J. Int. Financ. Markets Inst. Money 88 (2023) 101818

Contents lists available at ScienceDirect

Journal of International Financial Markets, Institutions & Money

journal homepage: www.elsevier.com/locate/intfin

Global financial uncertainty shocks and external monetary vulnerability: The role of dominance, exposure, and history☆

Karsten Kohler[a,*], Bruno Bonizzi[b], Annina Kaltenbrunner[c]

[a] Economics Department, Leeds University Business School, Maurice Keyworth Building, Woodhouse, Leeds LS2 9JT, United Kingdom
[b] University of Hertfordshire, Business School, United Kingdom
[c] Leeds University Business School, United Kingdom

A R T I C L E I N F O

JEL classification:
E44
F31
F32
G15

Keywords:
International financial system
Gross capital flows
Exchange rates
Foreign exchange intervention
Global uncertainty shocks
Emerging markets

A B S T R A C T

The paper investigates the role of country-specific factors in external monetary vulnerability to global uncertainty shocks. We identify three structural determinants that may shape cross-country heterogeneity in the monetary response to financial uncertainty shocks: dominance in the international monetary and financial system, exposure to fickle capital flows, and volatile macrofinancial histories. Based on vector autoregressions, we operationalise external monetary vulnerability through an index based on estimated impulse responses of interest rate differentials, exchange rates, and foreign exchange reserves from quarterly data for 36 countries. We then investigate the covariates of this index and find that history and exposure are most strongly related to a country's external vulnerability. In particular, past currency and sovereign default crises as well as exposure to non-bank foreign investors and portfolio debt may increase sensitivity to a global uncertainty shock. By contrast, macroeconomic fundamentals such as public debt appear less relevant.

1. Introduction

The asymmetric nature of the international monetary and financial system is a long-standing theme in international finance. Especially the role of the US dollar as the dominant international currency and its associated 'exorbitant privilege' has been studied extensively (Eichengreen, 2012; Eichengreen et al., 2018; Farhi and Maggiori, 2017; Gopinath and Stein, 2020; Gourinchas et al., 2019; Maggiori et al., 2019). It has been argued that this asymmetric structure renders countries that issue non-dominant currencies, especially emerging markets, vulnerable to episodes of increased financial uncertainty (Andrade and Prates, 2013; Bonizzi, 2017; Kaltenbrunner, 2015; de Paula et al., 2017).[1] Some theoretical work suggests that international currencies offer investors a non-pecuniary 'liquidity yield' or 'safety premium' reflected in lower borrowing costs (Engel, 2016; Engel and Wu, 2022; Farhi and Maggiori, 2017; Gopinath and Stein, 2020). Episodes of increased global financial uncertainty lead to an increase in the liquidity yield on international currency assets, resulting in a flight-to-quality phenomenon that comes with an appreciation of those currencies. By contrast, non-dominant currency assets must offer a higher expected rate of return, reflected in depreciations of the spot exchange rate and rising interest rate differentials – a monetary response that tends to be particularly severe in emerging

☆ We are grateful for helpful comments from Qi Dong, Matthew Greenwood-Nimmo, Jakob Kapeller, Sophie Van Huellen as well as participants of the 7th Cross Country Perspectives in Finance (CCPF) Conferences in June and December 2022, the research seminar of the Institute for Socio-Economics (University Duisburg–Essen) in June 2022, the 25th FMM Conference in October 2021, and the 33th EAEPE Conference in September 2021. All errors are ours.

* Corresponding author.
E-mail addresses: k.kohler@leeds.ac.uk (K. Kohler), b.bonizzi@herts.ac.uk (B. Bonizzi), a.kaltenbrunner@leeds.ac.uk (A. Kaltenbrunner).

[1] This literature uses the notion of a 'currency hierarchy' to describe the asymmetric structure of the international monetary and financial system.

https://doi.org/10.1016/j.intfin.2023.101818
Received 26 March 2023; Accepted 7 August 2023
Available online 16 August 2023

market economies (Bhattarai et al., 2020; Choi, 2018; Fink and Schüler, 2015) and often comes with financial instability and economic contraction. Recent theoretical and empirical work suggests that the effects of such adverse shocks on exchange rates and interest rates may successfully be mitigated through sterilised foreign exchange intervention (Alla et al., 2019; Blanchard et al., 2015; Frankel, 2019; Ghosh et al., 2016), but only at a loss in foreign exchange reserves.

An aspect that has been explored less is how these monetary effects differ across countries. How heterogeneous are countries in their monetary response to financial uncertainty shocks? And what country-specific factors determine this heterogeneity? The present paper addresses these questions with a two-step empirical strategy.[2] First, we quantify the monetary effects of a global financial uncertainty shock proxied by the US stock market volatility index VIX on a set of 36 countries with independent currencies and floating exchange rates, comprising both advanced (AEs) and emerging market economies (EMEs). From country-wise vector autoregressions (VARs) with quarterly data with a maximum span from 1990Q1 to 2019Q4,[3] we estimate the response of the US dollar exchange rate, the interest rate differential, and the change in foreign reserves, controlling for gross capital flows as key transmitters of the shock. Based on the cumulative impulse responses, we construct an *external monetary vulnerability index* that measures the severity in the depreciation of exchange rates, the rise in the interest rate differential, and the loss in foreign reserves, allowing for a cross-country comparison of degrees of vulnerability.

In a second step, we explore in multivariate regressions potential structural, i.e. country-specific and slow-changing, factors that may explain the observed cross-country heterogeneity. Drawing on various branches of literature, we identify three main types of structural factors that shape vulnerability to global financial uncertainty shocks: (i) the degree of dominance in the international monetary and financial system, which may give rise to safe-asset status that reduces monetary vulnerability (Eichengreen et al., 2018; Farhi and Maggiori, 2017; Gopinath and Stein, 2020; Gourinchas et al., 2019; Maggiori et al., 2019); (ii) exposure to fickle capital flows and currency mismatches given that non-bank foreign investors might be sensitive to global factors (Cerutti et al., 2019; Puy, 2016; Raddatz and Schmukler, 2012) and that foreign-currency debt can increase volatility (Eichengreen et al., 2007); and (iii) volatile macrofinancial histories such as past currency crises and sovereign defaults, which may influence historically entrenched risk perceptions of investors (Burger and Warnock, 2006). We compare the explanatory power of those structural factors with standard macroeconomic fundamentals such as GDP per capita, the stock of foreign reserves, public debt ratios, and the monetary policy regime. Besides various robustness tests, we also perform a cluster analysis to gain further insights into the empirical incidence of those structural determinants across different groups of countries and how they map into differences in external monetary vulnerability.

Our analysis contributes to a growing literature on the domestic effects of global financial shocks in four ways (Aizenman et al., 2016; Akıncı, 2013; Bhattarai et al., 2020; Bonciani and Ricci, 2020; Carrière-Swallow and Céspedes, 2013; Choi, 2018; Fink and Schüler, 2015; Gelos et al., 2022; Kalemli-Özcan, 2019; Miranda-Agrippino and Rey, 2020; Li et al., 2019; Obstfeld et al., 2019; Obstfeld and Zhou, 2023). First, many studies specifically focus on EMEs (Bhattarai et al., 2020; Choi, 2018; Fink and Schüler, 2015; Gelos et al., 2022; Obstfeld et al., 2019; Obstfeld and Zhou, 2023), whereas we consider both EMEs and AEs, enabling us to assess how well the AE/EME distinction predicts external monetary vulnerability. Second, while most research has investigated the response of indicators related to domestic real and financial activity (Choi, 2018; Bonciani and Ricci, 2020; Fink and Schüler, 2015; Gelos et al., 2022; Obstfeld et al., 2019; Obstfeld and Zhou, 2023), we are specifically concerned with the *monetary* response represented by the US-dollar exchange rate and the interest rate differential. This allows us to capture the flight-to-quality phenomenon discussed in the theoretical literature on liquidity yields (Engel, 2016; Engel and Wu, 2022; Farhi and Maggiori, 2017; Gopinath and Stein, 2020). Third, existing empirical research has not accounted for sterilised foreign exchange intervention that may mitigate the effect on exchange rates and short-term interest rates, but comes at a cost. By considering losses in FX reserves as part of monetary vulnerability, our analysis speaks to the aforementioned theoretical work on FX intervention (Alla et al., 2019; Benes et al., 2015; Cavallino, 2019; Gabaix and Maggiori, 2015; Ghosh et al., 2016). Fourth, and most importantly, while a few studies have shown that cross-country heterogeneity in the macroeconomic response to uncertainty shocks is related to institutional quality (Choi, 2018; Bonciani and Ricci, 2020; Gelos et al., 2022), the exchange rate regime (Gelos et al., 2022; Obstfeld et al., 2019; Obstfeld and Zhou, 2023), different monetary policy strategies (Bhattarai et al., 2020; Obstfeld and Zhou, 2023), and trade and financial openness (Bonciani and Ricci, 2020; Gelos et al., 2022), we account for structural factors related to countries' relevance in the international monetary and financial system, exposure to capital flows, and macrofinancial histories that have hitherto received less attention. In this way, we provide empirical evidence for the literature that has highlighted deeply rooted factors that shape the effects of financial integration, which in turn helps identify policies beyond conventional macroeconomic stabilisation that may reduce vulnerability.

Our main findings are as follows. First, we document substantial cross-country heterogeneity in the monetary response to global financial uncertainty shocks. EMEs like Brazil, Russia, and Argentina exhibit the strongest external monetary vulnerability. At the opposite end of the spectrum are AEs such as Switzerland, Japan, and Germany that display little sensitivity to the shock at all or even gain foreign reserves. Perhaps more surprisingly, some EMEs such as Thailand and the Philippines also exhibit relatively low degrees of external vulnerability, whereas, for example, New Zealand and Norway display above-average vulnerability. This suggests that the common finding that EMEs are more strongly affected by uncertainty shocks (Bonciani and Ricci, 2020; Carrière-Swallow and Céspedes, 2013) only holds as a rough approximation when it comes to external monetary vulnerability. Second, we

[2] A two-step approach to investigate cross-country heterogeneity has also been applied, e.g., in Cerutti et al. (2019) and Aizenman et al. (2016), but with different research questions.

[3] Our main focus is on the pre-pandemic period, but in robustness tests we also consider an extended sample period until 2022Q4.

find that whereas macrofinancial history, exposure to capital flows, and dominance in the international monetary and financial system are all related to the degree of vulnerability, history and exposure exhibit the greatest explanatory power and are robust throughout various specifications. Monetary dominance is also relevant, but has lower explanatory power and is slightly less robust. By contrast, macroeconomic fundamentals appear less relevant for a country's vulnerability in flight-to-quality episodes. Third, we identify four country groups: two extremes that perform well (poorly) across all three structural determinants which maps into low (high) external vulnerability, and two intermediate groups of countries that exhibit a medium sensitivity to external shocks despite rather different structural characteristics. One intermediate group of mostly AEs is relatively dominant but exposed, whereas another intermediate group of mostly Asian EMEs is not dominant but also not strongly exposed. This suggests that monetary dominance and exposure may to some degree offset each other in their effect on external monetary vulnerability. Overall, our results suggest that external monetary vulnerability is affected by slow-changing structural factors beyond short-term macroeconomic stability. Correspondingly, our analysis highlights structural policies such as support for domestic financial institutions that reduce countries' exposure to volatile capital flows.

