast, others argue that the potential adverse impact of exchange rate volatility on external debt that is denominated in a foreign currency is irrespective of the choice of the exchange rate regime (Cain et al., 2012).

In this regard, based on the data for 87 low-and middle-income countries during the period 1970-2006, Cain et al. (2012) show that in the long-run, GDP, exchange rate and net international reserves are inversely related to the external debt. Likewise, Asonuma (2016) based on 18 sovereign debt default and restructuring episodes during the period 1998-2013, underscores the positive link between real exchange rate depreciation and default decision (debt unsustainability). The rationale is that real depreciation increases the burden of debt service and increases the likelihood of default. Grekou (2018) found that for emerging and developing countries, undervalued domestic currency exerts positive influence on economic growth via the competitiveness channel, but it also reduces growth via foreign currency-denominated debt channel. Finally, Augustine and Kumar (2020) also found evidence for India that domestic currency depreciation leads to both short-term and long-term increase in external debt.

Several empirical papers have also examined the macroeconomic ramifications of exchange rate volatility. Here, Bahmani-Oskooee and Gelan (2018) found on a panel of African countries that the exchange rate volatility affected trade flows only over the short-term. On the other hand, Benhima (2012) found that with increasing level of dollarization, the higher exchange rate volatility reduces the productivity growth.

3 Empirical Methodology

In our empirical framework, we use the panel cointegration methods to investigate the effect of domestic currency depreciation on external debt. We opt for this approach as it is best suited for non-stationary heterogeneous panels with large number of both groups and time series observations. Furthermore, this approach also enables us to study separately the short-term and long-term effects of exchange rate developments on external debt. Therefore, we use the dynamic fixed effects (DFE) estimator of Blackburne and Frank (2007) to estimate the following ARDL model:

$$\begin{aligned}\Delta Debt_{i,t} = \sum_{j=1}^{p-1} \Phi_j \Delta Debt_{i,t-j} + \sum_{j=0}^{q-1} \Pi_j \Delta ER_{i,t-j} + \sum_{j=0}^{r-1} \Theta_j \Delta X_{i,t-j} + \\ \beta_{0,i}(Debt_{i,t-1} - \beta_1 ER_{i,t} - \sum_{j=0}^{u} \beta_j X_{i,t} - \delta_i) + \varepsilon_{i,t}\end{aligned} \tag{1}$$

where $Debt_{i,t}$ represents the external debt of a country i in time t, which we proxy as the ratio of external debt to GDP. ER represents the measure of exchange rate. Finally, X is the vector of control variables, which enables us to control for other factors that may have affected the external debt of the sampled countries during the studied period, while δ_i are the country fixed effects, which enable us to control for the time invariant and unobservable heterogeneity across countries. We opt for the DFE estimator, as it enables us to distinguish the short-term effect (Π_j) and the long-term effect (β_1) of exchange rate movements on external debt. Furthermore, the DFE estimator by restricting the long-term coefficients to be equal assumes that there exists a single long-run relationship between the studied variables across all the panels (i.e., countries). $\beta_{0,i}$ is the coefficient of the error correction term. Furthermore, by clustering standard errors at regional level, we control for the intra-regional correlation in the calculation of standard errors.

Apart from studying the effect of exchange rate on external debt, we also study the effect of exchange rate volatility on external debt. Therefore, we simply replace the measure of exchange rate from equation 1 with a measure of exchange rate volatility:

$$\begin{aligned}\Delta Debt_{i,t} = \sum_{j=1}^{p-1} \Phi_j \Delta Debt_{i,t-j} + \sum_{j=0}^{q-1} \Pi_j \Delta Vol_{i,t-j} + \sum_{j=0}^{r-1} \Theta_j \Delta X_{i,t-j} + \\ \beta_{0,i}(Debt_{i,t-1} - \beta_1 Vol_{i,t} - \sum_{j=0}^{u} \beta_j X_{i,t} - \delta_i) + \varepsilon_{i,t}\end{aligned} \tag{2}$$

where Vol is our measure of exchange rate volatility. In equation 2, our main coefficient of interest is β_1 as this coefficient investigates the long-run effect of higher exchange rate volatility on external debt.

In the next step of our empirical analysis, we investigate the country-level factors that could influence the long-run relationship between the exchange rate and the external debt. As a result, we include interaction terms in the long-run equation, which interact the conditioning country-level factors with our measure of exchange rate:[3]

$$\begin{aligned}\Delta Debt_{i,t} = \sum_{j=1}^{p-1} \Phi_j \Delta Debt_{i,t-j} + \sum_{j=0}^{q-1} \Pi_j \Delta ER_{i,t-j} + \sum_{j=0}^{r-1} \Theta_j \Delta X_{i,t-j} + \\ \beta_{0,i}(Debt_{i,t-1} - \beta_1 ER_{i,t} - \beta_2 Cond_{i,t} - \beta_3 ER_{i,t} * Cond_{i,t} - \sum_{j=0}^{u} \beta_j X_{i,t} - \delta_i) + \varepsilon_{i,t}\end{aligned} \tag{3}$$

where $Cond$ represents a country-level characteristic, which could influence the relationship between the exchange rate and external debt. Therefore, in equation 3, the coefficient β_3 is the coefficient of interest, as this coefficient studies the role of the country-level conditioning factor in affecting the long-run effect of exchange rate on external debt. We study the conditionality of this relationship based on the several country-level characteristics – exchange rate regime, government debt, financial development, central bank independence, financial openness and illicit capital flows.

Finally, as a robustness check, we also re-estimate our baseline regressions with the pooled mean group estimator (PMG) of Pesaran and Smith (1995) and Pesaran et al. (1999):

$$\begin{aligned}\Delta Debt_{i,t} = \sum_{j=1}^{p-1} \Phi_{i,j} \Delta Debt_{i,t-j} + \sum_{j=0}^{q-1} \Pi_{i,j} \Delta ER_{i,t-j} + \sum_{j=0}^{r-1} \Theta_{i,j} \Delta X_{i,t-j} + \\ \beta_{0,i}(Debt_{i,t-1} - \beta_1 ER_{i,t} - \sum_{j=0}^{u} \beta_j X_{i,t} - \mu) + \varepsilon_{i,t}\end{aligned} \tag{4}$$

The PMG estimator, like the DFE estimator enables us to study both the short-run and long-run relationship between the exchange rate and the external debt. However, the PMG estimator does not include the country fixed effects (i.e., it does not allow for panel-specific intercepts). Additionally, the PMG estimator, unlike the DFE estimator, allows the coefficients from the short-run equation and the coefficient of the error correction term to vary across panels. Thus, the PMG estimator assumes that there exists a long-run relationship among the studies variables across all countries, but the short-term deviations from this long-term relationship are allowed to be country-specific.

[3]Such approach was previously used by Leroy and Lucotte (2016), Horvath et al. (2018), and Fisera and Horvath (2021) in the case of the related PMG estimator.

4 Data

We conduct our analysis on an unbalanced panel of emerging economies over the years 1999-2019. The data is at quarterly frequency. At its fullest extent, our dataset includes 63 emerging economies. However, due to the missing data for several of the important control variables, our baseline sample is reduced to 41 emerging economies. The countries included in the sample were identified as emerging based on the IMF's World Economic Outlook (WEO) reports.[4] We report the list of countries included in our analysis in Table A1 in the Appendix.

As our primary dependent variable, we use the ratio of external debt to GDP. The external debt data is taken from the World Bank's Quarterly External Debt Statistics and it is expressed in U.S. dollars. Consequently, our results are not driven by the valuation changes in external debt due to changes of the domestic currency's external debt. The external debt data represents the gross external debt positions at the end of each quarter for all sectors, all maturities, all instruments, and all currencies.[5] We plot the development of the external debt to GDP ratio for the countries in our sample in Figure A1 in the Appendix. The external debt to GDP ratio remained stable until 2010 – rising slowly thereafter.

Our primary explanatory variable is a measure of exchange rate. As our main measure of exchange rate, we use the exchange rate of the domestic currency per U.S. dollar. We opted for this measure, as it enables us to maximize the sample size and additionally, most countries' external debt is predominantly expressed in U.S. dollars. Consequently, this approach further helps us to minimize the changes in external debt caused merely by exchange rate developments. Furthermore, we also use the Nominal Effective Exchange Rate (NEER) as an additional measure of exchange rate because NEER captures the overall development of the exchange rate of the domestic currency vis-?-vis the currencies of the countries' main trade partners. Thus, NEER helps us to control for situations when the domestic currency might have depreciated against the U.S. dollar but appreciated against the currencies of its main trading partner. The data on exchange rates are taken from the IMF.

Several measures of exchange rate volatility had been used by previous empirical studies. In our case, we decided to follow the standard and most widely used approach of measuring exchange rate volatility and we calculated the exchange rate volatility as the moving standard deviation of the first differences of the logarithm of exchange rate.[6] Such approach was used by for instance Clark et al. (2004) and Hondroyiannis et al. (2008).[7] This measure of exchange

[4]Most of the countries in our sample are classified as middle-income economies by the World Bank.

[5]We would have preferred to use the data for only the external debt denominated in foreign currency. However, as for most of the countries in our sample, such data is not available at all or not available for the entire studied period, given the fact that emerging economies issue most of their external debt in foreign currencies, we use the data on overall external debt.

[6]The exchange rate is the domestic currency per U.S. dollar. The moving standard deviation was calculated for 8 quarters. Consequently, our volatility measure captures the short-run volatility.

[7]Sometimes, the exchange rate volatility is also calculated as the difference between predicted and actual exchange rate. However, we could not opt for this approach, as for our sample of developing economies, we lack the data on predicted or forward exchange rates. Another commonly used approach of calculating exchange rate volatility is based on ARCH/GARCH models. However, this approach is based on predicting the exchange rates and predictions of exchange rate are often inaccurate and difficult to make (Clark et al., 2004; Meese and Rogoff, 1983).

rate volatility captures the observed volatility and can be easily calculated for a sample of emerging economies. We plot our calculated measure of exchange rate volatility in Figure A2 in the Appendix. The measure of exchange rate volatility indicates that higher exchange rate volatility occurred during the period of the Global Financial Crisis of 2008-2009 (GFC), but relatively high volatility persisted throughout the most of 2010s. Highest exchange rate volatility was observed for countries with floating exchange rate regimes, while countries with soft peg and hard peg exchange rate regimes experienced comparably lower levels of exchange rate volatility.

Additionally, we saturate all our regressions with several control variables, which should enable us to control for other factors that could have affected the external debt during the studied period. If certain control variables were not available at the quarterly frequency, linear interpolation was used to convert annual data to quarterly frequency. Our selection of control variables is in line with the prior literature (Cain et al., 2012; Grekou, 2018; Soyres et al., 2019; Tiruneh, 2004). The full list of all variables, their definitions and sources can be found in Table A2 in the Appendix, while we report the summary statistics in Table 1. The correlations among the variables are reported in Table A3 in the Appendix. The summary statistics indicate that on average, the external debt for the countries in our sample only equalled some 50 % - though substantial differences exist. Some of the countries in our sample exhibited quite substantial exchange rate depreciations. Overall, at just under 15 % and 40 % of GDP, the government consumption and government debt, respectively, were low by advanced countries' standards. This probably explains the rather low incidence of sovereign debt crises observed for the emerging economies included in our analysis. Nonetheless, these countries exhibit rather low levels of financial development, low rates of private debt and their bonds' yields were on average approximately 3.5 % higher than in the case of advanced economies. The countries in our sample are not very open economies, as the mean imports to GDP ratio is just slightly more than 30 %, they are net recipients of both Official Development Aid (ODA) and Foreign Direct Investments (FDIs), and they exhibit relatively high levels of central bank independence.

Before proceeding with the empirical analysis, we conduct panel unit root tests for the variables included in our regression analysis – since we use the non-stationary heterogeneous panel estimators, the non-stationarity of the variables is an important requirement.[8] We report the results of the unit root tests in Tables A4 and A5 in the Appendix. Additionally, we also conduct panel cointegration test of Westerlund (2007) for our baseline regression specifications. The results of the panel cointegration tests are reported in Table A6 and A7 in the Appendix and they indicate cointegration among the variables included in our regressions.

[8]The estimators can handle the combination of stationary and non-stationary variables, as long as they are cointegrated.

Table 1: Summary Statistics

Variable	Unit	Obs.	Mean	St. Dev.	Min	Max
External debt	% of GDP	1,854	50.28	34.42	0.00	347.02
USD exchange rate	Index	1,854	129.69	72.39	72.45	725.25
Exchange rate volatility	Log	1,854	0.04	0.03	0.00	0.20
NEER	Index	1,185	96.29	15.61	39.58	153.58
Real GDP	Index	1,854	427.64	1028.19	96.10	11,229.90
Government consumption	% of GDP	1,854	15.17	3.66	7.62	27.48
Private credit	% of GDP	1,854	51.96	32.76	9.68	160.12
Debt forgiveness	Dummy	1,854	0.14	0.35	0	1
M2	% of GDP	1,307	45.19	30.4	9.00	210.89
Sovereign debt crisis	Dummy	1,854	0.01	0.08	0	1
EMBI spread	b.p.	1,854	359.60	108.27	161.66	1,144.38
GDP (PPP) per capita	PPP, USD	1,854	14,345	6,272	2,967	50,781
FDI net inflows	% of GDP	1,802	2.54	3.92	-18.98	60.07
Imports	% of GDP	1,538	31.71	17.93	0.13	114.55
FX reserves	% of GDP	1,854	70.95	38.98	4.48	296.49
ODA net inflows	% of GNI	1,375	0.68	1.7	-0.48	7.31
Financial development	Index	1,703	0.37	0.14	0.12	0.75
Government debt	% of GDP	1,638	39.93	18.7	3.88	117.88
CBI	Index	1,854	0.68	0.18	0.14	0.90
CBI (normalized)	Index	1,823	0.52	0.15	0.10	0.78
Financial Openness	Index	1,728	0.56	0.32	0.00	1.00
Illicit capital flows	% of GDP	1,803	-0.21	3.8	-32.59	30.56

5 Results

In this section, we report our results. First, we study the long-term relationship between the exchange rate and external debt. Second, we study the conditionality of the effect of exchange rate on external debt. Third, we investigate the asymmetrical effects of exchange rate depreciation on external debt. Fourth, we conduct several robustness checks to verify the robustness of our results.