The remainder of the paper is structured as follows. The next section reviews literature that informs our choice of structural determinants of monetary vulnerability. Section 3 discusses the empirical strategy and data. Section 4 presents the empirical results: estimated degrees of vulnerability, their determinants, the clustering of determinants across country groups, and various extensions and robustness tests. The last section concludes and discusses implications of our findings.

2. Global uncertainty shocks and monetary vulnerability: Theory and existing evidence

A strand of theoretical literature that is closely related to our empirical analysis studies domestic effects of adverse global financial shocks in an environment of imperfect financial markets (Alla et al., 2019; Cavallino, 2019; Farhi and Werning, 2014; Gabaix and Maggiori, 2015). In these small-open economy models, uncovered interest rate parity (UIP) does not hold as there is imperfect substitutability across internationally traded financial assets, which is reflected in risk premia. A representative (log-linearised) version of such a risk-adjusted UIP condition can be written as

$$(\mathbb{E}[s_{t+1}] - s_t) - (i_t - i_t^*) + \phi_t + \beta\theta_t = 0, \tag{1}$$

where $s_t, i_t, i_t^*, \phi_t, \theta_t, \beta$ are the spot exchange rate (domestic currency units per foreign currency unit), the domestic and foreign interest rate, an endogenous and exogenous component of the risk premium, and the sensitivity to the exogenous shock. An increase in the exogenous risk premium θ_t, e.g. due to a global uncertainty shock, lowers foreigners' appetite for home assets, which must be offset by a depreciation of the spot exchange rate (an increase in s_t), a rise in the interest rate differential, a reduction in the endogenous component of the risk premium ϕ_t, or a combination of those responses. A closely related strand of literature has argued that θ_t may constitute a non-monetary 'liquidity yield' or 'safety premium' on international safe assets (Engel, 2016; Engel and Wu, 2022; Farhi and Maggiori, 2017; Gopinath and Stein, 2020). A global uncertainty shock may then increases the safety premium on internationally dominant currencies.

The risk-adjusted UIP condition is often integrated into small-open economy models to study the effectiveness of capital controls or sterilised foreign exchange intervention (FXI) in reducing macroeconomic volatility. In these models, FXI operates through a portfolio balance channel as it changes the asset composition of the private sector, which in turn manipulates the endogenous component ϕ_t of the risk premium on domestic assets. The central bank can thus mitigate some of the effects of the global uncertainty shock, leading to a smaller depreciation of the domestic currency and a lower increase in the domestic interest rate at the expense of a loss in foreign reserves. A theoretical implication of this approach that has been less explored is that the intensity of the response to external shocks, represented by the parameter β, may differ across countries based on certain country-characteristics.[4]

A more empirically-oriented literature studies domestic macroeconomic effects of global uncertainty shocks and financial distress (Bhattarai et al., 2020; Carrière-Swallow and Céspedes, 2013; Choi, 2018; Fink and Schüler, 2015; Li et al., 2019; Obstfeld et al., 2019; Obstfeld and Zhou, 2023). This research has shown that shocks to US financial conditions captured by, e.g., the stock market volatility index VIX or US systemic financial stress indicators have considerable contractionary real effects abroad, especially in EMEs. With respect to the monetary effects, Bhattarai et al. (2020) document for a sample of 15 EMEs capital flow reversals, currency depreciation, and higher borrowing cost, consistent with the above theoretical framework. They find a more procyclical monetary policy response for a group of Asian EMEs (plus Russia and Turkey) compared to a group of Latin American EMEs, which they relate to greater monetary policy concerns over capital flow volatility. Choi (2018) finds that the rise in interest rate differentials is attenuated by institutional quality such as the strength of legal rights and efficiency of debt enforcement. Obstfeld et al. (2019) document that countries with fixed exchange rate regimes undergo a stronger contraction in domestic credit growth. Bonciani and Ricci (2020) use interaction terms in a local projection framework to study the effects of shocks to a global factor in the realised volatility in risky asset prices. They document cross-country heterogeneity that is related to external debt and financial risk ratings. (Obstfeld and Zhou, 2023) document currency depreciation, increased policy rates, and lower equity prices for a panel of 26 EMEs in response to an appreciation of the US dollar against a basket of advanced economy currencies. The heterogeneity of these effects depends on the exchange rate regime, monetary policy framework and external liabilities. Gelos et al. (2022) study the effects of an increase in US corporate bond spreads on the distribution of capital flows to EMEs. They find that structural characteristics

[4] In Alla et al. (2019), β is equal to unity, whereas in Cavallino (2019) and Gabaix and Maggiori (2015), it depends on exchange rate volatility and foreign investors' sensitivity to it. Farhi and Werning (2014) more generally discuss investors' preferences for a particular country's assets.

mediate these effects: capital account openness exacerbates flows, financial market development mitigates them, while institutional quality does not have a significant impact. Unlike these studies, we consider structural determinants that have not been investigated before that are related to the international monetary system, exposure to capital flows, and macrofinancial history. Furthermore, we compare AEs and EMEs and specifically focus on the response of exchange rates and interest rates while allowing for FXI.

The theoretical underpinnings for the structural factors we consider stem from a strand of literature that discusses countries' positions in the international monetary and financial system. The factors highlighted therein are not normally discussed in the literature on uncertainty shocks. One branch of this literature focuses on international currencies that are used as foreign exchange reserves, units of account in international debt contracts, and international means of exchange (e.g. to invoice trade) (Chinn and Frankel, 2008; Eichengreen, 2012; Eichengreen et al., 2018; Farhi and Maggiori, 2017; Gopinath and Stein, 2020; Gourinchas et al., 2019; Maggiori et al., 2019). International currency status is associated with the 'exorbitant privilege' of a weaker external constraint, reflected in low external borrowing cost and excess returns on external assets. In periods of international financial stress, the demand for internationally liquid safe assets increases, resulting in currency appreciation and reduced yields (Engel, 2016; Engel and Wu, 2022). While the focus has long been on the US dollar as the dominant international currency, the rise of the euro and the Chinese yuan demonstrate that international currency status need not be confined to a single currency (Chinn and Frankel, 2008; Eichengreen et al., 2018; Eichengreen and Lombardi, 2017). Preconditions for international currency (or safe asset) status are financial openness and size (Chinn and Frankel, 2008): to be internationally liquid, a currency issuer must be able to absorb foreign assets in exchange for domestic assets. Other factors are attractiveness for investors through stability in value and the ability to service their debt, as reflected in macroeconomic fundamentals such as fiscal surpluses and low public debt ratios (He et al., 2019).

A further branch of theoretical literature examines currencies that do not have international or safe asset status (Andrade and Prates, 2013; Bonizzi, 2017; Kaltenbrunner, 2015; de Paula et al., 2017). For these currency issuers, flight-to-quality episodes typically come with currency depreciation and rising borrowing cost. Cerutti et al. (2019) empirically document that the sensitivity of individual countries to a common global factor in bond and equity portfolio flows is largely determined by exposure to global mutual funds. Several studies show that mutual funds are more sensitive in their international portfolio allocation to global financial shocks than other financial investors (Puy, 2016; Raddatz and Schmukler, 2012). An earlier literature explores the causes and consequences of not being able to borrow abroad in home currency, the so-called 'original sin' (Eichengreen et al., 2007). Original sin is associated with increased macroeconomic vulnerability to external shocks and especially prevalent in EMEs, but has become somewhat less acute for many public borrowers over the last two decades. Burger and Warnock (2006) argue that countries with better historical inflation performance and stronger legal institutions exhibit more developed local bond markets. This suggests that macrofinancial histories may influence the sensitivity of countries to global financial shocks.

In sum, the literature on global uncertainty shocks on the one hand documents a flight-to-quality phenomenon in response to global financial distress that is consistent with recent theoretical work on UIP deviations due to financial market imperfections. On the other hand, the literature on the international monetary and financial system and exposure of countries to capital flows implies that uncertainty shocks can be expected to have uneven impacts across countries depending on structural characteristics. Specifically, the more dominant a currency's role in the international monetary system, the less likely it is to undergo currency depreciation, interest rate increases, and losses in FX reserves. By the same token, currencies with more volatile macrofinancial histories that do not enjoy international currency status, are exposed to risk-sensitive foreign investors, and suffer from original sin are expected to exhibit a more adverse response to financial stress. Our analysis ties these two separate strands together by providing an analysis of structural sources to cross-country heterogeneity in response to financial uncertainty shocks, allowing us to consider factors beyond macroeconomic fundamentals.

3. Empirical strategy and dataset

3.1. Estimation approach

In the first step of our two-step empirical strategy, we run country-wise vector VARs that estimate the response of domestic macro-financial variables to a global financial shock. The structural VAR(p) takes the form:

$$A_0 y_t = \nu + \sum_{j=1}^{p} A_j y_{t-j} + \epsilon_t, \tag{2}$$

where y_t is a vector of m variables, ν is a vector of intercepts, p is the lag order, A_0 and A_j are $m \times m$ parameter matrices, and ϵ_t is a vector of error terms. In the following, the vector y_t will include a proxy for the global financial shock x_t followed by a set of endogenous domestic financial variables $y_{1t}, y_{2t}, \ldots, y_{m-1t}$. In line with the theoretical literature discussed above, the response variables are the exchange rate (*XR*), the interest rate differential (*INTR*), and the change in foreign exchange reserves (*FXI*). In addition, we control for gross capital inflows (*GKI*) and outflows (*GKO*) as key transmitters of the shock. Thus, the vector y_t is given by $y_t = [x_t, XR_t, INTR_t, FXI_t, GKI_t, GKO_t]'$.

The estimated reduced-form version of the VAR(p) in Eq. (2), written in VAR(1)-form, is given by $y_t = \mu + By_{t-1} + u_t$, where B is the $pm \times pm$ companion matrix. To obtain structural impulse response functions (*IRFs*), we rely on the common identification assumption that the global financial shock does not respond contemporaneously to any of the domestic variables in the VAR and thus order x_t first.[5] As in Schmitt-Grohé and Uribe (2018), we additionally require the specification of the first equation for the global financial shock x_t to be identical across countries to enable a cross-country comparison. To achieve this, we first estimate a univariate autoregressive model for x_t using the Akaike information criterion (AIC) to determine the optimal lag length q. Prior to estimation, we then impose restrictions on the reduced-form coefficient matrix B, such that $b_{1,q+1}, \ldots, b_{1,pm} = 0$, where $b_{1,s}$ are the coefficients of the first row of B. This ensures that the first equation in the VAR is a univariate autoregressive process of order q for all countries. We will examine the robustness of our results to this restriction. Finally, note that in line with common practice (e.g. Bhattarai et al., 2020; Cesa-Bianchi et al., 2018), all variables are included in (log-)levels without prior filtering since the slope coefficients on unit root variables can be re-written as coefficients on differenced (and thus stationary) variables (Sims et al., 1990). We use the AIC to determine the lag length p of each country-specific VAR (allowing for a maximum lag length of four). Based on our identification strategy, we obtain impulse responses of all domestic variables in the VAR to a global financial shock.