5.1 Exchange Rate and External Debt

Before proceeding with the empirical analysis, we simply plot the relationship of our two studied variables: exchange rate and external debt. And indeed, Figure A4 in the Appendix shows that the higher the rate of exchange rate depreciation, the more significant increase in external debt to GDP ratio over the following four quarters. That is, this simple initial analysis provides some early evidence that depreciation of domestic currency might be associated with a more long-lasting increase in external debt to GDP ratio.

In the first step of our empirical analysis, we focus on studying the long-run relationship between the exchange rate movements and external debt. In Table 2, we report the results of the regressions evaluating the effect of exchange rate on external debt using the DFE estimator. As our cointegration-based estimator requires presence of cointegration among the variables included in the model, we limit the number of regressors included in each specification.[9] Consequently, we select our baseline specification (specification 4) and afterwards, we augment the baseline specification with additional control variables one at a time. Furthermore, this approach also enables us to address the collinearity issues and maximize the sample size -– as for numerous control variables, we lack observations for some countries.

The results reported in Table 2 robustly indicate that there exists a robust long-run relationship between the exchange rate and external debt. In all specifications, the coefficient of exchange rate is positive and statistically significant. This finding indicates that the exchange rate depreciation[10] contributes to higher external debt over the long-term. While the effect of exchange rate on external debt is statistically significant, its economic significance is rather limited. As a depreciation of exchange rate contributes to an increase in external debt to GDP ratio by some 0.05 % over the long-term.[11] In other words, a one standard deviation change in exchange rate would only increase the external debt to GDP ratio by slightly less than one fifth of the standard deviation of external debt to GDP ratio. Nevertheless, our results suggest that currency depreciation does indeed lead to higher external debt over the long-term. Furthermore, our results indicate that in line with the theoretical expectations, higher government consumption and private credit ratios to GDP lead to higher external debt over the

[9] A number of studies, which utilize these cointegration-based estimators limit the number of regressors in the regression, including Asteriou et al. (2020) or Fisera and Horvath (2021).

[10] The exchange rate is expressed in direct quotation, hence, an increase in its value represents depreciation of domestic currency.

[11] The coefficient of exchange rate varies across specifications. Nevertheless, in most cases, including the baseline specification, it is approximately 0.05.

long run. We also find that higher EMBI spreads lead to higher external debt, while for net oil exporters, higher oil prices reduce external debt. Somehow surprisingly, we also find that higher FX reserves and higher ODA net inflows also contribute to higher external debt. We argue that the former observation is likely caused by the fact that countries with higher FX reserves are able to take on more external debt, while the latter observation is likely caused by the fact that more indebted countries are also more likely to need ODA. Across all specifications, the coefficient of the error correction term is statistically significant, negative and between 0 and -1, which confirms the presence of error correction. In the short-run equation, we find a statistically significant negative effect of depreciation on external debt.[12]

So far, our empirical analysis indicates that domestic currency depreciation[13] by leading to a long-term increase in external debt to GDP ratio might pose a risk for emerging economies' debt sustainability. Thus, it could be hypothesized that having a domestic currency with a floating exchange rate (and the associated more independent exchange rate policy) could be riskier for emerging economies – as floating exchange rates are more likely to sustain periodic exchange rate depreciations. To verify this hypothesis, in the next step of our analysis, we replace the measure of exchange rate with the measure of exchange rate volatility, as our main explanatory variable. Namely, higher exchange rate volatility is more likely to be associated with floating exchange rates. Consequently, for the results reported in Table 3, the measure of exchange rate volatility serves as the key explanatory variable. For the measure of exchange rate volatility, our results are less robust. Nevertheless, the coefficient of the measure of exchange rate volatility is positive across all specifications – indicating that higher volatility also leads to higher external debt over the long-term. However, this coefficient is not statistically significant across several specifications. Thus, we take these results with a grain of salt. Nevertheless, we find some evidence that more volatile exchange rate of the domestic currency might also undermine the sustainability of external debt in the case of emerging economies.

[12] We only included certain key variables in the short-run equation. Namely, we argue that the remaining control variables are relatively stable over time and thus their quarterly changes are unlikely to affect quarterly changes in external debt. Additionally, this approach also enables us to address the fact that some of our control variables are interpolated to quarterly frequency.

[13] Obviously, our primary measure of exchange rate captures both appreciations and depreciations, and therefore, it could be argued that our results could be driven by appreciation episodes just as well. However, the results reported in sub-section 5.3 indicate that our results are in fact driven by depreciation episodes.

Table 2: Effect of Exchange Rate on External Debt

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	External debt (% of GDP)													
Long-run equation														
USD exchange rate	0.112***	0.095***	0.080***	0.049**	0.052**	0.039***	0.043*	0.046*	0.067***	0.043**	0.051**	0.044**	0.044**	0.068***
	(0.010)	(0.013)	(0.011)	(0.024)	(0.020)	(0.009)	(0.026)	(0.025)	(0.008)	(0.021)	(0.023)	(0.021)	(0.020)	(0.008)
Real GDP		0.002***	-0.000	-0.001	-0.001	-0.002*	-0.001	-0.002	-0.000	-0.001	-0.001	-0.001	-0.001	0.001
		(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.000)	(0.002)	(0.002)	(0.001)	(0.002)	(0.000)
Gov. cons. (% of GDP)			5.624***	2.688***	2.715***	4.588***	2.834***	2.594***	2.503***	2.522***	2.689***	2.066**	3.054***	1.542***
			(1.967)	(0.849)	(0.675)	(0.580)	(0.855)	(0.897)	(0.249)	(0.934)	(0.660)	(0.829)	(0.570)	(0.563)
Priv. credit (% of GDP)				0.936***	0.926**	1.614**	0.934***	0.976**	1.198**	0.925**	1.001***	1.082***	0.737**	0.568**
				(0.362)	(0.367)	(0.645)	(0.334)	(0.389)	(0.525)	(0.360)	(0.384)	(0.414)	(0.322)	(0.221)
Debt forgiv.					6.769									
					(5.950)									
M2 (% of GDP)						-1.069								
						(0.678)								
Sov. debt crisis							77.369							
							(47.503)							
EMBI spread								0.015***						
								(0.004)						
GDP (PPP) per capita									-39.694					
									(28.159)					
Interact Oil										-0.142***				
										(0.049)				
FDI inflows (% of GDP)											1.066			
											(0.706)			
Imports (% of GDP)												0.336		
												(0.222)		
FX reserves (% of GDP)													0.271***	
													(0.040)	
ODA infl. (% of GDP)														2.993***
														(1.000)
Short-run equation														
Error correction	-0.075***	-0.074***	-0.075***	-0.093***	-0.094***	-0.085***	-0.092***	-0.091***	-0.098***	-0.095***	-0.092***	-0.083***	-0.102***	-0.135***
	(0.024)	(0.023)	(0.026)	(0.017)	(0.017)	(0.017)	(0.015)	(0.018)	(0.017)	(0.019)	(0.016)	(0.009)	(0.015)	(0.014)
D.USD exchange rate	-0.027***	-0.027***	-0.026***	-0.060***	-0.061***	-0.051***	-0.065***	-0.062***	-0.062***	-0.060***	-0.060***	-0.060***	-0.058***	-0.029**
	(0.008)	(0.009)	(0.009)	(0.013)	(0.013)	(0.007)	(0.017)	(0.013)	(0.014)	(0.013)	(0.013)	(0.014)	(0.012)	(0.014)
D.Real GDP		0.001	0.000	0.002	0.001	0.002***	0.002	0.003	0.001	0.002	0.001	0.001	0.003**	0.002
		(0.002)	(0.002)	(0.002)	(0.003)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.001)	(0.003)
Constant	2.929***	2.862***	-3.251***	-4.051**	-4.218**	-4.489***	-4.175**	-4.482**	31.157*	-3.484*	-4.586***	-4.493**	-5.892***	-2.533*
	(0.869)	(0.689)	(1.062)	(1.777)	(1.700)	(0.663)	(1.726)	(1.892)	(18.877)	(1.875)	(1.510)	(2.098)	(1.473)	(1.434)
Observations	2,739	2,034	2,03	1,854	1,854	1,307	1,854	1,854	1,854	1,854	1,802	1,538	1,854	1,375
Countries	63	41	41	41	41	30	41	41	41	41	40	37	41	35

Notes: D stands for the first difference. Interact Oil is interaction term, which interacts a dummy variable for oil exporters and the oil prices. The exchange rate is expressed in direct quotation, thus an increase in its values corresponds to depreciation. All the regressions were estimated with the DFE estimator. Standard errors are in parentheses. * indicates significance at 10 % level, ** at 5 % level and *** at 1 % level.

Table 3: Effect of Exchange Rate Volatility on External Debt

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
							External debt (% of GDP)							
Long-run equation														
Exchange rate volatility	3.198**	3.453***	3.219**	1.917	1.943	1.608	1.627*	1.896	1.719*	1.798	1.988*	2.130**	1.701*	1.152
	(1.291)	(1.309)	(1.435)	(1.169)	(1.187)	(1.009)	(0.934)	(1.217)	(1.019)	(1.214)	(1.153)	(1.068)	(1.029)	(1.177)
Real GDP		0.002***	-0.000	-0.001	-0.001	-0.002**	-0.001	-0.001	-0.000	-0.001	-0.000	-0.000	-0.001	0.000
		(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Gov. cons. (% of GDP)			5.776***	3.235***	3.304***	5.025***	3.349***	3.201***	3.367***	3.055***	3.274***	2.520**	3.578***	2.630***
			(0.644)	(0.687)	(0.572)	(0.533)	(0.713)	(0.741)	(0.526)	(0.827)	(0.290)	(1.099)	(0.488)	(0.574)
Priv. credit (% of GDP)				0.786***	0.776***	1.396***	0.790***	0.798***	0.978***	0.784***	0.854***	0.912***	0.596***	0.561***
				(0.193)	(0.193)	(0.402)	(0.188)	(0.185)	(0.322)	(0.198)	(0.205)	(0.231)	(0.173)	(0.211)
Debt forgiv.					7.070									
					(6.873)									
M2 (% of GDP)						-0.971*								
						(0.554)								
Sov. debt crisis							68.360**							
							(28.033)							
EMBI spread								0.004						
								(0.007)						
GDP (PPP) per capita									-27.800					
									(22.065)					
Interact Oil										-0.113***				
										(0.027)				
FDI inflows (% of GDP)											1.178			
											(0.717)			
Imports (% of GDP)												0.309		
												(0.225)		
FX reserves (% of GDP)													0.283***	
													(0.042)	
ODA infl. (% of GDP)														1.519
														(1.352)
Short-run equation														
Error correction	-0.070***	-0.074***	-0.076***	-0.091***	-0.091***	-0.083***	-0.090***	-0.090***	-0.092***	-0.093***	-0.089***	-0.083***	-0.100***	-0.116***
	(0.013)	(0.010)	(0.014)	(0.010)	(0.011)	(0.013)	(0.009)	(0.010)	(0.012)	(0.012)	(0.010)	(0.005)	(0.009)	(0.016)
D.Exchange rate volatility	0.014***	-0.086	-0.086	-0.128**	-0.134**	-0.102*	-0.134**	-0.131**	-0.127**	-0.124*	-0.142**	-0.127*	-0.115**	-0.064
	(0.002)	(0.061)	(0.064)	(0.061)	(0.061)	(0.055)	(0.059)	(0.057)	(0.062)	(0.064)	(0.061)	(0.069)	(0.057)	(0.044)
D.Real GDP		0.001	0.001	0.002**	0.002	0.003***	0.002*	0.003*	0.002	0.003**	0.002	0.002	0.004***	0.001
		(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.003)
Constant	2.802***	2.582***	-3.832***	-4.298***	-4.491***	-4.710***	-4.351***	-4.410***	18.865	-3.835**	-4.910***	-4.679*	-6.182***	-3.398**
	(0.845)	(0.737)	(0.481)	(1.584)	(1.536)	(0.484)	(1.590)	(1.477)	(15.169)	(1.768)	(1.261)	(2.401)	(1.433)	(1.599)
Observations	2,739	2,034	2,03	1,854	1,854	1,307	1,854	1,854	1,854	1,854	1,802	1,538	1,854	1,375
Countries	63	41	41	41	41	30	41	41	41	41	40	37	41	35

Notes: D stands for the first difference. Interact Oil is interaction term, which interacts a dummy variable for oil exporters and the oil prices. The increase in the value of the measure of exchange rate volatility corresponds to higher exchange rate volatility. All the regressions were estimated with the DFE estimator. Standard errors are in parentheses. * indicates significance at 10 % level, ** at 5 % level and *** at 1 % level.

5.2 Exchange Rate and External Debt: Conditionality

Having found in the previous sub-section robust evidence of a positive relationship between the exchange rate depreciation and external debt, we now proceed to investigate the country-level characteristics, which could influence this relationship. In other words, we aim to investigate the factors, which could limit the long-term increase in external debt to GDP ratio and the associated decrease in external debt sustainability in the emerging countries. First, as outlined earlier, the higher exchange rate volatility is more likely to occur in countries with more flexible exchange rates and more independent exchange rate policy. As a result, we move on to directly investigate the role of exchange rate regime in affecting the relationship between the exchange rate and the external debt. Using the database of Ilzetzki et al. (2017), we identify the exchange rate regime for each of the countries in our sample at a quarterly frequency. Afterwards, based on the data on exchange rate regimes, we create a dummy variable for soft pegs (i.e., intermediate exchange rate regimes) and a dummy variable for floating exchange rates. Subsequently, we interact each of these two dummy variables with the measure of exchange rate and add these interaction terms in the baseline regressions.[14] Thus, this approach enables us to study, how does the effect of exchange rate depreciation on external debt differ in the case of soft pegs and floats when compared to hard pegs. We report these results in Table 4. First, in specification 1, we introduce an interaction between the measure of exchange rate and a dummy variable for floating exchange rate. Here, we find that the coefficient of the measure of exchange rate retains its positive and statistically significant sign, but the coefficient also turns smaller. This finding indicates that exchange rate depreciation leads to a less significant increase in external debt in the case of (less volatile) fixed exchange rates (both hard pegs and soft pegs). This conclusion is further reinforced by the positive and statistically significant coefficient of the interaction term, which suggests that in the case of floating exchange rate regimes, the currency depreciation leads to a more significant long-term increase in external debt. We plot this relationship in Figure A5 in the Appendix, where we plot the Total Marginal Effects (TME) of exchange rate on external debt – conditional on exchange rate regime. The TMEs suggest that the long-term increase in external debt due to exchange rate depreciation is more than twice as high in the case of countries with floating exchange rate regimes. Second, in specification 2, we enter both the interaction of exchange rate and floating dummy and the interaction of exchange rate and soft peg dummy. In this case, the coefficient of our measure of exchange rate losses its statistical significance and it even turns negative. Therefore, it seems that in the case of hard peg exchange rate regimes, the exchange rate depreciation does not have a long-term effect on external debt. For soft pegs, we fail to find evidence of a statistically significant long-run relationship between the exchange rate movements and external debt. On the other hand, we once again find that in the case of floating exchange rates, the exchange rate depreciation does lead to higher external debt. As a result, we conclude that for emerging economies, the floating exchange rate regimes and the higher exchange rate volatility associated with this type of exchange rate regime seem

[14] We have demeaned the measure of exchange rate included in the interaction terms to address the collinearity issues.

to contribute to higher long-term increase in external debt to GDP ratio following a currency depreciation.

Table 4: Effect of Exchange Rate on External Debt – The Role of Exchange Rate Regime

Variables	(1) External debt	(2) (% of GDP)
Long-run equation		
USD exchange rate	0.040*	-0.038
	(0.024)	(0.027)
Real GDP	-0.001	-0.001
	(0.002)	(0.002)
Gov. cons (% of GDP)	2.629*	3.052***
	(1.354)	(0.639)
Private credit (% of GDP)	0.903*	0.820*
	(0.501)	(0.476)
Floating ER dummy	-1.285	-50.357
	(8.157)	(42.848)
Soft peg ER dummy		-50.436
		(35.767)
Interact (Exchange Rate*Floating)	0.049*	0.142***
	(0.029)	(0.034)
Interact (Exchange Rate*Soft peg)		0.016
		(0.035)
Short-run equation		
Error correction	-0.094***	-0.091***
	(0.011)	(0.014)
D.USD exchange rate	-0.061	-0.074
	(0.055)	(0.057)
D.Real GDP	0.002	0.002*
	(0.001)	(0.001)
Constant	-3.697*	1.053
	(2.174)	(3.028)
Observations	1,854	1,854
Countries	41	41

Notes: D stands for the first difference. All the regressions were estimated with the DFE estimator. Both interaction terms include the demeaned measure of exchange rate and exchange rate regime dummy specified above. Floating ER dummy takes the value of 1 if a country had floating exchange rate regime during the quarter and zero otherwise. Soft peg ER dummy takes the value of 1 if a country had one of the soft peg (or intermediate) exchange rate regimes and zero otherwise. Standard errors are in parentheses. * indicates significance at 10 % level, ** at 5 % level and *** at 1 % level.

Next, we investigate the conditionality of the effect of exchange rate depreciation on external debt on several country-level characteristics. To this end, we add interaction terms, which interact the measure of exchange rate and the country-level conditioning variables, in the baseline regressions. As the conditioning variables, we have selected the following variables: government debt, financial development, and private credit (as another commonly used measure of financial development). As a primary measure of financial development, we use the composite index of financial development by Svirydzenka (2016). Government debt and private credit are

expressed as a percentage of GDP. For each of these conditioning variables, we enter two different interaction terms separately into the baseline regressions. First, we interact demeaned measure of exchange rate and demeaned conditioning variable. Second, we interact demeaned measure of exchange rate with a dummy variable, which takes the value of one, if the conditioning variable's value is above the sample median and zero otherwise. We report the results of these regressions in Table 5.

We only find limited evidence that higher central government debt affects the effect of depreciation on external debt – as only the first interaction term is positive and statistically significant. Therefore, we conclude that government debt does not seem to play a role in affecting the transmission of exchange rate development to external debt. Additionally, we find strong evidence that financial development plays an important role in affecting the relationship between exchange rate and external debt – as three out of four interaction terms studying this relationship are statistically significant. All these coefficients are also positive – indicating that with higher levels of financial development, the currency depreciations lead to an even greater increase in external debt over the long-term. We hypothesize that these results could be driven by the fact that more financially developed emerging economies are able to take on more external debt after the depreciation.

Having studied the influence of several key macroeconomic characteristics of a country in influencing the long-term consequences of depreciation on external debt, we now move on to investigate the role of issues, which are particularly relevant for the policymakers in emerging economies. First, emerging countries often exhibit lower levels of central bank independence (CBI) and the governments often exert significant influence over the central banks and their policy. However, a more independent central bank might manage the inflation expectations better and thus, the country might benefit from lower costs of external funding (Fisera et al., 2021; Klomp and Sseruyange, 2020). Then, domestic currency depreciation might lead to a less significant increase in external debt. Therefore, in the next step of our empirical analysis, we investigate the role of CBI in affecting the long-term consequences of domestic currency depreciation on external debt. As our measure of central bank independence, we use the de jure central bank independence index of Garriga (2016), which we interact with our measure of exchange rate. The results, which we report in Table 6, indicate that in countries with higher level of CBI, the exchange rate depreciation leads to a less substantial long-term increase in external debt. This is evidenced by negative and statistically significant coefficient of the interaction term of exchange rate and CBI.

However, Klomp and Sseruyange (2020) argue that the de jure indices of CBI might not be accurate in the case of emerging economies. Namely, in many emerging economies where the enforcement of the rule of is less stringent, the de jure independence of the central bank might not necessarily be also reflected in de facto independence of the central bank from government interference. To address this drawback of our measure of CBI, we normalize the measure of CBI by the Rule of Law Index of the World Bank.[15] Then, in the normalized index

[15]We have normalized the rule of law index, so that it attains values of between 0.5 and 1, as we argue that

Table 5: Effect of Exchange Rate on External Debt – The Role of Conditioning Variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	External debt (% of GDP)					
Long-run equation						
USD exchange rate	0.036***	0.050*	0.104***	0.043**	0.077***	0.001
	(0.013)	(0.026)	(0.012)	(0.019)	(0.015)	(0.035)
Real GDP	-0.002	-0.002	-0.001	0.001	-0.001	-0.001
	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Gov. cons. (% of GDP)	1.644***	2.164**	2.639***	6.079**	2.635***	5.129***
	(0.447)	(0.888)	(0.615)	(3.020)	(0.743)	(1.546)
Private credit (% of GDP)	0.921**	0.919***			0.909**	
	(0.376)	(0.341)			(0.369)	
Interact	0.002**	0.011	0.196***	0.026	0.002**	0.136***
	(0.001)	(0.020)	(0.071)	(0.109)	(0.001)	(0.017)
Government debt (% of GDP)	0.318***					
	(0.115)					
Government debt dummy		7.448***				
		(2.460)				
Financial development			144.188*			
			(85.895)			
Financial development dummy				3.262		
				(3.168)		
Private credit dummy						19.869*
						(10.532)
Short-run equation						
Error correction	-0.113***	-0.094***	-0.094***	-0.079***	-0.096***	-0.086***
	(0.023)	(0.021)	(0.020)	(0.029)	(0.019)	(0.020)
D.USD exchange rate	-0.067***	-0.060***	-0.038***	-0.052***	-0.062***	-0.056***
	(0.015)	(0.013)	(0.014)	(0.009)	(0.015)	(0.013)
D.Real GDP	0.002*	0.002	0.003	0.000	0.002	0.001
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Variable in interaction term	Gov. debt	Gov. debt dummy	Fin. dev.	Fin. dev. dummy	Private credit	Private credit dummy
Observations	1,638	1,638	1,703	1,703	1,854	1,854
Countries	38	38	40	40	41	41

Notes: D stands for the first difference. All the regressions were estimated with the DFE estimator. All interaction terms include the measure of exchange rate and conditioning variable specified above. Government debt dummy, financial development dummy and private credit dummy take the value of 1, if the value of these variables is above their sample median and zero otherwise. Due to high correlation, we exclude the variable private credit from regressions including financial development. To save space, we do not report the coefficient of the constant. Standard errors are in parentheses. * indicates significance at 10 % level, ** at 5 % level and *** at 1 % level.

of CBI, the countries with lower levels of the Rule of Law Index will have slightly reduced values for the CBI. Using the normalized measure of CBI, we once again find that higher levels of CBI limit the long-term increase in external debt to GDP ratio after the depreciation. In this case, the coefficient of the interaction is slightly smaller but it is significant at 5 % level. Consequently, we find robust evidence that higher central bank independence reduces negative consequences of depreciation for external debt. To better illustrate our results, we plot the TMEs of exchange rate on external debt conditional on the value of our two measures of CBI in Figure A6 and A7 in the Appendix. The TMEs evidence that with higher levels of CBI the long-term effect of depreciation on external debt turns negative, suggesting that for emerging countries with more independent central banks, presumably by better managing the inflation expectations and keeping the interest rates low, the weaker currency may eventually even reduce the external debt burden over the long-term.

Apart from lower levels of CBI, the emerging countries are also vulnerable to large capital flows and the discussion on the merits of free flows of capital in the case of emerging economies remains ongoing. Therefore, we also investigate the role of financial openness in affecting the relationship between exchange rate and external debt. We use the Chinn-Ito index of Chinn and Ito (2006) as our measure of financial openness. The results are reported in Table 6 in specification 3 but we do not find evidence that removing the barriers to flows of capital actually affects the long-term consequences of domestic currency depreciation for external debt burden.

Nonetheless, emerging economies are also vulnerable to the phenomenon of the illicit capital flows, which might not be captured by a de jure measure of financial openness. As a result, in the final step of our empirical analysis, we investigate the role of illicit capital flows. To measure the illicit capital flows, we use the standard approach and use the Net Errors and Omissions (NEO) from the balance of payments expressed as a percentage of GDP as our measure of illicit capital flows (Siranova et al., 2021). First, we study the role of the magnitude of illicit capital flows in affecting the relationship between depreciation and external debt. To this end, we express the NEO in absolute values (i.e., for now, we do not distinguish between inflows and outflows, we are just interested in the magnitude of the illicit flows). We report the results in specification 4 in Table 6. Here, the interaction term of our measures of illicit capital flows and exchange rate is statistically significant and positive – suggesting that countries, which experienced higher volumes of illicit capital flows also experienced a more pronounced increase in external debt due to exchange rate depreciation over the long-term. We plot the TMEs of exchange rate on external debt conditional on overall volume of illicit capital flows in Figure A8 in the Appendix. Our results indicate that in countries with average values of illicit capital flows, the long-term increase in external debt due to the depreciation is almost twice as big as in the case of countries with lowest observed values of illicit capital flows. Afterwards, we split our measure of illicit capital flows into inflows and outflows and we report the results in Table 6 in specifications 6 and 7, respectively. We find that illicit capital inflows augment the long-term

normalizing it to the values between 0 and 1 would have penalized the countries with very low levels of rule of law too much.