To construct our index of external monetary vulnerability, we use the cumulative impulse responses in the fourth quarter of *INTR*, *XR*, and the negative of *FXI*, defined as $CIRF_4^k = \sum_{i=0}^{4} IRF_i^k$, where $k = INTR, XR, -FXI$.[6] Taking a weighted mean over these three cumulative responses, where the weights are given by the inverse of the average over country-wise standard deviations ($w_k = 1/\overline{SD_k}$), yields what we call the *external monetary vulnerability index* (*VULNEX*):

$$VULNEX = \frac{1}{\sum w_k}\left(\sum_k w_k CIRF_4^k\right). \tag{3}$$

This measure assigns larger weights to the responses of variables with smaller variation. We will assess the robustness of our main results to two alternative versions of the *VULNEX*: one with the inverse of the standard errors of the cumulative IRF as weights to account for estimation uncertainty, and one based on an unweighted average.[7]

In a second step, we explore the correlates of this measure through multivariate cross-country regressions. Based on our discussion in Section 2, we consider several proxies that capture the three structural determinants monetary dominance, exposure, and macrofinancial history. We contrast these determinants with several macroeconomic fundamentals. We will use principal component analysis to parsimoniously combine information embodied in different proxies (discussed in more detail below) to reduce multicollinearity, but also explore the performance of individual proxies.

3.2. Dataset and empirical indicators

Our dataset covers 36 economies, out of which 24 are commonly regarded as EMEs and 13 as AEs.[8] The sample reflects our focus on comparing countries with independent currencies that exhibit a certain degree of flexibility such that the exchange rate can carry some of the adjustment. We excluded the USA as the issuer of the dominant international currency and the source of the global financial shock, countries without an independent currency, and countries with pegged exchange rates as documented in the comprehensive regime classification in Ilzetzki et al. (2019). We included the Euro Area as a whole, as well as its three largest economies: France, Germany, and Italy.[9] Given these restrictions, country choice was mostly governed by quarterly data availability.[10] To maximise the time span for each country, data from multiple sources were pooled. The maximum span ranges from 1990Q1 to 2019Q4. In some cases, overlapping interest rates series of different length were spliced by extrapolating newer series backwards with the growth rate of older series to obtain the maximum possible number of observations.[11] As in Blanchard et al. (2015), we restricted the sample start in a few cases to exclude major crises events that led to changes in the exchange rate regime (see Appendix A). On average, the country-wise VARs have 73 degrees of freedom.

To proxy the global financial shock, we follow a large literature and use the log of the Chicago Board Options Exchange Market Volatility index (*VIX*) (Alla et al., 2019; Bruno and Shin, 2015; Bhattarai et al., 2020; Carrière-Swallow and Céspedes, 2013; Choi, 2018; Obstfeld et al., 2019; Rey, 2015). Alternative financial shock indicators will be explored in robustness tests. Our measure for the exchange rate is the (logged) bilateral nominal exchange rate with the US dollar (*XR*).[12] We consider both short- and long-term

[5] This implies that A_0^{-1} has a lower-triangular structure. A_0^{-1} can then be retrieved through the Cholesky decomposition P of the variance–covariance matrix Σ_u of the reduced-form VAR, $\Sigma_u = PP'$, such that $P = A_0^{-1}$ (Lütkepohl 2005, chap.2). A recursive structure is commonly assumed in the uncertainty shock literature even with respect to US macroeconomic variables; see Caggiano et al. (2020) for a discussion. Note that the ordering of the remaining variables is irrelevant for the identification of the structural shock of the first variable (x_t).

[6] The negative of *FXI* measures losses in foreign reserves; thereby all three measures can be interpreted as indicators of vulnerability to a global financial shock.

[7] We further experimented with weights based on principal component analysis and on interquartile ranges instead of standard deviations, and the results were very similar.

[8] EMEs: Argentina, Brazil, Chile, China, Colombia, Czech Republic, Georgia, Guatemala, Hungary, India, Indonesia, Israel, Korea, Mexico, Paraguay, Peru, Philippines, Poland, Romania, Russia, Singapore, South Africa, Thailand, Turkey.
AEs: Australia, Canada, Euro Area, France, Germany, Iceland, Italy, Japan, New Zealand, Norway, Sweden, Switzerland, United Kingdom.

[9] We refrained from including further Euro Area countries as their policy rate and exchange rate are identical, so that the results can be expected to be similar.

[10] We dropped countries for which there were less than 30 degrees of freedom in the VAR. In the baseline VAR with *INTR_ST*, Georgia was therefore excluded as it had less than 30 degrees of freedom, leaving 36 countries.

[11] See Appendix A for details.

[12] An increase in *XR* thus represents a depreciation of the domestic currency vis-á-vis the US dollar. Effective exchange rates, which are trade-weighted exchange rates with respect to a basket of currencies, would be an alternative, but these series typically have a shorter time span. Given the dominant role of the US dollar in trade invoicing, international credit contracts, and foreign exchange reserves (Gopinath and Stein, 2020; Maggiori et al., 2019), the US dollar exchange rate is the most important exchange rate for the countries in our sample.

Table 1
Determinants of cross-country heterogeneity.

Type	Variable	Definition	Used in principal component
Monetary dominance	*FXTURN*	Share of currency in global foreign exchange market turnover	*PC_DOMINANCE*
	FORASSET	Gross foreign assets (excluding FX reserves) to GDP	
	KAOPEN	Chinn-Ito capital account openness index	
Exposure	*NONBANKINV*	Share of government debt held by non-bank foreign investors	*PC_EXPOSURE*
	PORTFDEBT	Net portfolio external debt to foreign exchange turnover ratio	
	FCLIAB	Share of foreign currency liabilities	
Macrofinancial history	*CURCRIS*	Annual historical frequency of currency crises	*PC_HISTORY*
	SOVDEFAULT_DOM	Annual historical frequency of domestic sovereign default	
	SOVDEFAULT_EXT	Annual historical frequency of external sovereign default	
Fundamentals	*GINI_PC*	Gross national income per capita in US dollars	
	FXRES	Foreign exchange reserves (excluding gold) to GD	
	IT	Number of years of inflation targeting (1990–2019)	
	GOVDEBT	Government debt to GDP ratio	

nominal interest rates. The policy or short-term interest rate (*INTR_ST*) is used in the baseline estimation, but we also check whether results differ with the long-term interest rate on (typically 10-year) government bonds (*INTR_LT*). Both variables are constructed as the differential with respect to the corresponding US interest rate. The change in foreign exchange reserves captures foreign exchange intervention by central banks (*FXI*). Following Blanchard et al. (2015), we construct it as the change in reserve assets plus changes in the central bank off-balance sheet foreign-exchange position, which measures intervention through derivative operations. The measure is normalised by lagged (and seasonally adjusted) nominal GDP. As short-term capital flows are expected to transmit the effect of global financial shocks on domestic financial variables, we additionally include the sum of portfolio and other investment gross in- and outflows (*GKI* and *GKO*), also normalised by lagged GDP.

For the second step, we compile a cross-country dataset of structural determinants of monetary vulnerability. For the majority of indicators, we use the median value of annual data over the period 2006–2019 (unless stated otherwise).[13] For the degree of dominance in the international monetary and financial system (Eichengreen, 2012; Farhi and Maggiori, 2017; Gourinchas et al., 2019; Maggiori et al., 2019), we consider (i) the share of the domestic currency in global foreign exchange market turnover (*FXTURN*), (ii) the gross foreign asset position (excluding foreign exchange reserves) as a ratio to GDP (*FORASSET*) as a proxy for size (Chinn and Frankel, 2008), from the database compiled by Lane and Milesi-Ferretti (2018),[14] and (iii) financial openness as pre-condition for monetary dominance (Chinn and Frankel, 2008), utilising the financial account openness index (*FINOPEN*) constructed by Chinn and Ito (2006).[15]

Second, several measures are used to assess the exposure to fickle capital flows and currency mismatches. To account for different types of external creditors that may differ in their sensitivity to global financial shocks (Cerutti et al., 2019; Puy, 2016; Raddatz and Schmukler, 2012), we consider the share of government debt held by foreign private investors, drawing on the updated database compiled by Arslanalp and Tsuda (2014b,a). We use a breakdown into bank (*BANKINV*) and non-bank foreign investors (*NONBANKINV*) with our main focus on the latter which have been found to be more sensitive to global financial shocks (Cerutti et al., 2019; Puy, 2016; Raddatz and Schmukler, 2012). In addition, the ratio of net portfolio external debt relative to foreign exchange turnover was used to proxy exposure to short-term external liabilities that are expected to be more responsive to shocks (*PORTFDEBT*). Finally, to account for exposure to currency mismatches as a source of volatility (Eichengreen et al., 2007), we use the share of external liabilities that are denominated in foreign currency (*FCLIAB*) from (Bénétrix et al., 2019).

Third, we use a set of measures for volatile macrofinancial histories that may impact the liquidity and risk perceptions of international investors (Burger and Warnock, 2006). Drawing on the historical work on financial crises by Reinhart and Rogoff (2011), we consider currency crises (*CURCRIS*) and sovereign defaults (*SOVDEF*) (external and domestic), and will also explore inflation crises (*INFLCRIS*) for comparison.[16] We use the annual frequency of these events between 1800 and 1989, i.e. before the sample start of our VAR estimations.[17] This rules out trivial contemporaneous correlations between these measures and the *VULNEX*. As an alternative measure for exchange rate risk, we also consider the volatility of the nominal US dollar exchange rate between the end of the Bretton Woods system and the sample start of the VAR (1974Q1-1989Q4), which we construct as the coefficient of variation over this period (*XRVOL*).

[13] The starting date for the median values is set in correspondence with the latest country-specific sample start of the VARs (2006 for China). While the estimation sample for most countries reaches back well beyond 2006, a common cut-off was implemented to ensure the determinants are comparable across countries. See Appendix A for data definitions and sources.

[14] We will compare the gross position to the net foreign asset position (*NFA*), which is less informative about size.

[15] We also experimented with the index constructed by Fernández et al. (2014), which is highly correlated with the one by Chinn and Ito (2006), but it made little difference to our results.

[16] Currency crises are defined as an annual depreciation of 15% or more. External sovereign defaults are defined as the failure to meet a principal or interest payment on foreign debt obligations on the due date under the conditions specified in the original contract. Domestic sovereign default is defined analogously but does not involve external creditors. Inflation crises are annual inflation rates of 20% or higher.

[17] Our main results are robust to counting the annual crisis frequency from 1900 instead of 1800.