Table 6: Effect of Exchange Rate on External Debt – Role of CBI and Capital Flows

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	External debt (% of GDP)					
Long-run equation						
USD exchange rate	0.110***	0.052**	-0.005	0.056**	0.052**	0.078***
	(0.013)	(0.021)	(0.141)	(0.023)	(0.025)	(0.014)
Real GDP	-0.000	-0.001	-0.001	-0.002	-0.001	-0.001
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Gov. cons. (% of GDP)	5.396**	2.990***	2.134***	2.815***	2.690**	2.729***
	(2.102)	(0.685)	(0.541)	(1.031)	(1.055)	(0.985)
Private credit (% of GDP)		0.879**	0.954**	0.968**	0.966***	0.964**
		(0.346)	(0.412)	(0.379)	(0.374)	(0.378)
Interact	-0.468*	-0.292**	-0.216	0.012***	0.007***	0.020
	(0.283)	(0.136)	(0.341)	(0.003)	(0.002)	(0.014)
CBI	-4.062					
	(39.354)					
CBI (normalized)		17.304				
		(28.964)				
Financial openness			-11.091*			
			(6.448)			
Illicit capital flows				0.620		
				(0.789)		
Illicit capital inflows					-0.078	
					(0.733)	
Illicit capital outflows						0.998
						(0.644)
Short-run equation						
Error correction	-0.079***	-0.096***	-0.099***	-0.093***	-0.092***	-0.092***
	(0.029)	(0.019)	(0.013)	(0.017)	(0.018)	(0.017)
D.USD exchange rate	-0.025***	-0.060***	-0.067***	-0.063***	-0.062***	-0.061***
	(0.010)	(0.013)	(0.016)	(0.015)	(0.014)	(0.014)
D.GDP_Real	0.001	0.002	0.002	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Variable in interaction term	CBI	CBI (norm)	Fin. open.	Il. cap. flows	Il. cap. inflows	Il. cap. inflows
Observations	1,854	1,823	1,728	1,803	1,803	1,803
Countries	41	41	41	40	40	40

Notes: D stands for the first difference. All the regressions were estimated with the DFE estimator. All interaction terms include the measure of exchange rate and conditioning variable specified above. Due to high correlation, we exclude the variable private credit from regressions including CBI. To save space, we do not report the coefficient of the constant. Standard errors are in parentheses. * indicates significance at 10 % level, ** at 5 % level and *** at 1 % level.

positive effect of depreciation on external debt, while outflows do not seem to influence the studied relationship.

5.3 Asymmetrical Effects of Exchange Rate on External Debt

Next, we investigate the possibility of asymmetrical effects of exchange rate appreciations and depreciations. Namely, several empirical studies, which investigated the effects of exchange rate movements, have uncovered the differences between the effects of appreciations and depreciations (Bahmani-Oskooee and Fariditavana, 2015; Fisera and Horvath, 2021; Nouira and Sekkat, 2012; Nusair, 2017). As a result, the results from our baseline regressions from sub-section 5.1, could possibly be driven by appreciation episodes. To investigate this possibility, we estimate the non-linear ARDL model of Shin et al. (2013). Such approach was previously used in studying the real economy effects of exchange rates by for instance Bahmani-Oskooee and Fariditavana (2015) and Nusair (2017) in a time series setting, and Fisera and Horvath (2021) in a panel framework. Therefore, we split the measure of exchange rate to appreciations and depreciations:

$$ER_{i,t} = ER_{i,0} + ER^{+}_{i,t} + ER^{-}_{i,t} \tag{5}$$

where $ER^{+}_{i,t}$ and $ER^{-}_{i,t}$ are the partial sum processes of positive (depreciations) and negative (appreciations) changes in the exchange rate. Next, we replace our measure of exchange rate from the baseline regressions with the separate measures for appreciations and depreciations:

$$\begin{aligned}\Delta Debt_{i,t} = \sum_{j=1}^{p-1} \Phi_j \Delta Debt_{i,t-j} + \sum_{j=0}^{q-1} \Pi_{1j} \Delta ER^{+}_{i,t-j} + \sum_{j=0}^{n-1} \Pi_{2j} \Delta ER^{-}_{i,t-j} + \sum_{j=0}^{r-1} \Theta_j \Delta X_{i,t-j} \\ + \beta_{0,i}(Debt_{i,t-1} - \beta_1 ER^{+}_{i,t} - \beta_2 ER^{-}_{i,t} - \sum_{j=0}^{u} \beta_j X_{i,t} - \delta_i) + \varepsilon_{i,t}\end{aligned} \tag{6}$$

where $ER^{+}_{i,t}$ and $ER^{-}_{i,t}$ are measures of exchange rate depreciations and appreciations, respectively. We estimate the equation 6 with DFE estimator and report the results in Table 7. Interestingly, the coefficient of the measure of appreciation is not statistically significant, while the measure of depreciation is statistically significant and positive, indicating that our baseline results are in fact driven by the depreciations. In other words, we do find that only the depreciations of domestic currency have a long-term effect on external debt to GDP ratio. Having split the measure of exchange rate into appreciations and depreciations, we find that a depreciation of domestic currency by 1 % leads to an increase in external debt to GDP ratio by some 0.5 % on average over the long-term.

Furthermore, the impact of domestic currency depreciation on external debt might depend on the magnitude of the depreciation. That is, small depreciations and large depreciations might have different consequences for the country's external debt. To investigate this hypoth-

esis, we also introduce squared values of the measures of appreciation and depreciation in the equation 6 and we report the results in specification 2 in Table 7. Once again, we find that both the measure of appreciation and appreciation squared do not seem to influence the external debt. For depreciations, both corresponding coefficients are statistically significant. However, the coefficient of the measure of depreciation turns negative, while the coefficient of the squared measure of depreciation is positive – suggesting that small depreciations might even have a negative effect on external debt to GDP ratio, while it is the larger depreciations that lead to a long-term increase in external debt burden. Using the estimated coefficients, we present the external debt effect of different magnitudes of depreciation in Figure A9 in the Appendix. We are able to observe that at small magnitudes of domestic currency depreciation, its effect on external debt is even slightly negative. Presumably, small domestic currency depreciation, by increasing international competitiveness and improving economic performance, might to lead to a reduction in external debt to GDP ratio. It seems that depreciation of domestic currency by 7 % - 8 % has the most significant negative long-term effect. Then, with increasing magnitudes of depreciation, the negative effect starts to decrease. Based on Figure A9 in the Appendix, we find that domestic currency depreciations that exceed 15 % lead to a more substantial long-term increase in external debt.[16]

While the reduction of the external debt to GDP ratio associated with small depreciations could be explained by the improvement in the economic performance, this finding is still somehow surprising – as for the emerging economies with their less diversified economies, we would have expected the benefits associated with the improvement in economic performance due to depreciation to be outweighed by the increase in external debt. However, we hypothesize that these results could be driven by more developed emerging economies from our sample. As a result, we split our sample in half – into countries with above median and below median average GDP (PPP) per capita and we re-run our regressions on these sub-samples. We report the results of these regressions in specifications 3 and 4 in Table 7 and we plot the change in external debt to GDP ratio at different magnitudes of domestic currency depreciation in Figure A9 in the Appendix. We are able to observe that the richer half of the emerging countries in our sample generally benefit from domestic currency depreciation, as their external debt to GDP ratio drops at both smaller and medium rates of depreciation. On the other hand, the poorer half of the emerging countries from our sample only benefit marginally from small depreciations, and depreciations exceeding 10 % lead to a long-term increase in external debt to GDP ratio.

Finally, in specification 5 in Table 7, we re-run our regressions on a sub-sample of only a third of the poorest countries from our sample.[17] We find that the poorest emerging economies in our sample do not seem to benefit from depreciation of their domestic currency at all – and any depreciations exceeding 5 % lead to a long-term increase in external debt to GDP ratio and the associated decrease in external debt sustainability.

[16] While such a magnitude of depreciation might seem quite large and exceptional, more than 5 % of all depreciations for the emerging economies in our sample have exceeded the magnitude of 15 %.

[17] We defined these countries as having average GDP (PPP) per capita below the 33rd percentile for our sample.

Table 7: Asymmetrical Effect of Depreciation on External Debt

Variables	(1)	(2)	(3)	(4)	(5)
	External debt (% of GDP)				
Long-run equation					
ER Appreciation	-4.698	-2.979	-1.029	-2.102	5.151
	(4.029)	(2.516)	(1.779)	(3.134)	(5.953)
ER Appreciation Squared		0.143	0.008	0.323*	1.219
		(0.258)	(0.070)	(0.190)	(1.280)
ER Depreciation	0.512*	-0.499***	-1.412	-0.802**	-0.427
	(0.311)	(0.114)	(1.332)	(0.337)	(1.035)
ER Depreciation Squared		0.034***	0.140**	0.023***	0.094**
		(0.004)	(0.070)	(0.008)	(0.039)
Real GDP	-0.002	-0.002	-0.004	-0.002	-0.006
	(0.002)	(0.002)	(0.017)	(0.001)	(0.012)
Gov. cons. (% of GDP)	3.443***	3.553***	2.299	4.081**	1.284**
	(0.490)	(0.604)	(1.537)	(1.831)	(0.595)
Private credit (% of GDP)	0.944***	0.945***	0.783	1.011***	0.401
	(0.337)	(0.342)	(0.725)	(0.270)	(0.519)
Short-run equation					
Error correction	-0.084***	-0.083***	-0.072*	-0.089***	-0.095*
	(0.016)	(0.017)	(0.039)	(0.023)	(0.049)
D.ER Appreciation	0.041	0.011	-0.041	-0.046	-0.504*
	(0.054)	(0.052)	(0.069)	(0.054)	(0.258)
D.ER Appreciation Squared		-0.005	-0.004	-0.014**	-0.100**
		(0.009)	(0.005)	(0.007)	(0.051)
D.ER Depreciation	-0.109***	-0.162**	-0.040	-0.178*	-0.061
	(0.028)	(0.082)	(0.056)	(0.092)	(0.044)
D.ER Depreciation Squared		0.002	-0.004***	0.003*	-0.004***
		(0.001)	(0.001)	(0.001)	(0.001)
D.Real GDP	0.004***	0.003***	0.003	0.003	0.005***
	(0.001)	(0.001)	(0.002)	(0.003)	(0.002)
Constant	-4.825***	-4.687***	-2.222	-5.876**	0.618
	(1.648)	(1.596)	(1.860)	(2.406)	(1.836)
Sample	Full	Full	Poorer 50 %	Richer 50 %	Poorer 33 %
Observations	1,854	1,854	832	1,022	598
Countries	41	41	20	21	15

Notes: D stands for the first difference. The exchange rate is expressed in direct quotation, thus, an increase in its value represents depreciation. ER Depreciation stands for the measure of exchange rate depreciation, while ER Appreciation stands for the measure of exchange rate appreciation. Full stands for our entire sample of 41 emerging economies, Richer 50 % stands for the emerging countries from our sample with above sample median GDP (PPP) per capita, Poorer 50 % stands for countries with GDP (PPP) per capita below sample median, while Poorer 33 % stands for the poorest third of the emerging countries from our sample. All the regressions were estimated with the DFE estimator. Standard errors are in parentheses. * indicates significance at 10 % level, ** at 5 % level and *** at 1 % level.

5.4 Robustness Checks

Finally, in the last sub-section, we conduct several robustness checks to determine the robustness of our results. Firstly, we use a different measure of exchange rate – instead of the exchange rate of domestic currency per U.S. dollar, we use NEER as our alternative measure of exchange rate. The results of this robustness check are reported in specification 1 in Table A8 in the Appendix. This robustness check fully supports our baseline findings as the coefficient of NEER is negative and statistically significant – indicating that a currency depreciation contributes to higher external debt.[18] Thus, we find that not only the depreciation against the U.S. dollar contributes to higher external debt, but also a broad depreciation of the domestic currency against the currencies of the country's main trade partners leads to an increase in external debt.

In the second robustness check, we address another drawback of our main measure of exchange rate. Namely, our sample also includes countries, which peg their currencies to another global currency, the Euro. For these countries, a depreciation of their currency against the U.S. dollar could be caused by a depreciation of Euro against the U.S. dollar. Then, assuming that these countries' external debt is also mostly denominated in Euros, a depreciation merely against the U.S. dollar is unlikely to affect these countries' external debt. To address this drawback, we drop from our sample countries, which have Euro as anchor currency[19] and re-run our baseline regressions on only this reduced sample. The results of this robustness check are reported in specification 2 of Table A8 in the Appendix. This robustness check is also fully in line with our baseline estimations, as the coefficient of our main exchange rate measure is positive, statistically significant, and only marginally larger than in baseline regressions.

In the next robustness check, we opt for a different estimator to re-estimate our baseline regressions. Therefore, we re-estimate the baseline regressions with the main measure of exchange rate and the measure of exchange rate volatility using the standard PMG estimator. That is, using the PMG estimator, we exclude the fixed effects. The results of these regressions are reported in specifications 3-4 in Table A8 in the Appendix. Here, we once again find that exchange rate depreciation contributes to an increase over the long-term. The economic significance of this effect remains in line with our previous results. Interestingly, using the PMG estimator, the coefficient of exchange rate volatility measure retains its positive coefficient but as opposed to our baseline regressions, it is strongly statistically significant. As a result, we find some evidence that higher exchange rate volatility also has a positive long-term effect on external debt.

In the fourth robustness check, we use a different approach to verify the robustness of our findings on asymmetrical effects of currency appreciations and depreciations. Instead of splitting our measure of exchange rate into appreciations and depreciations, we simply augment

[18] Unlike our main measure of exchange rate, NEER is expressed in indirect quotation, hence an increase in its value actually represents appreciation of the domestic currency.

[19] We identify the countries with Euro as their anchor currency based on Ilzetzki et al. (2017), who identified anchor currency (or reference currency in case of countries with floating exchange rates) for each country based on the variability of exchange rate, invoicing currency of foreign trade, denomination of external debt, and denomination of FX reserves.

our baseline specifications and include an interaction between our measure of exchange rate and a dummy variable for depreciation in the baseline regressions. Thus, the coefficient of this interaction term should help us investigate, whether the relationship between the exchange rate and external debt changed during the periods when the domestic currency depreciated. We report the results of this analysis in Table A9 in the Appendix. We perform the analysis for both our measures of exchange rate – the domestic currency per U.S. dollar and NEER. We find that after including the interaction for depreciation periods in the regression framework, the main measure of exchange rate loses its statistical significance – suggesting that appreciation of domestic currency does not seem to affect the external debt over the long-term. On the other hand, the coefficient of the interaction term is positive and statistically significant. This finding provides us with further evidence that domestic currency depreciation does indeed lead to a long-term increase in external debt. We obtain equivalent findings when we use NEER as our measure of exchange rate.

Next, we study the long-term response of external debt to exchange rate movements at different magnitudes of domestic currency depreciation. To this end, we create dummy variables for small, medium and large depreciations[20] and we interact each of these dummy variables with both our measures of exchange rate. The results of these regressions are reported in Table A10 in the Appendix. For our main measure of exchange rate, we once again find that large depreciations seem to be driving our results, as only the coefficient of the interaction term for large depreciations is positive and statistically significant, suggesting that only large depreciations lead to a long-term increase in external debt. Similarly, for NEER, we find that large depreciations also lead to a long-term increase in external debt. Though, in the case of NEER, also the interaction term for small depreciations is statistically significant. However, the size of the coefficient is very small – indicating that small NEER depreciations might lead to a limited long-term increase in the external debt to GDP ratio.

Finally, in the last robustness check, we aim to address the possibility that there could be a reverse causality going from the external debt to exchange rate. To address this possibility, we simply estimate a simple Vector Error Correction Model (VECM) of external debt and our main measure of exchange rate. Using the obtained coefficients, we then generate impulse response functions (IRFs), which we report in Figures A10 and A11 in the Appendix. The IRFs indicate that in line with our baseline findings, the external debt exhibits a more long-term increase after a shock to exchange rate. On the other hand, exchange rate does not seem to respond to shocks in external debt.

6 Conclusions

In examining the long-run effect of exchange rate depreciation on external debt in the case of 41 emerging economies over the years 1999-2019, our results yield several interesting conclusions. While the long-run effect of exchange rate depreciation on the nominal value of external debt was

[20] We define small depreciations as depreciations of less than 5 %, medium depreciations as those between 5 % and 10 % and large depreciations as those exceeding 10 %.

relatively small, it has been consistently positive and largely statistically significant. Our results suggest that a 1 % depreciation of domestic currency contributes to an increase in external debt to GDP ratio by some 0.5 % over the long-term – though this finding is driven particularly by domestic currency depreciations of more substantial magnitude. In fact, we found that in general domestic currency depreciations only lead to a long-term increase in external debt burden if the rate of depreciation exceeds 15 %. Smaller depreciations might even lead to a decrease in external debt to GDP ratio over the long-term – presumably by improving the economic performance due to increased international competitiveness associated with weaker domestic currency. However, we also found that only the more developed emerging economies were able to benefit from domestic currency depreciation. On the other hand, the poorest of the emerging economies in our sample were unable to benefit from weaker domestic currency and they also experienced the most substantial long-term increase in external debt to GDP ratio. The short-run relationship captured by the error correction coefficient suggests that the relationship between exchange rate depreciation and external debt converges to its long-run equilibrium at the rate of approximately 8 % per quarter. These findings are fairly consistent across numerous regression specifications estimated using both the DFE estimator, as well as the PMG estimator, which we used as a robustness check. The somehow smaller impact of exchange rate depreciation on external debt could be attributed, among other things, to the increasing size of external debt issued in local currencies by emerging economies in recent periods (Dell'Erba et al., 2013). Nevertheless, our results indicate that domestic currency depreciation still reduces the sustainability of external debt in emerging countries – particularly in the case of poorer emerging economies.

Afterwards, we investigated the conditionality of the effect of exchange rate on external debt burden, and our empirical results do provide us with some interesting policy recommendations. In line with previous theoretical and empirical studies, which focused on the implications of exchange rate regime on external debt valuation (Barajas and Morales, 2003; Bleaney and Ozkan, 2011), we examined the role of exchange regime in affecting the impact of exchange rate on external debt. Our results seem to suggest countries with more volatile exchange rates and the countries with floating exchange rate regimes are more likely to experience an increase in the external debt burden following the domestic currency depreciation. Furthermore, we find strong evidence that higher financial development exacerbates the effect of depreciation on external debt. One of the most interesting results from our empirical exploration highlights the importance of central bank independence for the evolution of external debt. While we recognize that this finding requires deeper investigation, our results suggest that in countries with higher degree of central bank independence, the domestic currency depreciation leads to a less pronounced increase in the external debt to GDP ratio over the long-term. Our findings indicate that an increase in the value of central bank independence index from its mean value for our sample to its maximum observed value for our sample of emerging economies, would more than compensate for the long-term increase in external debt burden associated with the domestic currency depreciation. Therefore, our findings underline the importance of an independent

central bank, which by managing better the inflation expectations and as result keeping the borrowing costs lower, might help to reduce the risks posed by domestic currency depreciation for external debt sustainability. Additionally, we also found that higher susceptibility to illicit capital flows also augments the positive effect of depreciation on external debt, while higher financial openness does not seem to have any such effect. Finally, numerous robustness checks corroborated the robustness of our findings.

Overall, our results seem to suggest that the financial vulnerability of emerging economies with a larger proportion of external debt denominated in foreign currency results from an exogenous monetary policy environment. While the impact of domestic currency depreciation on external debt is relatively subdued in general, our results seem to indicate that more volatile and floating exchange rates in the case of emerging economies, may contribute to a more substantial long-term increase in external debt to GDP ratio. Consequently, our findings provide some evidence to support the hypothesis that fully floating exchange rates may not be optimal for emerging economies – particularly the less developed ones. Our results also suggest that both the degree of central bank independence and the vulnerability to illicit capital flows play an important role in managing the level of external debt. This former finding thus underscores the importance of central bank independence for emerging economies and calls for a further debate on how emerging economies should foster the independence of their respective central banks to pursue the goals of monetary policy that includes the optimal choice of the exchange rate regime.

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Appendix

Table A1: List of Countries

Albania	Egypt	Peru
Argentina	El Salvador	Philippines
Armenia	Guatemala	Poland
Belarus	Hungary	Romania
Bolivia	India	Russia
Brazil	Indonesia	Saudi Arabia
Bulgaria	Kazakhstan	Seychelles
Chile	Kenya	South Africa
China	Malaysia	Sri Lanka
Colombia	Mexico	Thailand
Costa Rica	Moldova	Turkey
Croatia	Morocco	Ukraine
Dominican Republic	Namibia	Uruguay
Ecuador	North Macedonia	

Table A2: Data Description

Variable	Description	Source
External debt	Gross Ext. Debt Pos., All Sectors, All maturities, All instruments, USD (% of GDP)	World Bank
USD exchange rate	National currency per USD, end of period, direct quotation, indexed to 100 in Q1 2010	IMF
Exchange rate volatility	Eight quarters moving standard deviation of first differences of logarithm of exchange rate	IMF/self-calculated
NEER	Nominal effective exchange rate, indirect quotation, indexed to 100 in Q1 2010	IMF, BIS
Real GDP	Gross domestic product, constant prices, indexed to 100 for first observation for each country	IMF
Government consumption	General government final consumption expenditure (% of GDP)	World Bank
Private credit	Domestic credit to private sector (% of GDP)	World Bank
Debt forgiveness	Dummy variable, which takes the value of 1 if debt forgiveness and reduction took place in the given year and 0 otherwise	World Bank
M2	M2 in domestic currency, current prices (% of GDP)	Thomson Reuters
Sovereign debt crisis	Dummy variable, which takes the value of 1 if sovereign debt crisis took place in the given year and 0 otherwise	Laeven and Valencia (2018)
EMBI spread	J.P. Morgan Emerging Markets Bond Spread	World Bank
GDP (PPP) per capita	Gross domestic product per capita, constant prices, international USD	IMF
FDI net inflows	Difference between net incurrence of liabilities and net acquisition of financial assets, direct investments, USD (% of GDP)	IMF
Imports	Imports of goods, current prices (% of GDP)	Thomson Reuters
FX reserves	International Reserves and Liquidity, Total Reserves excluding Gold, USD (% of GDP)	IMF
ODA net inflows	Net ODA received (% of GNI)	World Bank
Financial development	Composite index of financial development	IMF
Government debt	Central government debt (% of GDP)	IMF
Central bank independence (CBI)	Weighted composite de-jure central bank independence index	Garriga (2016)
Central bank independence (normalized)	CBI multiplied by Rule of Law index, which was normalized to take values between 0.5 and 1.0	Self-calculated
Financial openness	Chinn-Ito Index of de jure financial openness	Chinn and Ito (2016)
Illicit capital flows	Net errors and omissions from Balance of Payments (% of GDP)	IMF

Table A3: Correlation Matrix

	Ext debt	USD ER	ER vol.	NEER	Real GDP	Gov. cons.	Priv. credit	Debt forgiv.	M2	Sov. debt cris.	EMBI spread	GDP (PPP) p.c.	FDI infl.	Imp-orts	FX res.	ODA infl.	Fin. dev.	Gov. debt	CBI	CBI norm.	Fin. open.
External debt	1.00																				
USD ER	0.07	1.00																			
ER volatility	0.02	0.13	1.00																		
NEER	-0.08	-0.80	-0.30	1.00																	
Real GDP	-0.04	-0.05	-0.11	0.10	1.00																
Gov. cons.	0.33	0.05	0.12	-0.06	0.01	1.00															
Private credit	0.04	-0.10	0.09	0.05	0.05	0.29	1.00														
Debt forgiv.	-0.03	0.04	0.01	0.03	0.02	0.05	0.08	1.00													
M2	0.06	-0.15	-0.05	0.13	-0.03	0.15	0.72	0.06	1.00												
Sov. debt crisis	0.01	0.04	0.03	-0.11	-0.02	0.01	-0.04	0.00	-0.03	1.00											
EMBI spread	-0.03	0.02	0.16	0.01	-0.01	0.05	-0.03	0.03	-0.02	0.00	1.00										
GDP (PPP) p.c.	0.34	0.08	0.09	0.10	0.02	0.36	0.26	-0.07	0.17	-0.03	0.02	1.00									
FDI infl.	0.40	-0.04	-0.02	0.01	0.07	0.02	-0.16	0.01	-0.13	-0.04	-0.05	-0.04	1.00								
Imports	0.54	-0.01	0.01	0.08	-0.05	0.37	0.05	0.03	0.14	-0.02	-0.03	0.08	0.33	1.00							
FX reserves	0.19	-0.11	-0.05	0.10	-0.07	0.33	0.22	0.03	0.39	-0.07	-0.03	0.37	0.02	0.26	1.00						
ODA infl.	0.02	-0.02	-0.07	-0.11	-0.12	-0.00	-0.30	0.03	0.01	-0.00	-0.03	-0.59	0.24	0.22	-0.16	1.00					
Fin. devel.	0.06	-0.06	0.10	0.00	-0.09	0.31	0.69	-0.01	0.52	-0.05	-0.01	0.60	-0.20	-0.09	0.30	-0.51	1.00				
Gov. debt	0.36	0.16	0.02	-0.26	-0.06	0.21	-0.02	-0.13	0.14	0.05	-0.01	-0.08	0.02	0.12	-0.07	0.16	0.01	1.00			
CBI	0.26	0.05	0.02	0.20	0.05	0.10	-0.33	-0.06	0.04	0.04	0.00	0.20	0.12	0.17	0.03	0.10	-0.11	-0.01	1.00		
CBI norm.	0.44	-0.01	0.05	0.21	0.11	0.07	-0.20	-0.01	0.07	0.00	0.00	0.40	0.16	0.41	0.11	0.11	-0.16	-0.05	0.95	1.00	
Fin. open.	0.22	-0.29	-0.17	0.17	0.16	-0.12	-0.28	0.14	-0.10	-0.06	-0.08	0.20	0.20	0.19	0.12	-0.01	-0.22	-0.15	0.38	0.45	
NEO	-0.04	0.06	0.05	-0.06	-0.02	-0.03	-0.03	-0.04	-0.11	-0.00	0.00	-0.04	-0.13	-0.03	-0.05	-0.01	-0.06	0.00	-0.03	-0.03	-0.03

Notes: ER stands for exchange rate. CBI stands for central bank independence. CBI norm stands for the measure of central bank independence normalized by rule of law index. NEO stands for our measure of illicit capital flows.