Finally, we consider a number of macroeconomic fundamentals. The gross national income per capita in US dollars (*GNI_PC*) captures economic development, which is correlated with economic and political stability as well as institutional quality. In addition, we also examine the foreign exchange reserves-to-GDP ratio (*FXRES*) to capture the ability to intervene in FX markets, the number of years a country pursued an inflation-targeting regime between 1990 and 2019 (*IT*) as an indicator of the monetary policy commitment to price stability, and the government debt-to-GDP ratio (*GOVDEBT*) as an indicator for a country's ability to service its debts (He et al., 2019).

Based on this grouping of explanatory factors, we use first principal components (PCs) to create indices (see Table 1). The eigenvectors of the PCA are reported in Appendix C. It can be seen that all individual indicators load positively on the first PCs, i.e. a higher share in global FX turnover increases the score of *PC_DOMINANCE*, a higher ratio of net portfolio debt increase *PC_EXPOSURE* and so forth. Instead of a PC for solid macroeconomic fundamentals for which the factor loadings did not have consistent signs,[18] we insert the relevant proxies individually in the regressions.

4. Results

4.1. Impulse responses and external monetary vulnerability index

Fig. 1 depicts the median over the country-wise impulse responses to a one standard-deviation shock to the *VIX*, together with the interquartile range.[19] A one standard-deviation shock to the *VIX* corresponds to an increase by around 21% (for comparison, the *VIX* rose by about 85% in the fourth quarter of the 2008 crisis). It can be seen that after about 10 quarters, the shock has largely dissipated.[20] The global financial shock comes with a median depreciation of the domestic currency against the US dollar by almost 2% in the first quarter. The differential of the domestic short-term interest rate with respect to the US federal funds rate increases by almost 0.2%-pts, peaking in the fifth quarter. The interquartile range indicates that some countries undergo a substantially stronger increase in the interest rate than others. There is a median loss in foreign exchange reserves through FX sales of around 0.17% of GDP on impact. The interquartile range again points to heterogeneity, with some countries intervening quite heavily whereas others' foreign reserves barely change. Short-term gross capital in- and outflows contract severely on impact (by about 3.4% and 0.55% of GDP, respectively) and take several quarters to return to their steady states. Overall, these results are in line with the theoretical discussion in Section 2: an increase in financial uncertainty enforces a higher expected rate of return for the median country, but there is also evidence that the intensity of this response differs considerably across countries.

Fig. 2 displays the *VULNEX*, our proxy for the degree of external monetary vulnerability as defined in Eq. (3), ranked from lowest to highest.[21] We note that the top eight of the ranking is populated by Switzerland with a score of −1.6, followed by Thailand, Japan, Chile, Germany, the Euro Area, Iceland, and the United Kingdom (with a score of 0.35). Many of those countries are AEs that are known to be financial centres, and some may enjoy regional safe asset status. However, with Thailand and Chile, there are also two EMEs among the top eight of the ranking. This illustrates that the commonly applied binary distinction between AEs and EMEs constitutes at best a rough predictor for monetary vulnerability. The bottom eight of the ranking are made up of EMEs starting with Colombia with a score of 1.9, then Mexico, Brazil, Brazil, Paraguay, Turkey, Romania, Russia, and finally Argentina with a score of 5.4. Indeed, many of these countries are known to regularly undergo volatile macrofinancial episodes. However, the *VULNEX* also shows that some EMEs are substantially worse off than others. Overall, this calls for a more detailed examination of the structural determinants of vulnerability across countries.

4.2. Determinants of external monetary vulnerability

4.2.1. Regression analysis with principal components

Fig. 3 gives a first impression of the relationship between the *VULNEX* and the main determinants of interest. GNI per capita is negatively correlated with the *VULNEX*, as richer countries tend to exhibit lower external monetary vulnerability. However, it is also evident that income alone does a poor job at explaining different degrees of vulnerability across countries with a similar level of income, specifically at lower levels. As expected, *PC_DOMINANCE* is negatively correlated with the *VULNEX*; but it fails to explain substantial variation in the *VULNEX* between countries like Thailand and Argentina. *PC_EXPOSURE* and *PC_HISTORY* exhibit the expected positively correlation and comparatively high R^2s of 0.28 and 0.37, respectively. Overall, the scatter plots indicate a potential role for all of the four types of determinants, but suggest that the indices individually only have limited explanatory power.

Table 2 reports results from multivariate regressions of the *VULNEX* on the principal components.[22] Specification (1) is the baseline, containing all three indices: *PC_DOMINANCE*, *PC_EXPOSURE*, and *PC_HISTORY*. Each index is statistically significant at conventional levels and exhibits the expected sign: monetary dominance reduces the vulnerability score, whereas exposure to fickle

[18] *GNI_PC* and *FXRES* load positively, but *IT* and *GOVDEBT* negatively and positively, respectively.

[19] Figure A1 in Appendix B alternatively displays a weighted average of the country-specific IRFs along with weighted averages of the country-specific confidence bands. The results are very similar.

[20] The estimated lag length q of the univariate process for the VIX is $q = 1$.

[21] Cumulative IRFs in the fourth quarter of all variables in the VAR along with confidence bands are reported in Appendix B.

[22] Due to data availability constraints, the Euro Area, Guatemala, Iceland, Paraguay, and Singapore drop out, yielding $N = 31$ observations in the baseline regression.

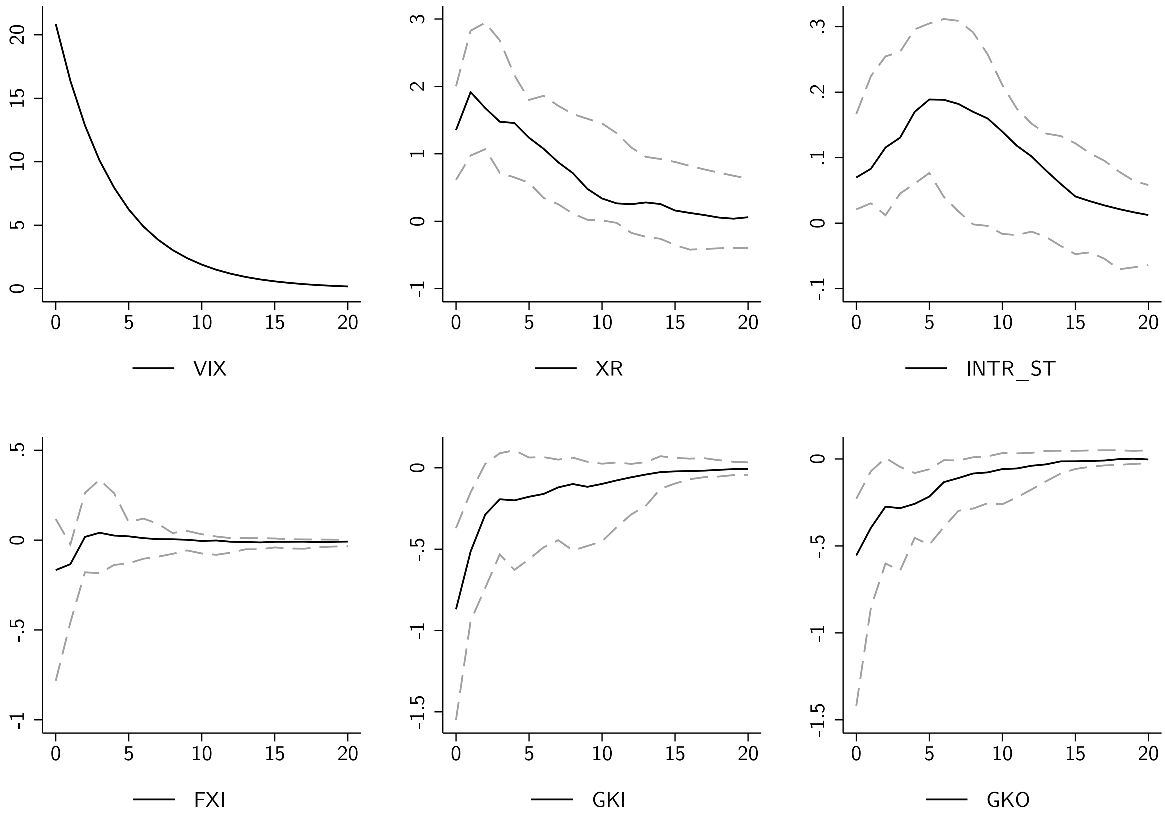

Fig. 1. Impulse responses to VIX shock.
Notes: Median (solid line) and interquartile range (dashed lines) over countries' impulse responses. VIX: logged implied volatility index in S&P500 stock options, XR: logged nominal exchange rate with US dollar; INTR_ST: short-term nominal interest rate differential with US; FXI: foreign exchange intervention(%GDP); GKI: short-term gross capital inflow (%GDP); GKO: short-term gross capital outflows (%GDP).

capital flows and currency mismatches, and a history of crises increase it. Compared to the binary regressions reported in Fig. 3 with R^2s of up to 0.37, the explanatory power of this model increases to an adjusted R^2 of 0.49. We also report a Shapley decomposition of the adjusted R^2 into the relative percentage shares contributed by each of the three variables. History appears to have the largest explanatory power (52%), followed by exposure (34%) and dominance (14%).

Specifications (2)–(6) investigate the relevance of macroeconomic fundamentals. In (2), *GNI_PC* is added but turns out to be statistically insignificant and reduces the explanatory power compared to the baseline. However, *PC_DOMINANCE* becomes statistically insignificant, which is likely due to collinearity with *GNI_PC*.[23] Similarly, *FXRES* in specification (3) is statistically insignificant. While *IT* is statistically significant (at the 10% level) with the expected negative sign, its explanatory power is virtually zero as can be seen from the Shapley decomposition. *GOVDEBT* is statistically insignificant and reduces explanatory power compared to the baseline. Finally, specification (6) combines the three PCs with all fundamentals. Here, *FXRES* and *IT* are statistically significant and have the expected signs, whereas *GNI_PC* and *GOVDEBT* remain insignificant. However, the Shapley decomposition indicates that each of the fundamentals has comparatively low explanatory power (less than 7%) compared to the three PCs.

Overall, monetary dominance, exposure to capital flows, and volatile macrofinancial history all predict a country's monetary sensitivity to global financial shocks as measured by the *VULNEX*. Comparing the three groups of variables, macrofinancial history has the largest explanatory power, followed by exposure and monetary dominance. By contrast, GNI per capita and other macroeconomic fundamentals like the government debt ratio are less relevant. The only macroeconomic fundamentals that display some significance are the stock of foreign exchange reserves and inflation targeting, but these do not add notable explanatory power vis-á-vis history, exposure, and dominance. While the possibility of unresolved endogeneity problems calls for caution with a causal interpretation, these results provide insights into the types of countries that tend to be more sensitive to uncertainty shocks.

4.2.2. Regression analysis with individual indicators

Next, we examine the performance of individual indicators as opposed to principal components (see Table 3). We start with a baseline specification with the proxies we consider most relevant from the theoretical perspectives discussed above, and then

[23] The correlation between *GNI_PC* and *PC_DOMINANCE* is 0.75.