Table A4: Panel Unit Root Tests I

		External debt	USD ER	ER volatility	NEER	Real GDP	Gov. cons.	Private credit	Debt forgiv.	M2	Sov. debt crisis	EMBI spread
	Observations	1,854	1,854	1,854	1,185	1,854	1,854	1,854	1,854	1,307	1,854	1,854
	Number of panels	41	41	41	24	41	41	41	41	30	41	41
	Avg. number of periods	45	45	45	49	45	45	45	45	44	45	45
Im-Pesaran-Shin	P-value	0.00***	1.00	1.00	0.81	1.00	1.00	1.00	1.00	0.84	1.00	0.00***
Dickey-Fuller	Inverse chi-squared, p-value	0.62	1.00	0.18	0.25	1.00	0.97	0.02**	0.91	0.16	1.00	0.00***
	Inverse normal, p-value	0.91	1.00	0.02**	0.52	1.00	0.95	0.75	0.00***	0.97	0.07*	0.00***
	Inverse logit, p-value	0.94	1.00	0.02**	0.51	1.00	0.95	0.74	0.00***	0.82	0.08*	0.00***
	Mod. inv. chi-squared, p-value	0.64	0.99	0.18	0.26	1.00	0.96	0.01***	0.90	0.16	1.00	0.00***
Phillips-Perron	Inverse chi-squared, p-value	0.00***	0.64	0.07*	0.31	0.83	0.89	0.00***	0.37	0.01***	1.00	0.00***
	Inverse normal, p-value	0.00***	0.94	0.00***	0.64	1.00	0.96	0.95	0.00***	0.90	0.00***	0.00***
	Inverse logit, p-value	0.00***	0.87	0.00***	0.63	1.00	0.95	0.82	0.00***	0.55	0.00***	0.00***
	Mod. inv. chi-squared, p-value	0.00***	0.65	0.07*	0.32	0.83	0.88	0.00***	0.39	0.00***	1.00	0.00***

Notes: P-values are reported. For all panel unit root tests, the H0 is that all panels contain unit root. For Im-Pesaran-Shin test, the Ha is that some panels are stationary, while for Dickey-Fuller and Phillips-Perron test, the Ha is that at least one panel is stationary. ER stands for exchange rate.

Table A5: Panel Unit Root Tests II

		GDP (PPP) p.c.	FDI net infl.	Imports	FX reserves	ODA net infl.	Fin. develop.	Gov. debt	CBI	CBI norm.	Fin. open.	NEO
	Observations	1,854	1,802	1,538	1,854	1,375	1,703	1,638	1,854	1,823	1,728	1,803
	Number of panels	41	40	37	41	35	40	38	41	41	41	40
	Avg. number of periods	45	45	42	45	39	43	43	45	44	42	45
Im-Pesaran-Shin	P-value	1.00	0.00***	0.00***	0.00***	1.00	0.99	0.06*	1.00	0.99	1.00	0.00***
Dickey-Fuller	Inverse chi-squared, p-value	0.11	0.00***	0.29	0.21	0.83	0.00***	0.00***	0.00***	0.00***	0.09*	0.00***
	Inverse normal, p-value	1.00	0.00***	0.47	0.45	0.95	0.81	0.00***	0.00***	0.98	0.06*	0.00***
	Inverse logit, p-value	1.00	0.00***	0.49	0.44	0.94	0.55	0.00***	0.00***	0.82	0.02**	0.00***
	Mod. inv. chi-squared, p-value	0.11	0.00***	0.30	0.21	0.83	0.00***	0.00***	0.00***	0.00***	0.08*	0.00***
Phillips-Perron	Inverse chi-squared, p-value	0.66	0.00***	0.00***	0.00***	0.44	0.10	0.00***	0.00***	0.05*	0.00***	0.00***
	Inverse normal, p-value	1.00	0.00***	0.00***	0.00***	0.13	0.72	0.37	0.00***	0.94	0.00***	0.00***
	Inverse logit, p-value	1.00	0.00***	0.00***	0.00***	0.15	0.61	0.00***	0.00***	0.75	0.00***	0.00***
	Mod. inv. chi-squared, p-value	0.67	0.00***	0.00***	0.00***	0.46	0.10*	0.00***	0.00***	0.04**	0.00***	0.00***

Notes: P-values are reported. For all panel unit root tests, the H0 is that all panels contain unit root. For Im-Pesaran-Shin test, the Ha is that some panels are stationary, while for Dickey-Fuller and Phillips-Perron test, the Ha is that at least one panel is stationary. CBI stands for central bank independence.

Table A6: Westerlund Panel Cointegration Test I

Statistic	(1)	(2)	(3)	(4)	(5)	(6)
Gt	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
Ga	0.01***	0.16	0.70	0.67	0.32	0.19
Pt	0.00***	0.00***	0.03**	0.00***	0.00***	0.00***
Pa	0.00***	0.00***	0.99	0.01***	0.00***	0.00***

Notes: P-values are reported. H0 is no cointegration. For Gt and Ga statistic, rejection of H0 should be taken as evidence of cointegration of at least one cross-sectional unit. For Pt and Pa statistic, rejection of H0 should be taken as evidence of cointegration for the entire panel. The reported results correspond to our baseline regressions. That is, column (1) corresponds to specification (4) in Table 2, column (2) corresponds to specification (4) in Table 3. While columns 3-6 correspond to specifications (1), (3), (5) and (7) from Table 5, respectively.

Table A7: Westerlund Panel Cointegration Test II

Statistic	(1)	(2)	(3)	(4)	(5)	(6)
Gt	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
Ga	0.78	0.83	0.84	0.93	0.97	0.96
Pt	0.01**	0.00***	0.00***	0.00***	0.00***	0.00***
Pa	0.99	0.00***	0.03**	0.00***	0.07*	0.04**

Notes: P-values are reported. H0 is no cointegration. For Gt and Ga statistic, rejection of H0 should be taken as evidence of cointegration of at least one cross-sectional unit. For Pt and Pa statistic, rejection of H0 should be taken as evidence of cointegration for the entire panel. The reported results correspond to the specifications from Table 6.

Table A8: Robustness Checks

Variables	(1)	(2)	(3)	(4)
	External debt (% of GDP)			
Long-run equation				
NEER	-0.217**			
	(0.084)			
USD exchange rate		0.051***	0.064***	
		(0.017)	(0.021)	
Exchange rate volatility				0.901***
				(0.273)
Real GDP	-0.002	0.000	-0.046***	-0.144***
	(0.002)	(0.000)	(0.014)	(0.027)
Gov. cons. (% of GDP)	3.344***	2.221***	-7.113***	2.413***
	(1.156)	(0.566)	(1.290)	(0.219)
Private credit (% of GDP)	1.094***	0.482***	4.371***	0.127***
	(0.232)	(0.137)	(0.307)	(0.028)
Constant			79.502***	2.734
			(17.948)	(6.218)
Short-run equation				
Error correction	-0.080***	-0.124***	-0.023**	-0.032***
	(0.008)	(0.015)	(0.010)	(0.012)
D.NEER	0.068**			
	(0.035)			
D.USD exchange rate		-0.010	-0.101**	
		(0.022)	(0.045)	
D.Exchange rate volatility				-0.202
				(0.128)
D.Real GDP	0.003***	0.002	-0.032	0.073
	(0.000)	(0.002)	(0.055)	(0.058)
Constant	-3.218**	-2.785***		
	(1.363)	(0.974)		
Estimator	DFE	DFE	PMG	PMG
Observations	1,185	1,425	1,854	1,854
Countries	24	34	41	41

Notes: D stands for the first difference. NEER is expressed in indirect quotation, thus an increase in its value represents appreciation of domestic currency. USD exchange rate is expressed in direct quotation, thus, an increase in its value represents depreciation. The increase in the value of the measure of exchange rate volatility corresponds to higher exchange rate volatility. Specifications 1 and 2 were estimated with the DFE estimator, while specifications 3 and 4 were estimated with the standard PMG estimator. Specification 2 excludes countries, which have Euro as their anchor currency. Standard errors are in parentheses. * indicates significance at 10 % level, ** at 5 % level and *** at 1 % level.

Table A9: Asymmetrical Effect of Exchange Rate on External Debt – With Interactions

Variables	(1) External debt (% of GDP)	(2) External debt (% of GDP)
Long-run equation		
USD exchange rate	-0.035	
	(0.067)	
NEER		-0.078
		(0.063)
Real GDP	-0.001	-0.002
	(0.002)	(0.002)
Gov. cons. (% of GDP)	2.765***	3.338***
	(0.989)	(1.140)
Private credit (% of GDP)	0.954***	1.082***
	(0.368)	(0.230)
Interact (USD Exchange rate*Depreciation)	0.137*	
	(0.079)	
Interact (NEER*Depreciation)		-0.269**
		(0.127)
Short-run equation		
Error correction	-0.092***	-0.080***
	(0.017)	(0.007)
D.USD exchange rate	-0.077***	
	(0.024)	
D.NEER		0.070*
		(0.037)
D.Real GDP	0.001	0.003***
	(0.002)	(0.000)
Constant	-3.255**	-4.228**
	(1.641)	(1.700)
Observations	1,854	1,185
Countries	41	24

Notes: D stands for the first difference. NEER is expressed in indirect quotation, thus an increase in its value represents appreciation of domestic currency. USD exchange rate is expressed in direct quotation, thus, an increase in its value represents depreciation. Depreciation is a dummy variable, which takes the value of 1 if the domestic currency had depreciated in the given quarter and zero otherwise. All the regressions were estimated with the DFE estimator. Standard errors are in parentheses. * indicates significance at 10 % level, ** at 5 % level and *** at 1 % level.

Table A10: Asymmetrical Effect of Exchange Rate Depreciation on External Debt – With Interactions

Variables	(1) External debt (% of GDP)	(2) External debt (% of GDP)
Long-run equation		
USD exchange rate	-0.049	
	(0.081)	
NEER		-0.076
		(0.065)
Interact (USD exchange rate*Depreciation Small)	0.115	
	(0.084)	
Interact (USD exchange rate*Depreciation Medium)	0.213	
	(0.134)	
Interact (USD exchange rate*Depreciation Large)	0.497*	
	(0.291)	
Interact (NEER*Depreciation Small)		-0.125**
		(0.057)
Interact (NEER*Depreciation Medium)		-0.576
		(0.405)
Interact (NEER*Depreciation Large)		-1.621**
		(0.814)
Real GDP	-0.001	-0.002
	(0.002)	(0.002)
Gov. cons. (% of GDP)	2.755**	3.653**
	(1.117)	(1.466)
Private credit (% of GDP)	0.988**	1.061***
	(0.406)	(0.209)
Short-run equation		
Error correction	-0.091***	-0.077***
	(0.019)	(0.009)
D.USD exchange rate	-0.122***	
	(0.045)	
D.NEER		0.101*
		(0.059)
D.Real GDP	0.001	0.003***
	(0.002)	(0.000)
Constant	-3.189*	-4.431**
	(1.724)	(1.913)
Observations	1,854	1,185
Countries	41	24

Notes: D stands for the first difference. NEER is expressed in indirect quotation, thus an increase in its value represents appreciation of domestic currency. USD exchange rate is expressed in direct quotation, thus, an increase in its value represents depreciation. Depreciation Small is a dummy variable, which takes the value of 1 if the domestic currency had depreciated in the given quarter by less than 5 % and zero otherwise. Depreciation Medium is a dummy variable, which takes the value of 1 if the domestic currency had depreciated in the given quarter by between 5 % and 10 %, and zero otherwise. Depreciation Large is a dummy variable, which takes the value of 1 if the domestic currency had depreciated in the given quarter by more than 10 % and zero otherwise. All the regressions were estimated with the DFE estimator. Standard errors are in parentheses. * indicates significance at 10 % level, ** at 5 % level and *** at 1 % level.