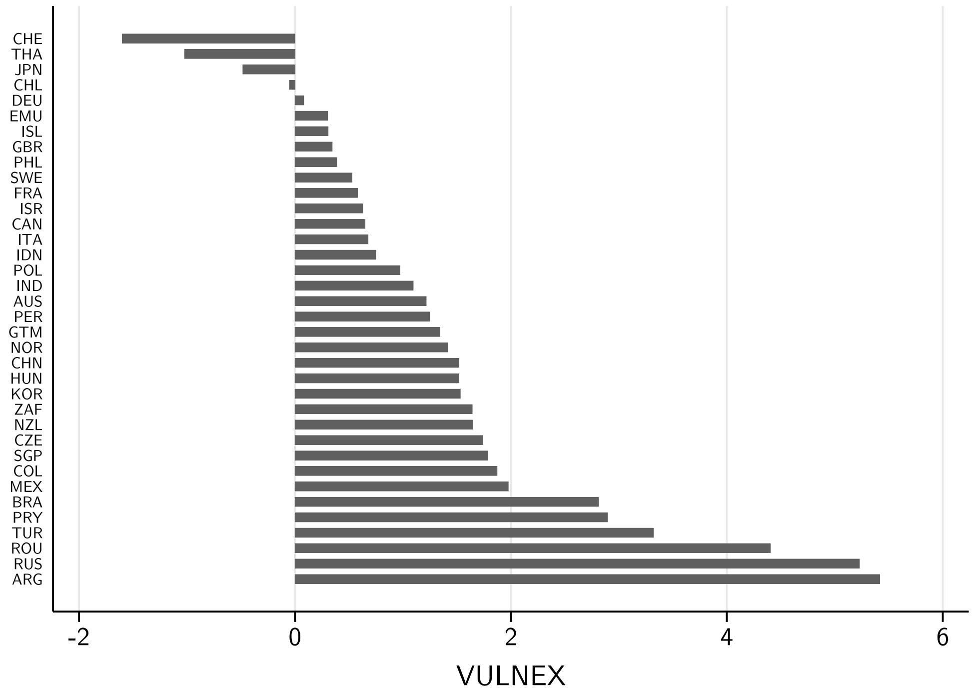

Fig. 2. External monetary vulnerability index (*VULNEX*).
Notes: *VULNEX* is the weighted mean over the cumulative impulse response of *INTR*, *XR*, and the negative of *FXI* in the fourth quarter. Weights are given by the inverse of the average country-wise standard deviations over those variables.

explore the performance of alternative proxies. The baseline (1) consists of *FXTURN* as the main indicator for monetary dominance in global foreign exchange markets, *NONBANKINV* for exposure to non-bank foreign investors, and the frequency of past currency crises (*CURCRIS*) as the main proxy for volatile macrofinancial histories. All three indicators are statistically significant and have the expected signs. The adjusted R^2 is 0.24, compared to 0.49 in the baseline specification with PCs (Table 2), suggesting that combining information from multiple proxies does improve explanatory power. According to the Shapley decomposition, *CURCRIS* has the largest contribution to the adjusted R^2 (56%) followed by *FXTURN* (25%) and *NONBANKINV* (19%).

Specifications (2)–(5) add macroeconomic fundamentals to the baseline (1). Similar to the regressions with PCs, *GNI_PC* is statistically insignificant and does not improve the explanatory power of the baseline (as reflected in a virtually identical adjusted R^2 and a higher AIC). The stock of foreign exchange reserves (*FXRES*) has the expected negative sign and is borderline statistically insignificant. It only marginally improves the explanatory power. The indicator for inflation targeting (*IT*) has the expected negative sign but is statistically insignificant. Similarly, the government debt to GDP ratio (*GOVDEBT*) is statistically insignificant and reduces the explanatory power of the model.

Specifications (6)–(11) test alternative proxies for our three structural determinants dominance, exposure, and history. In (6)–(7), we replace *FXTURN* with the net and gross foreign asset position, *NFA* and *FORASSETS*. Only *FORASSETS* is statistically significant and has the expected negative sign, confirming that *NFA* is not a good proxy for financial size and that gross positions are more important for the monetary response to financial shocks. Specifications (8)–(9) experiment with alternative measures of foreign exposure. In (8), *NONBANKINV* is replaced with the share of government debt held by foreign banks (*BANKINV*). Interestingly, this variable is statistically insignificant, indicating that non-bank foreign investors react more strongly than banks when international risk perceptions change. In (9), we use instead the share of foreign currency debt (*FCLIAB*), which has the expected positive sign but is borderline statistically insignificant, suggesting that exposure to fickle capital flows is more important for the *VULNEX* than currency mismatches. Specifications (10)–(11) further explore the relevance of volatile macrofinancial histories for the *VULNEX*. The volatility of exchange rates between 1974Q1 and 1989Q4 (*XRVOL*) as an alternative indicator for exchange rate risk is also positive and statistically significant (but less preferable than *CURCRIS* in terms of the number of observations). By contrast, the history of inflation crises (*INFLCRIS*) is not a statistically significant predictor of the *VULNEX*. This suggests that exchange rate instability may be more important for external monetary vulnerability than price instability.

Overall, this exercise confirms and expands the results with the PCs. Individual indicators for monetary dominance, exposure, and history are statistically significant and exhibit the expected signs. Besides relevance in global foreign exchange markets, the gross rather than net foreign asset position is negatively correlated with vulnerability. For exposure, non-bank foreign investors matter more than banks and currency mismatches. With respect to macrofinancial history, it is unstable exchange rate rather than inflation histories that correlate with current monetary vulnerabilities.

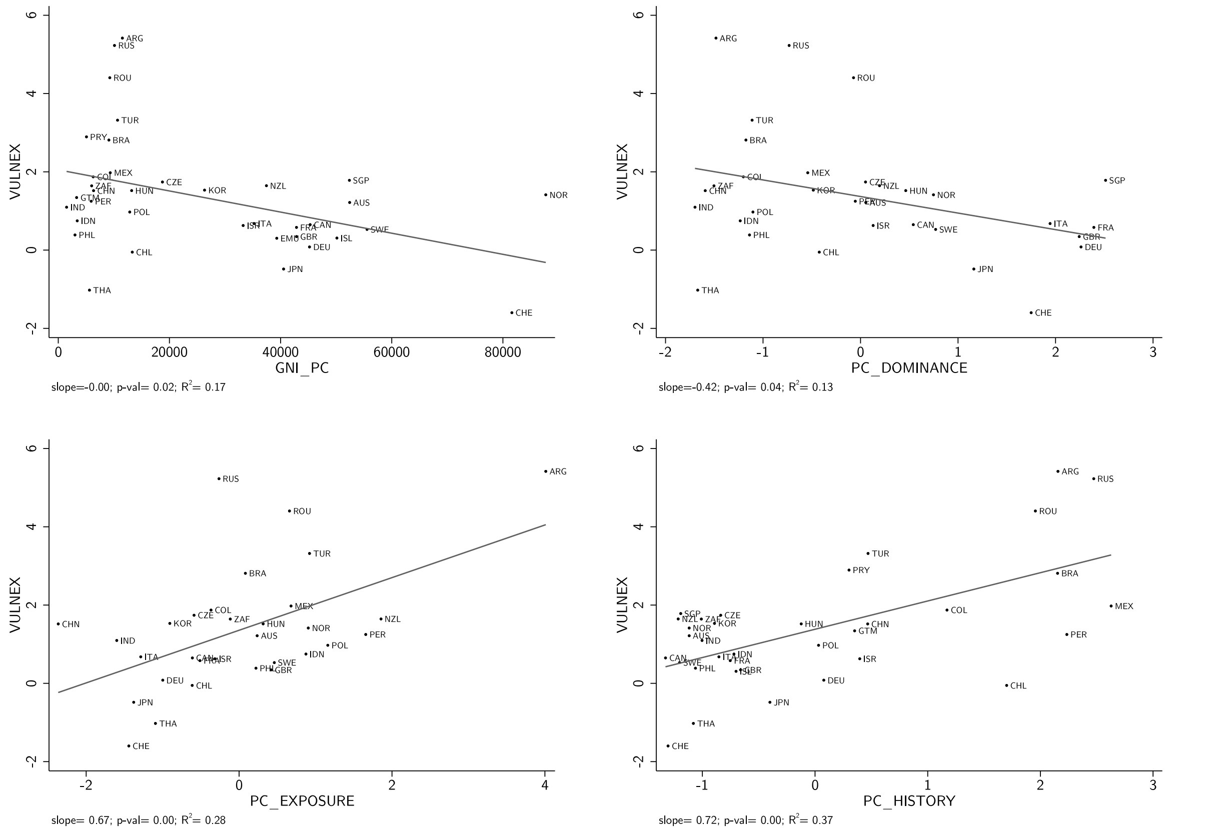

Fig. 3. Scatter plots of external monetary vulnerability index (*VULNEX*) and structural determinants.
Notes: Heteroskedasticity-robust standard errors were applied. p-val is the p-value of the slope coefficient. PC_DOMINANCE: first principal component of FXTURN, KAOPEN, and FORASSET; PC_EXPOSURE: first principal component of NONBANKINV, FCLIAB, and PORTFDEBT; PC_HISTORY: first principal component of CURCRIS, SOVDEF-DOM, and SOVDEF-EXT..

4.2.3. Cluster analysis

History, exposure, and dominance are all correlated with external monetary vulnerability, but how are they distributed across countries in our sample? To gain insights into the incidence of structural factors and how they map into vulnerability, we conduct a partition cluster analysis that splits countries into groups based on the three PCs. We use the k-medians clustering method,[24] specifying a predetermined number of $k = 4$ clusters for convenience.[25]

The first cluster contains only AEs: the Eurozone countries France, Germany, Italy, as well as Japan, the United Kingdom, and Switzerland (see Table 4). This cluster has the largest average score of *PC_DOMINANCE* and the lowest score of *PC_EXPOSURE*, and also exhibits the lowest average *VULNEX* (−0.07). The second cluster contains mostly AEs (Australia, Canada, Norway, New Zealand, and Sweden, as well as Czech Republic, Hungary, and Israel), while the third cluster consists of a group of only EMEs (China, India, Indonesia, Korea, Philippines, Poland, Thailand, Turkey, and South Africa). The second and third cluster have similar average *VULNEX* scores (1.17 and 1.13, respectively), but very different structural determinants: the second cluster performs relatively well with respect to monetary dominance and macrofinancial history but is quite strongly exposed to fickle capital flows and currency mismatches. Conversely, the third cluster ranks lowest in terms of monetary dominance but is less exposed than the second cluster. Finally, the fourth cluster is composed of another group of EMEs: Argentina, Brazil, Chile, Colombia, Mexico, Peru, Romania, and Russia. This group has the strongest exposure and most volatile history, and a comparatively low monetary dominance score. It is also the cluster with the highest *VULNEX* score of 2.86.

The clustering confirms our previous finding that the AE/EME divide only serves as a crude predictor of external monetary vulnerability. While financially dominant AEs with internationally relevant currencies clearly perform best and exposed EMEs with turbulent macrofinancial histories populate the bottom, there is no clear grouping into AEs and EMEs in the middle. Instead, we

[24] In the k-medians clustering method, grouping is accomplished via an iterative algorithm that starts by randomly using k individuals as group centres and then forming an initial clustering by assigning the remaining individuals to the group with the closest centre. Then the median over those initial clusters is calculated, and individuals are shifted again to the cluster whose median is closest. This process is repeated until no more reshuffling occurs.

[25] This is supported by the fact that any further reduction of the within sum of squares is negligible after $k \geq 4$.

Table 2
Multivariate regressions of external monetary vulnerability index (*VULNEX*) on structural determinants: principal components.

	(1)	(2)	(3)	(4)	(5)	(6)
PC_DOMINANCE	−0.255*	−0.273	−0.335**	−0.295**	−0.266	−0.465*
	(0.137)	(0.184)	(0.130)	(0.130)	(0.162)	(0.237)
PC_EXPOSURE	0.438***	0.435**	0.351*	0.530***	0.443**	0.412**
	(0.158)	(0.170)	(0.179)	(0.146)	(0.177)	(0.184)
PC_HISTORY	0.531**	0.539**	0.554**	0.462*	0.532**	0.500*
	(0.228)	(0.248)	(0.234)	(0.234)	(0.229)	(0.245)
GNI_PC		0.000				0.000
		(0.000)				(0.000)
FXRES			−0.024			−0.035*
			(0.017)			(0.019)
IT				−0.028*		−0.039**
				(0.016)		(0.018)
GOVDEBT					0.001	−0.002
					(0.007)	(0.006)
Constant	1.314***	1.277***	1.711***	1.718***	1.270**	2.420***
	(0.196)	(0.367)	(0.298)	(0.263)	(0.475)	(0.677)
Obs	31	31	31	31	31	31
Adj. R-squared	0.493	0.473	0.500	0.506	0.473	0.499
AIC	98.873	100.862	99.267	98.879	100.855	101.532
Shapley var1	0.142	0.096	0.171	0.151	0.125	0.114
Shapley var2	0.338	0.349	0.293	0.374	0.338	0.310
Shapley var3	0.520	0.482	0.531	0.474	0.533	0.433
Shapley var4		0.073	0.005	0.000	0.004	0.068
Shapley var5						0.038
Shapley var6						0.025
Shapley var7						0.013

Notes: Heteroskedasticity-robust standard errors were applied; standard errors in parentheses. AIC: Akaike information criterion. Shapley var 1–7: percent contribution of variable 1–7 (in order of appearance) to the adjusted R^2. *PC_DOMINANCE*: first principal component of *FXTURN*, *KAOPEN*, and *FORASSET*; *PC_EXPOSURE*: first principal component of *NONBANKINV*, *FCLIAB*, and *PORTFDEBT*; *PC_HISTORY*: first principal component of *CURCRIS*, *SOVDEF-DOM*, and *SOVDEF-EXT*.

* $p < 0.10$.

** $p < 0.05$.

*** $p < 0.01$.

observe an offsetting relationship between monetary dominance and financial exposure. Despite low monetary dominance, the group of mostly Asian EMEs performs similar to the group with AEs like Australia, New Zealand, and several Eastern European countries that exhibit more dominance and a better historical performance, but are also more externally exposed. These results suggest that there are multiple factors that determine a country's response to global financial shocks. Performing relatively well in one dimension only, like monetary dominance, may be insufficient to reduce vulnerability.

4.3. Extensions and robustness tests

4.3.1. Results with long-term interest rates

While short-term interest rates are largely controlled by monetary policy, long-term rates are determined in (government) bond markets. Some of the literature on safe assets, liquidity yields and the UIP deviation specifically focuses on government bonds (Engel, 2016; Engel and Wu, 2022; He et al., 2019). We thus assess whether our main results differ when estimating the VAR with long-term interest rates (*INTR_LT*) instead of short-term rates.[26]

Overall, the results in Table 5 are similar compared to the *VULNEX* with short-term interest rates. In specifications (1)–(3), all PCs individually are statistically significant and have the expected signs, but in the multivariate specification (4), *PC_DOMINANCE* is no longer statistically significant. Similarly, all three individual indicators, *FXTURN*, *NONBANKINV*, *CURCRIS*, are statistically significant and have the expected sign, but *FXTURN* has lower explanatory power compared to the results with short-term interest rates (Shapley value of only 10% compared to 25%).[27] By contrast, *NONBANKINV* has slightly larger explanatory power. This suggests that monetary dominance may be less effective in reducing the sensitivity of long-term interest rates to global financial shocks than it is for policy rates. By contrast, exposure to capital flows appear to be more relevant for long-term interest rates. This can be expected, given that non-bank foreign investors are highly active in government bond markets and may thereby exercise strong effects on long-term rates.

[26] See Appendix B for estimated impulse responses and the resulting alternative external monetary vulnerability index. The correlation between the baseline *VULNEX* and the *VULNEX* with long-term interest rates is 0.93, suggesting that there are only moderate differences. Note that Georgia was retained in the VAR estimations but instead China, Guatemala, and Paraguay had to be dropped to insufficient observations.

[27] Further estimations with individual indicators are reported in Appendix B.

Table 3
Multivariate regressions of external monetary vulnerability index (*VULNEX*) on structural determinants: individual indicators.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
FXTURN	−0.042***	−0.032**	−0.061***	−0.060***	−0.037*			−0.046***	−0.021	−0.028**	−0.047***
	(0.013)	(0.012)	(0.015)	(0.018)	(0.019)			(0.015)	(0.020)	(0.014)	(0.013)
NONBANKINV	0.042**	0.038**	0.030**	0.049***	0.040**	0.037**	0.028**			0.035**	0.044**
	(0.016)	(0.015)	(0.013)	(0.018)	(0.019)	(0.017)	(0.013)			(0.016)	(0.019)
CURCRIS	7.469*	6.451	7.405*	6.737*	7.435*	8.078*	6.263	8.262*	7.382*		
	(4.170)	(4.398)	(4.140)	(3.908)	(4.240)	(4.252)	(4.193)	(4.235)	(4.099)		
GNI_PC		−0.000									
		(0.000)									
FXRES			−0.036*								
			(0.021)								
IT				−0.039							
				(0.025)							
GOVDEBT					−0.002						
					(0.007)						
NFA						0.001					
						(0.003)					
FORASSETS							−0.004**				
							(0.001)				
BANKINV								0.084			
								(0.094)			
FCLIAB									2.930		
									(1.763)		
XRVOL										0.006***	
										(0.002)	
INFLCRIS											4.578
											(3.938)
Constant	0.156	0.584	1.075*	0.749	0.269	−0.083	0.668	0.522	−0.366	0.314	0.407
	(0.561)	(0.712)	(0.547)	(0.759)	(0.816)	(0.584)	(0.612)	(0.440)	(0.874)	(0.496)	(0.649)
Obs	31	31	31	31	31	32	32	31	32	28	31
Adj. R-squared	0.237	0.239	0.264	0.268	0.210	0.135	0.257	0.174	0.223	0.352	0.132
AIC	111.508	112.257	111.233	111.075	113.444	118.411	113.545	113.975	114.625	92.789	115.536
Shapley var1	0.254	0.150	0.346	0.321	0.160	0.165	0.059	0.348	0.125	0.114	0.514
Shapley var2	0.186	0.154	0.105	0.211	0.182	1.052	0.409	0.784	0.568	0.142	0.355
Shapley var3	0.560	0.438	0.513	0.464	0.622	−0.217	0.531	−0.132	0.307	0.744	0.131
Shapley var4		0.257			0.037						

Notes: Heteroskedasticity-robust standard errors were applied; standard errors in parentheses. AIC: Akaike information criterion. Shapley var 1–4: percent contribution of variable 1–4 to the adjusted R^2 (in order of appearance).

* $p < 0.10$.

** $p < 0.05$.

*** $p < 0.01$.

Table 4
Structural determinants and average *VULNEX* across four country clusters.

	PC_DOMINANCE	*PC_EXPOSURE*	*PC_HISTORY*	*VULNEX*
1	1.96	−0.87	−0.65	−0.07
2	0.37	0.28	−0.82	1.17
3	−1.28	−0.32	−0.53	1.13
4	−0.71	0.73	2.06	2.86

Notes: Cluster 1: CHE, DEU, FRA, GBR, ITA, JPN; cluster 2: AUS, CAN, CZE, HUN, ISR, NOR, NZL, SWE; cluster 3: CHN, IDN, IND, KOR, PHL, POL, THA, TUR, ZAF; cluster 4: ARG, BRA, CHL, COL, MEX, PER, ROU, RUS. *PC_DOMINANCE*: first principal component of *FXTURN*, *KAOPEN*, and *FORASSET*; *PC_EXPOSURE*: first principal component of *NONBANKINV*, *FCLIAB*, and *PORTFDEBT*; *PC_HISTORY*: first principal component of *CURCRIS*, *SOVDEF-DOM*, and *SOVDEF-EXT*. Average values over clusters.

4.3.2. Extended sample period

Our main results focus on the 1990Q1-2019Q4 period. The global disruptions caused by the 2020–23 COVID-19 pandemic and the 2022 Russian invasion of Ukraine have likely constituted a structural break whose ramifications for the role of structural factors in monetary vulnerability are yet to play out. Nevertheless, we perform a preliminary analysis where we extend the sample period to 2022Q4 and re-estimate the *VULNEX* (see Appendix B). In absolute terms, the ranking of countries by the *VULNEX* has not changed much and the correlation between the baseline and extended *VULNEX* is 0.93. Somewhat surprisingly, external monetary vulnerability is lower with the extended sample period: the average *VULNEX* score falls by -21%. Interestingly, many of the countries that were at the top of the baseline *VULNEX* have undergone the strongest reduction in vulnerability (e.g. Argentina, Paraguay, and Romania). By contrast, some countries that exhibited the lowest degrees of vulnerability such as Japan, Switzerland, and Thailand have undergone an increase in their *VULNEX* scores. Overall, cross-country heterogeneity thus has become somewhat smaller.

4.3.3. Further robustness tests

In this section, we present a number of additional robustness tests to the baseline specification in Table 2 with the three PCs. In the first column of Table 6, we apply a jackknife estimator that drops one observation each from the sample and takes the average over the N replications. In our small-sample environment, this serves as a check how sensitive the results are to individual countries.

Table 5
Multivariate regressions of external monetary vulnerability index with long-term interest rates on structural determinants.