Figure A1: Average External Debt (% of GDP)

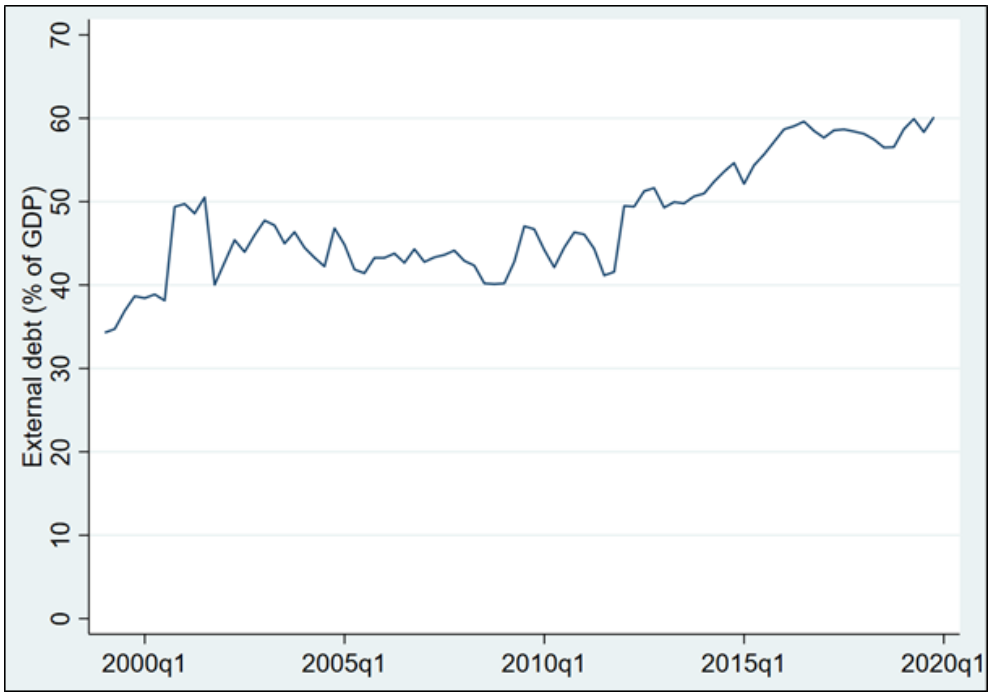


Figure A2: Average Exchange Rate of Domestic Currency per U.S. Dollar (Index 100=2010)

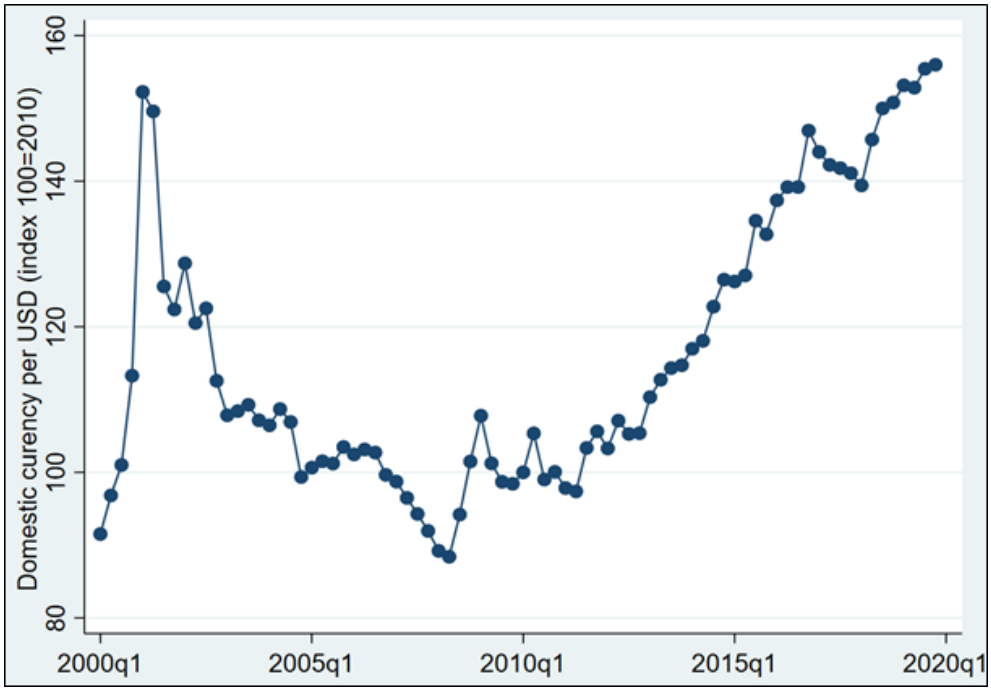


Figure A3: Average Exchange Rate Volatility by Exchange Rate Regime

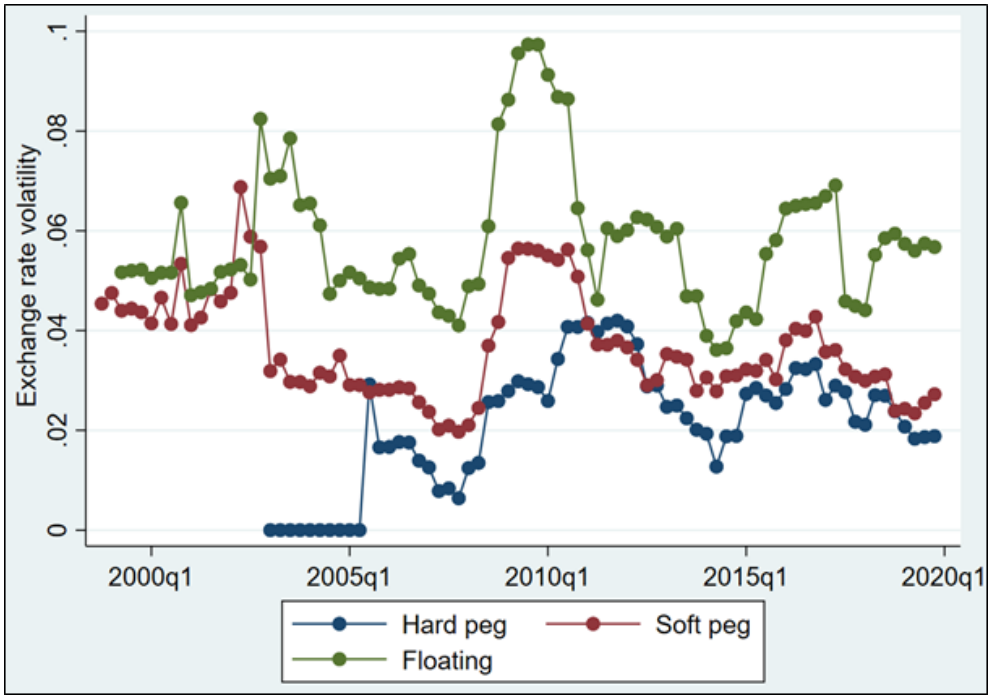
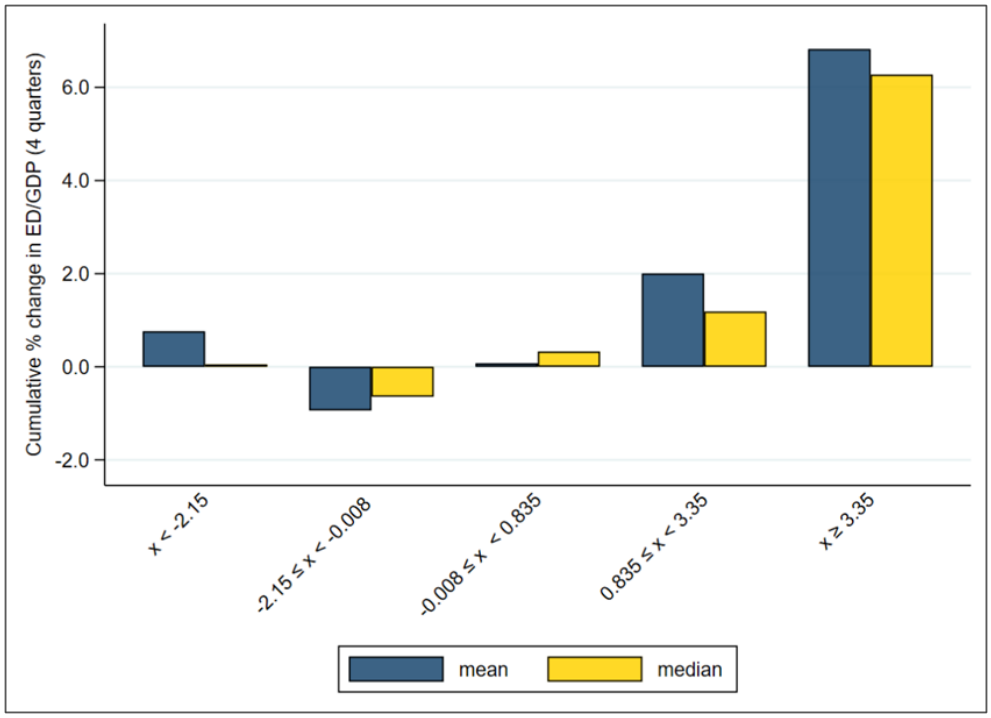


Figure A4: Mean and Median Annual Change of External Debt After Different Changes in Exchange Rate



Notes: Y-axis represents different quarterly % changes of exchange rate. The five intervals correspond to quintiles of exchange rate changes (i.e., each interval contains fifth of observations of exchange rate changes). Exchange rate is expressed in direct quotation, that is, positive changes represent depreciations.

Figure A5: Total Marginal Effects (TME) of Exchange Rate on External Debt - Conditional on Exchange Rate Regime (ERR)

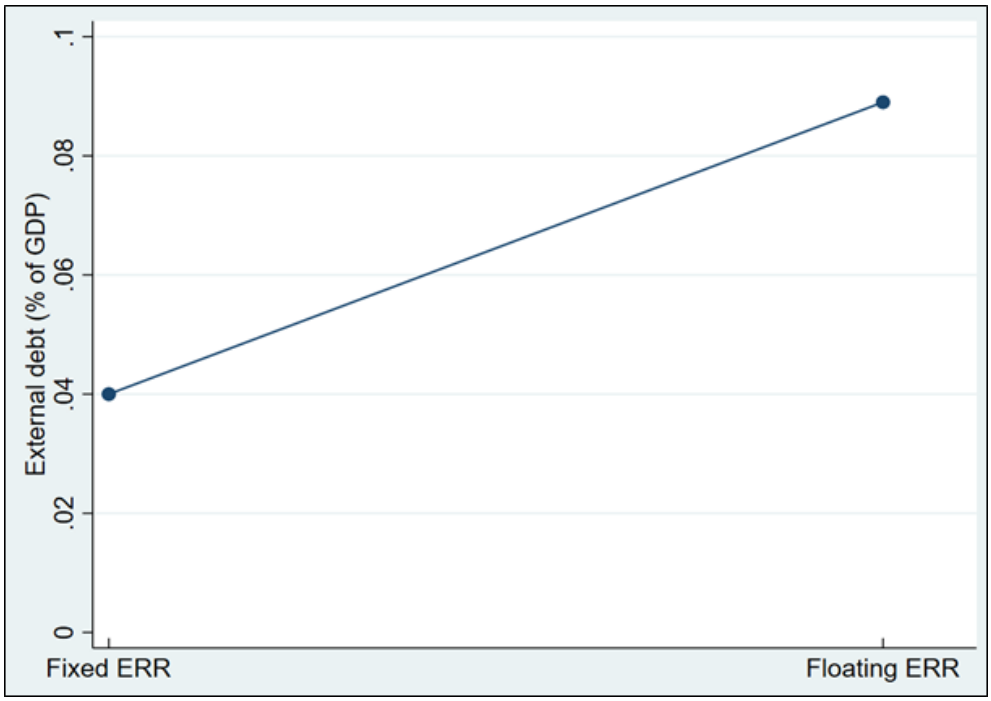
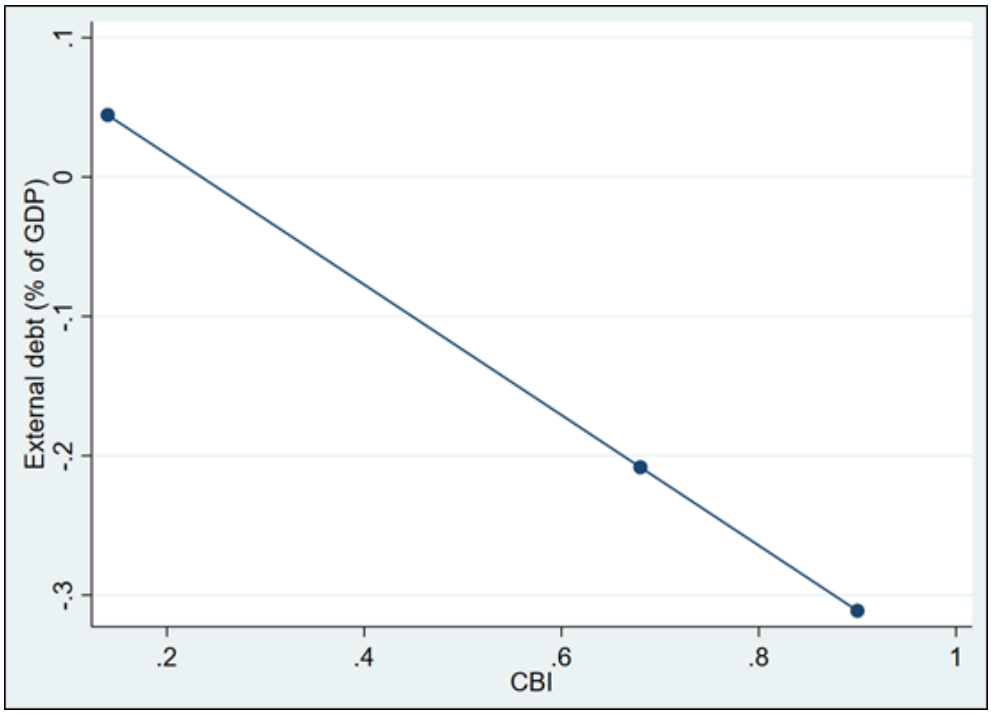
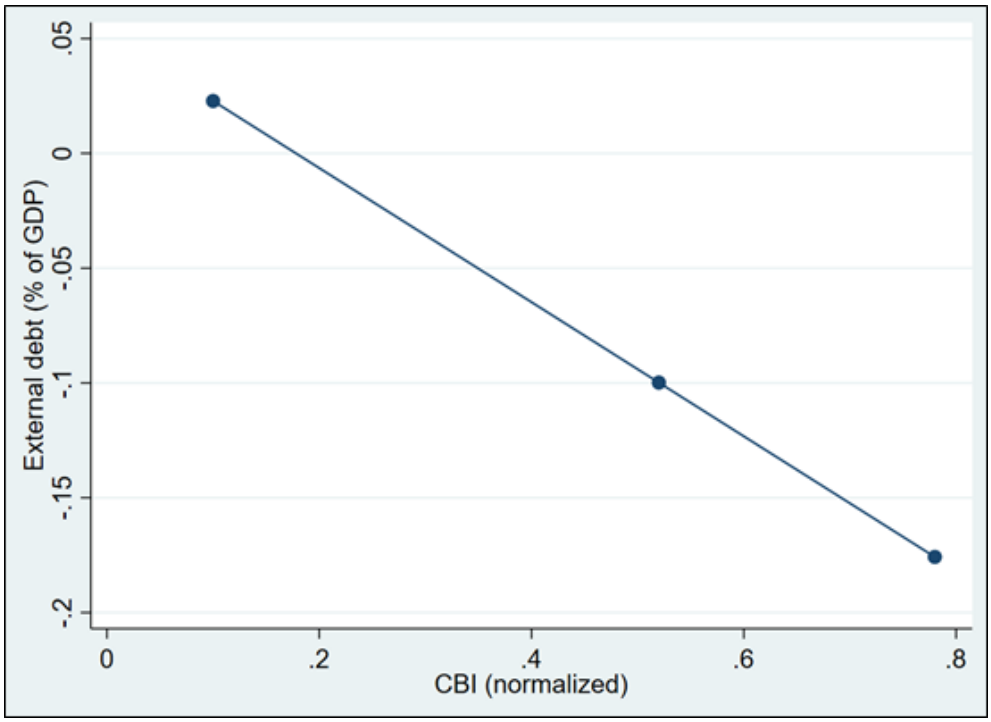