	(1)	(2)	(3)	(4)	(5)
PC_DOMINANCE	−0.343**			−0.159	
	(0.165)			(0.103)	
PC_EXPOSURE		0.560***		0.300*	
		(0.110)		(0.173)	
PC_HISTORY			0.630***	0.508**	
			(0.195)	(0.237)	
FXTURN					−0.028**
					(0.010)
NONBANKINV					0.039***
					(0.014)
CURCRIS					7.290*
					(3.934)
Constant	1.241***	1.235***	1.248***	1.202***	0.015
	(0.230)	(0.220)	(0.187)	(0.179)	(0.416)
Obs	31	30	32	30	30
Adj. R-squared	0.084	0.216	0.373	0.445	0.264
AIC	105.330	98.314	95.530	89.715	98.193
Shapley var1				0.097	0.106
Shapley var2				0.267	0.210
Shapley var3				0.636	0.684

Notes: Heteroskedasticity-robust standard errors were applied; standard errors in parentheses. AIC: Akaike information criterion. Shapley var 1–3: percent contribution of variable 1–3 (in order of appearance) to the adjusted R^2. *PC_POWER*: first principal component of *FXTURN*, *KAOPEN*, and *FORASSET*; *PC_EXPOSURE*: first principal component of *NONBANKINV*, *FCLIAB*, and *PORTFDEBT*; *PC_HISTORY*: first principal component of *CURCRIS*, *SOVDEF-DOM*, and *SOVDEF-EXT*.

* $p < 0.10$.

** $p < 0.05$.

*** $p < 0.01$.

As expected, p-values are slightly higher but all coefficients remain statistically significant and the estimated coefficients are even slightly larger. In the second and third columns, we use alternative versions of the *VULNEX* to assess whether the main results depend on our weighting scheme: in specification *SE*, the weights are given by the inverse of the standard error of the cumulative impulse response in the fourth quarter, and in *AVR* we use an unweighted average. In both cases, the estimated coefficients remain statistically significant. In the fourth specification, we select the lag length of the VARs with the Bayesian information criterion (BIC) instead of AIC. The BIC typically selects a shorter lag length. It can be seen that the main results hold up. In column five, we present an alternative *VULNEX* based on VAR estimations in which the coefficients on the domestic variables in the VIX-equation were not constrained to be zero. The coefficients on *PC_EXPOSURE* and *PC_HISTORY* remain statistically significant, but *PC_DOMINANCE* now becomes borderline statistically insignificant. As there are no economic grounds to expect differences given the assumed exogeneity of the *VIX*, this points to a genuine lack of robustness of *PC_DOMINANCE* compared to the other PCs.

Specifications (6) and (7) report results when using two different financial stress indices compiled by the Office of Financial Research as alternative financial uncertainty shock variables. The *FSI* is a daily market-based indicator of stress in global financial markets that is based on 33 financial market variables. The FSI is broader than the S&P 500-based *VIX* but it specifically measures financial stress. We consider both the general *FSI* and the *FSI* volatility (*FSI VOL*), which contains measures of implied and realised volatility from equity, credit, currency, and commodity markets. The main results hold up: all coefficients retain their sign and remain statistically significant. For comparison, specifications (8) and (9) consider two uncertainty indicators that do not specifically measure financial uncertainty. The US economic policy uncertainty index (EPU) compiled by Baker et al. (2016) covers news about policy-related uncertainty, temporary tax measures that create uncertainty, and disagreement between economic forecasters. The World Uncertainty Index (WUI) compiled by Ahir et al. (2022) measures the frequency of the word ‘uncertain’ (or its variants) in the Economist Intelligence Unit country reports. The correlation between these two indicators and the (logged) VIX is low (0.39 and −0.04, respectively), suggesting that they indeed measure uncertainty that is distinct from financial uncertainty. Correspondingly, it is not surprising that the resulting *VULNEXES* are not significantly correlated with any of our three PCs, which are hypothesised to be determinants of vulnerability to *financial* uncertainty. Finally, we use the *VULNEX* with the extended sample period until 2022Q4 in specification (10). *PC_EXPOSURE* and *PC_HISTORY* retain their statistical significance. By contrast, *PC_DOMINANCE* now becomes (borderline) insignificant, which may reflect our finding that several AEs with strong monetary dominance have become more vulnerable during the pandemic. Overall, we conclude that our main results with *PC_EXPOSURE* and *PC_HISTORY* are highly robust, and that the results with *PC_DOMINANCE* are mostly robust.[28]

[28] Table A9 in Appendix C further reports Pearson correlation coefficients between the baseline *VULNEX* and the alternative *VULNEXES* used in specifications (2)–(10). Except for the *VULNEXES* with the non-financial uncertainty shocks EPU and WUI, correlations are high (above 0.87) and statistically significant, suggesting that our baseline estimate of external monetary vulnerability is highly robust.

Table 6
Robustness tests.

	(1) JACKKNIFE	(2) SE	(3) AVR	(4) BIC	(5) UNCONSTR	(6) FSI	(7) FSI VOL	(8) EPU	(9) WUI	(10) EXT SAMP
PC_DOMINANCE	−0.255*	−0.238***	−0.461*	−0.180*	−0.160	−0.376**	−0.303*	−0.075	−0.031	−0.183
	(0.094)	(0.007)	(0.098)	(0.080)	(0.147)	(0.041)	(0.097)	(0.618)	(0.820)	(0.122)
PC_EXPOSURE	0.438**	0.352**	0.698**	0.266*	0.285**	0.431*	0.449*	0.046	0.019	0.359***
	(0.026)	(0.014)	(0.013)	(0.063)	(0.016)	(0.052)	(0.076)	(0.740)	(0.943)	(0.009)
PC_HISTORY	0.531**	0.443**	0.840**	0.522**	0.375**	0.631**	0.593*	0.243	0.045	0.378*
	(0.039)	(0.017)	(0.020)	(0.026)	(0.049)	(0.042)	(0.082)	(0.243)	(0.815)	(0.065)
Constant	1.314***	1.238***	3.215***	1.331***	0.970***	2.098***	1.601***	0.219	0.274	1.131***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.280)	(0.286)	(0.000)
Obs	31	31	31	31	31	30	30	31	31	31
Adj. R-squared	0.493	0.571	0.442	0.415	0.415	0.473	0.407	0.021	−0.106	0.387
AIC	98.873	79.059	134.439	95.476	83.273	108.134	111.437	98.088	114.103	92.813
Shapley var1	0.142	0.172	0.164	0.110	0.120	0.207	0.161	−0.733	0.335	0.119
Shapley var2	0.338	0.316	0.328	0.214	0.320	0.264	0.302	−1.009	0.341	0.389
Shapley var3	0.520	0.513	0.508	0.676	0.560	0.529	0.538	2.742	0.324	0.492

Notes: Heteroskedasticity-robust standard errors were applied; standard errors in parentheses. AIC: Akaike information criterion. Shapley var 1–3: percent contribution of variable 1–3 (in order of appearance) to the adjusted R^2. *PC_DOMINANCE*: first principal component of *FXTURN*, *KAOPEN*, and *FORASSET*; *PC_DOMINANCE*: first principal component of *NONBANKINV*, *FCLIAB*, and *PORTFDEBT*; *PC_HISTORY*: first principal component of *CURCRIS*, *SOVDEF-DOM*, and *SOVDEF-EXT*. SE: based on weighted average with inverse of standard error of cumulative impulse responses in fourth quarter as weights. AVR: based on unweighted average of cumulative responses in fourth quarter. BIC: based on lag-selection with Bayesian Information Criterion. UNCONSTR: based on VAR without zero-restrictions on domestic variables in VIX-equation. FSI: based on general OFR financial stress index as global financial shock. FSI-VOL: based on volatility-based OFR financial stress index as the global financial shock. EPU: based on Economic Policy Uncertainty Index as global uncertainty shock. WUI: based on World Uncertainty Index as global uncertainty shock. EXT SAMP: based on extended sample until 2022Q4.

* $p < 0.10$.

** $p < 0.05$.

*** $p < 0.01$.

5. Conclusion

This paper has investigated structural sources of cross-country heterogeneity in external monetary vulnerability to global financial uncertainty shocks. It proposed a novel measure of such vulnerability based on estimated impulse responses of nominal exchange rates, interest rate differentials, and foreign reserves. It shows that the majority of countries undergo currency depreciation, rising interest rates, and/or lose foreign exchange reserves in response to those shocks, whereas some currencies appreciate and/or gain reserves. This is consistent with an interpretation of global financial uncertainty shocks as an increase in the liquidity yield on international currencies, which enforces an increase in the expected return on currencies that do not enjoy this status (Engel, 2016; Engel and Wu, 2022; Farhi and Maggiori, 2017; Gopinath and Stein, 2020). The contractionary monetary effects that we document for most countries are also in line with recent small open economy models that allow for non-monetary premia on financial assets (Alla et al., 2019; Cavallino, 2019; Farhi and Werning, 2014; Gabaix and Maggiori, 2015). Our results contribute to this literature by demonstrating substantial cross-country differences in the magnitude of these effects, which we show to be related to features such as exposure to foreign currency debt and non-bank financial institutions, volatile macrofinancial histories, and dominance in the international monetary system. Thereby, our results highlight deep-seated structural factors as determinants of monetary vulnerability beyond macroeconomic policy regimes or microeconomic institutional factors.

Our finding that external vulnerability is related to exposure is consistent with the argument that sensitivity of capital flows to global financial factors depends on external creditor type (Cerutti et al., 2019; Puy, 2016; Raddatz and Schmukler, 2012). We show that this sensitivity is not only reflected in quantity but also price adjustment in exchange rates and interest rates. Our findings further support the argument that macrofinancial history influences investors' risk perceptions of internationally traded financial assets (Burger and Warnock, 2006). By contrast, macroeconomic fundamentals such as GDP per capita and public debt ratios appear to be less relevant.

With respect to research on the international monetary and financial system (Eichengreen, 2012; Eichengreen et al., 2018; Farhi and Maggiori, 2017; Gopinath and Stein, 2020; Gourinchas et al., 2019; Maggiori et al., 2019), our findings demonstrate its asymmetric nature, which not only has profound macrofinancial implications for the dominant international currency issuer, but also for currencies that enjoy only limited international currency status – or none at all (Andrade and Prates, 2013; Bonizzi, 2017; Kaltenbrunner, 2015; de Paula et al., 2017). Our results suggest that currencies that are not the most dominant ones but do play a significant role in the system (e.g. the Swiss franc and Japanese yen) also enjoy some privilege in the form of lower degrees of external monetary vulnerability. That does not mean they are not affected by global financial shocks: appreciation pressures due to flight-to-quality may well interfere with domestic economic policy objectives. However, their response to the shock is very different from those of currency issuers with low international relevance and strong exposure to capital flows.

We further contribute to this literature by presenting evidence that similar degrees of vulnerability can be related to different structural factors: comparatively high exposure combined with more dominance, exhibited by a group of advanced countries such as Australia, Hungary, and Norway, or comparatively low exposure but less dominance, which can be found, for example, for India, Korea, and South Africa. Overall, this suggests that exposure, history, and dominance all influence external monetary vulnerability, and that exposure and dominance may partly offset each other.

Our results might evoke pessimism regarding the ability of non-dominant currency issuers to mitigate external monetary vulnerability. Histories of macrofinancial instability appear to cast a long shadow that cannot easily be overcome. However, there are several practical and policy implications that can be drawn from our analysis. Firstly, maintaining sound macroeconomic fundamentals such as low government debt might not substantially reduce the external monetary vulnerability of countries whose currencies enjoy limited international status. Instead, these countries might benefit from macroprudential regulation and controls on capital flows that support financial stability (Farhi and Werning, 2014; Ostry et al., 2011). An opening to portfolio investment flows might only be desirable after countries have acquired a certain footprint in global financial markets, e.g. through the accumulation of cross-border assets.