Figure A6: Total Marginal Effects (TME) of Exchange Rate on External Debt - Conditional on Central Bank Independence (CBI) Index



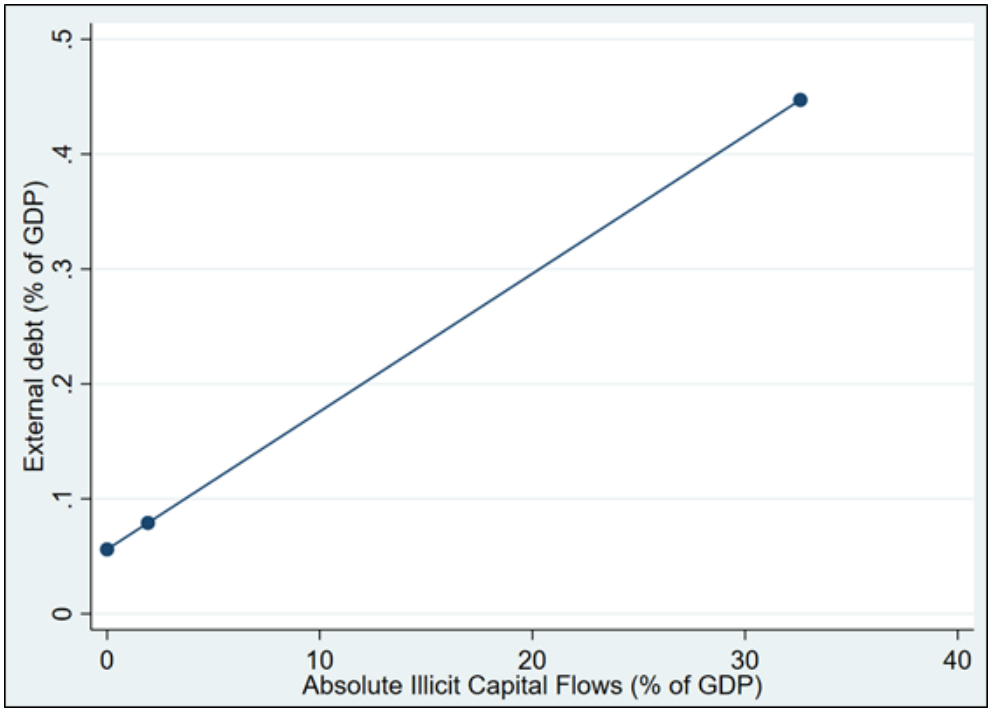
Notes: Response of external debt to depreciation at minimum, mean, and maximum values of CBI.

Figure A7: Total Marginal Effects (TME) of Exchange Rate on External Debt - Conditional on Normalized Central Bank Independence (CBI) Index



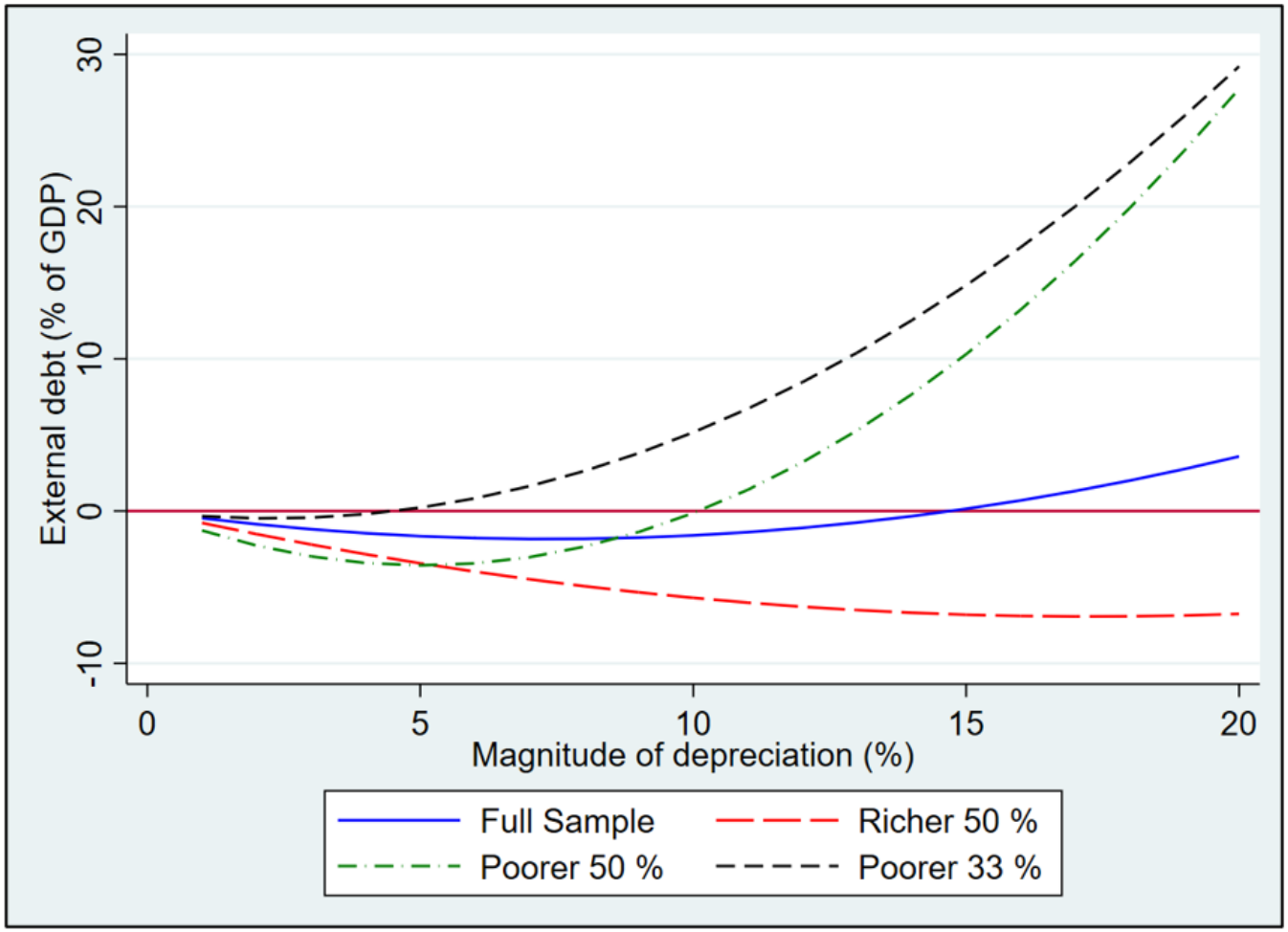
Notes: Response of external debt to depreciation at minimum, mean, and maximum values of CBI normalized.

Figure A8: Total Marginal Effects (TME) of Exchange Rate on External Debt – Conditional on Illicit Capital Flows



Notes: Response of external debt to depreciation at minimum, mean, and maximum values of absolute illicit capital flows.

Figure A9: Effect of Depreciation on External Debt at Different Magnitudes of Depreciation



Notes: Full sample stands for the entire sample of 41 emerging economies, Richer 50 % stands for emerging countries from our sample with above sample median GDP (PPP) per capita, Poorer 50 % stands for countries with GDP (PPP) per capita below sample median, while Poorer 33 % stands for the poorest third of the emerging countries from our sample. Y-axis: long-term response of external debt to GDP ratio to different magnitudes of depreciation (x-axis).

Figure A10: Impulse Response Function (IRF) of External Debt to Exchange Rate

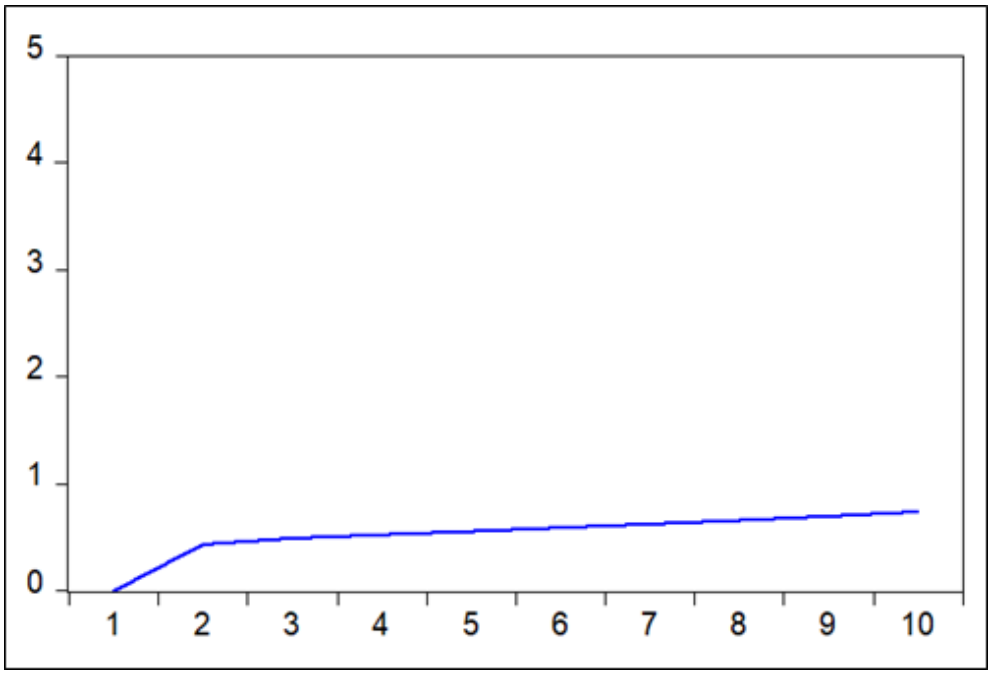
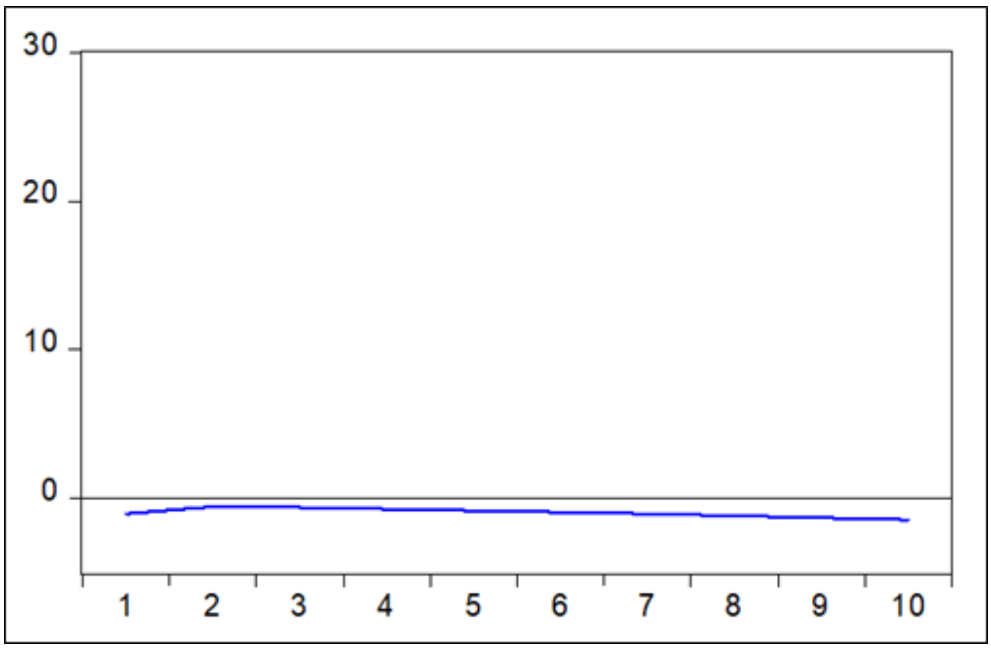


Figure A11: Impulse Response Function (IRF) of Exchange Rate to External Debt



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