Secondly, our finding that exposure to fickle capital flows is positively related to vulnerability suggests that policies that reduce such exposure can be beneficial. This points to the usefulness of capital controls that specifically target volatile short-term flows by non-bank financial institutions, i.e. portfolio flows, as well as other short-term flows, e.g. through instruments such as duration-based levies. More fundamentally, mitigating exposure to short-term capital flows could be accomplished by strengthening local as opposed to foreign borrowing, for example through the development of domestic financial institutions. These local financial institutions may include pension funds that provide a stable long-term demand for domestic bonds and national development banks that provide loans in local currency. For certain low-income countries, changing the composition of capital flows towards more concessional forms of lending might be a more appropriate option.

Finally, our study naturally exhibits limitations that could be addressed in future research. First, to deal with the limited number of observations in our cross-country analysis, one could use state-dependent local projections for the estimation of our external vulnerability index (see, e.g., Obstfeld and Zhou 2023). Second, we only provided a preliminary analysis of potential changes in external monetary vulnerability over the pandemic. Our results suggest a reduction in heterogeneity whereby many EMEs have become less and some AEs more vulnerable. Explaining this phenomenon will require further research.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data and code to reproduce the key results of the paper have been submitted as supplementary material.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.intfin.2023.101818.

References

Ahir, H., Bloom, N., Furceri, D., 2022. The World Uncertainty Index. Working Paper 29763, NBER.

Aizenman, J., Chinn, M.D., Ito, H., 2016. Monetary policy spillovers and the trilemma in the new normal: Periphery country sensitivity to core country conditions. J. Int. Money Finance 68, 298–330.

Akıncı, Ö., 2013. Global financial conditions, country spreads and macroeconomic fluctuations in emerging countries. J. Int. Econ. 91 (2), 358–371.

Alla, Z., Espinoza, R., Ghosh, A., 2019. FX intervention in the new keynesian model. J. Money Credit Bank. 52 (7), 1755–1791.

Andrade, R.P., Prates, D.M., 2013. Exchange rate dynamics in a peripheral monetary economy. J. Post Keynes. Econ. 35 (3), 399–416.

Arslanalp, S., Tsuda, T., 2014a. Tracking Global Demand for Emerging Market Sovereign Debt. IMF Working Paper 39.

Arslanalp, S., Tsuda, T., 2014b. Tracking global demand for advanced economy sovereign debt. IMF Econ. Rev. 62 (3), 430–464.

Baker, S.R., Bloom, N., Davis, S.J., 2016. Measuring economic policy uncertainty. Q. J. Econ. 131 (4), 1593–1636.

Benes, J., Berg, A., Portillo, R.A., Vavra, D., 2015. Modeling sterilized interventions and balance sheet effects of monetary policy in a new-keynesian framework. Open Econ. Rev. 26 (1), 81–108.

Bénétrix, A., Gautam, D., Juvenal, L., Schmitz, M., 2019. Cross-Border Currency Exposures. New evidence based on an enhanced and updated dataset. IMF Working Paper 299.

Bhattarai, S., Chatterjee, A., Park, W.Y., 2020. Global spillover effects of US uncertainty. J. Monetary Econ. 114, 71–89.

Blanchard, O., Adler, G., de Carvalho Filho, I., 2015. Can Foreign Exchange Intervention Stem Exchange Rate Pressures from Global Capital Flow Shocks? IMF Working Paper 15/159, International Monetary Fund, Washington DC.

Bonciani, D., Ricci, M., 2020. The international effects of global financial uncertainty shocks. J. Int. Money Finance 109, 1022–1036.

Bonizzi, B., 2017. An alternative post-keynesian framework for understanding capital flows to emerging markets. J. Econ. Issues 51 (1), 137–162.

Bruno, V., Shin, H.S., 2015. Capital flows and the risk-taking channel of monetary policy. J. Monetary Econ. 71, 119–132.

Burger, J.D., Warnock, F.E., 2006. Local currency bond markets. IMF Staff Pap. 53, 133–146.

Caggiano, G., Castelnuovo, E., Kima, R., 2020. The global effects of Covid-19-induced uncertainty. Econom. Lett. 194, 109392.

Carrière-Swallow, Y., Céspedes, L.F., 2013. The impact of uncertainty shocks in emerging economies. J. Int. Econ. 90 (2), 316–325.

Cavallino, P., 2019. Capital flows and foreign exchange intervention. Am. Econ. J.: Macroecon. 11 (2), 127–170.

Cerutti, E., Claessens, S., Puy, D., 2019. Push factors and capital flows to emerging markets: why knowing your lender matters more than fundamentals. J. Int. Econ. 119, 133–149.

Cesa-Bianchi, A., Ferrero, A., Rebucci, A., 2018. International credit supply shocks. J. Int. Econ. 112, 219–237.

Chinn, M.D., Frankel, J.A., 2008. The Euro May Over the Next 15 Years Surpass the Dollar as Leading International Currency. NBER Working Paper 13909.

Chinn, M.D., Ito, H., 2006. What matters for financial development? Capital controls, institutions, and interactions. J. Dev. Econ. 81 (1), 163–192.

Choi, S., 2018. The impact of US financial uncertainty shocks on emerging market economies: An international credit channel. Open Econ. Rev. 29 (1), 89–118.

de Paula, L.F., Fritz, B., Prates, D.M., 2017. Keynes at the periphery: Currency hierarchy and challenges for economic policy in emerging economies. J. Post Keynes. Econ. 40 (2), 183–202.

Eichengreen, B., 2012. Exorbitant Privilege: The Rise and Fall of the Dollar and the Future of the International Monetary System. Oxford University Press.

Eichengreen, B., Hausmann, R., Panizza, U., 2007. Currency mismatches, debt intolerance, and the original sin: Why they are not the same and why it matters. In: Edwards, S. (Ed.), Capital Controls and Capital Flows in Emerging Economies: Policies, Practices, and Consequences. University of Chicago Press, Chicago, pp. 121–169.
Eichengreen, B., Lombardi, D., 2017. RMBI or RMBR? Is the renminbi destined to become a global or regional currency? Asian Econ. Pap. 16 (1), 35–59.
Eichengreen, B., Mehl, A., Chitu, L., 2018. How Global Currencies Work: Past, Present, and Future. Princeton University Press.
Engel, C., 2016. Exchange rates, interest rates, and the risk premium. Amer. Econ. Rev. 106 (2), 436–474.
Engel, C., Wu, S.P.Y., 2022. Liquidity and exchange rates: An empirical investigation. Rev. Econom. Stud. advance access.
Farhi, E., Maggiori, M., 2017. A model of the international monetary system. Q. J. Econ. 133 (1), 295–355.
Farhi, E., Werning, I., 2014. Dilemma not trilemma? capital controls and exchange rates with volatile capital flows. IMF Econ. Rev. 62 (4), 569–605.
Fernández, A., Klein, M.W., Rebucci, A., Schindler, M., Uribe, M., 2014. Capital control measures: A new dataset. IMF Econ. Rev. 62 (3), 548–574.
Fink, F., Schüler, Y.S., 2015. The transmission of US systemic financial stress: Evidence for emerging market economies. J. Int. Money Finance 55, 6–26.
Frankel, J., 2019. Systematic managed floating. Open Econ. Rev. 30 (2), 255–295.
Gabaix, X., Maggiori, M., 2015. International liquidity and exchange rate dynamics. Q. J. Econ. 130 (3), 1369–1420.
Gelos, G., Gornicka, L., Koepke, R., Sahay, R., Sgherri, S., 2022. Capital flows at risk: Taming the ebbs and flows. J. Int. Econ. 134, 103555.
Ghosh, A.R., Ostry, J.D., Chamon, M., 2016. Two targets, two instruments: Monetary and exchange rate policies in emerging market economies. J. Int. Money Finance 60, 172–196.
Gopinath, G., Stein, J.C., 2020. Banking, trade, and the making of a dominant currency. Q. J. Econ. 136 (2), 783–830.
Gourinchas, P.-O., Rey, H., Sauzet, M., 2019. The international monetary and financial system. Annu. Rev. Econ. 11 (1), 859–893.
He, Z., Krishnamurthy, A., Milbradt, K., 2019. A model of safe asset determination. Amer. Econ. Rev. 109 (4), 1230–1262.
Ilzetzki, E., Reinhart, C.M., Rogoff, K.S., 2019. Exchange arrangements entering the twenty-first century: Which anchor will hold? Q. J. Econ. 134 (2), 599–646.
Kalemli-Özcan, S., 2019. U.S. Monetary Policy and International Risk Spillovers. NBER Working Paper 26297.
Kaltenbrunner, A., 2015. A post Keynesian framework of exchange rate determination: A Minskyan approach. J. Post Keynes. Econ. 38 (3), 426–448.
Lane, P.R., Milesi-Ferretti, G.M., 2018. The external wealth of nations revisited: International financial integration in the aftermath of the global financial crisis. IMF Econ. Rev. 66 (1), 189–222.
Li, D., Magud, N.E., Valencia, F., 2019. Financial shocks and corporate investment in emerging markets. J. Money Credit Bank. 52 (2–3), 613–644.
Lütkepohl, H., 2005. New Introduction to Multiple Time Series Analysis. Springer, Berlin, Heidelberg.
Maggiori, M., Neiman, B., Schreger, J., 2019. The rise of the dollar and fall of the euro as international currencies. AEA Pap. Proc. 109, 521–526.
Miranda-Agrippino, S., Rey, H., 2020. U.s. monetary policy and the global financial cycle. Rev. Econ. Stud. 87 (6), 2754–2776.
Obstfeld, M., Ostry, J.D., Qureshi, M.S., 2019. A tie that binds: Revisiting the trilemma in emerging market economies. Rev. Econ. Stat. 101 (2), 279–293.
Obstfeld, M., Zhou, H., 2023. The Global Dollar Cycle. Working Paper 31004, NBER.
Ostry, J.D., Ghosh, A.R., Chamon, M., Qureshi, M.S., 2011. Capital controls: When and why? IMF Econ. Rev. 59 (3), 562–580.
Puy, D., 2016. Mutual funds flows and the geography of contagion. J. Int. Money Finance 60, 73–93.
Raddatz, C., Schmukler, S.L., 2012. On the international transmission of shocks: Micro-evidence from mutual fund portfolios. J. Int. Econ. 88 (2), 357–374.
Reinhart, C.M., Rogoff, K.S., 2011. From financial crash to debt crisis. Amer. Econ. Rev. 101 (5), 1676–1706.
Rey, H., 2015. Dilemma Not Trilemma: The Global Financial Cycle and Monetary Policy Independence. NBER Working Paper 21162.
Schmitt-Grohé, S., Uribe, M., 2018. How important are terms-of-trade shocks. Internat. Econom. Rev. 59 (1), 85–111.
Sims, C.A., Stock, J.H., Watson, M.W., 1990. Inference in linear time series models with some unit roots. Econometrica 58 (1), 113–144.