International Capital Flow Pressures and Global Factors

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Draft version: October 25, 2022

Abstract

We study the risk sensitivity of international capital flow pressures using a new Exchange Market Pressure index that combines pressures observed in exchange rate adjustments with estimated incipient pressures that are masked by foreign exchange interventions and policy rate adjustments. The sensitivity of capital flow pressures to risk sentiment and so-called safe haven status of currencies evolve over time, vary significantly across countries and across stress events. Across countries, risk sensitivities and safe haven status are associated with self-fulfilling exchange rate expectations and carry trade funding currencies. In contrast, association with more traditional macroeconomic country characteristics is weak.

JEL Classification: F32, G11, G20.

Keywords: Exchange Market Pressure; Risk aversion; Safe haven; Capital flows; Exchange Rates; Foreign Exchange Intervention, Global Financial Cycle

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The views in this paper are solely the responsibility of the authors and do not necessarily reflect the views of the Federal Reserve Bank of New York, the Federal Reserve System, or Danmarks Nationalbank. The authors thank Pierre-Olivier Gourinchas for careful suggestions on features of the exchange market pressure specification; participants at the NBER ISOM 2022 meeting, especially Anusha Chari, Kristen Forbes, and Luc Laeven, for thoughtful feedback; Nastasija Loncar for help with foreign exchange intervention data; and generations of research assistants for their contributions to different aspects of this project, including most recently Sarah Hamerling, Svetlana Galvez Stojsavljevic and Stone Kalisa.

1 Introduction

International financial flows and currency values are important for economic outcomes and their drivers are consequently subject to intense study. Research finds that capital flows as well as exchange rates are driven both by local factors and so called global factors including global risk sentiment and the monetary policy stance of reserve currency issuers (Milesi-Ferretti and Tille 2011; Forbes and Warnock 2012; Fratzscher 2012; Rey 2015, Bruno and Shin 2014, Kalemli-Özcan 2019). The sensitivity of capital flows and currencies to global factors is key to understanding the degree to which local economies retain some domestic policy autonomy and the appropriate macro-financial policy toolkits to apply (Obstfeld et al. 2017).

Global factors clearly play an important role in driving capital flows and currencies. International capital flows tend to enter emerging markets when global risk perceptions are low and global liquidity ample, and retreat when global financial conditions tighten. Global factors also drive currencies, with risk-on currencies tending to depreciate with elevated global risk conditions, and so called safe haven currencies tending to appreciate (Ranaldo and Soederlind 2010; Botman et al. 2013; Habib and Stracca 2012; de Carvalho Filho 2013). At the same time, the strength of global factors in driving flows and currencies are often found to vary substantially across countries and over time (Avdjiev et al. 2020), and to be particularly strong when risk conditions are more pronounced (Chari et al. 2022, Forbes and Warnock 2021, Obstfeld, Ostry and Qureshi (2017)). Overall, the relative importance of the global factor in driving flows and currencies remains debated (Miranda-Agrippino and Rey 2015, Cerutti et al. 2019).

In this paper, we revisit these issues by recognizing that the observed responses of capital flows, exchange rates and domestic monetary policy to global factors are interdependent and cannot be viewed in isolation. In countries with fully flexible exchange rate regimes, exchange rates move quickly in response to incipient changes in capital flows, supplementing or even obviating the adjustment in capital flow volumes (Chari, Stedman and Lundblad, 2021). In contrast, in fixed exchange rate regimes, managed floats, or even in some de jure flexible exchange rate regimes, central banks use policy interventions such as domestic interest rate changes and official foreign exchange interventions to reduce exchange rate movements resulting from international capital flow pressures (Ghosh, Ostry and Qureshi, 2018).[1] In such cases, capital flow pressures may show up in foreign exchange interventions as well as outright flows, or in policy rate changes rather than in exchange rate changes. Viewing capital flow responses to global factors separately from the exchange rate or monetary policy regime of the country will hence at best give an incomplete

[1] Gagnon (2016) nicely summarizes the skeptical historical perspective on effectiveness, starting with the time of the Plaza Accord in the 1980s, before presenting recent evidence that foreign exchange intervention can be a useful tool to counter market-driven imbalances. Other recent evidence points to foreign exchange intervention having a higher success rate than previously argued on the basis of a range of criteria (Adler, Lisack and Mano 2015, Fratzscher, Gloede, Menkhoff, Sarno and Stöher 2019).

picture of the actual capital flow pressures at play.

To account for the interdependencies between capital flows on the one hand, and exchange rate changes, foreign exchange interventions and policy rate changes on the other, we first present a new measure of international capital flow pressures, which is a revamped version of an Exchange Market Pressure (EMP) index. As we later discuss, earlier versions of exchange market pressure indices have been used in a broad range of applications in the literature, from studying balance of payments crises (Eichengreen, Rose and Wyplosz 1994) to monetary policy spillovers (Aizenman, Chinn and Ito 2016) and classifying exchange rate regimes (Frankel 2019. Our construction builds on earlier versions but addresses some of their shortcomings through an approach combining balance of payments equilibrium, international portfolio demands for foreign assets, and valuation changes on portfolio-related wealth.[2] This international portfolio balance approach follows a long tradition, for example starting with Girton and Henderson (1976), Henderson and Rogoff (1982), Branson and Henderson (1985), Kouri (1981), and more recently relating to broader empirical and modelling innovations as in Blanchard, Giavazzi and Sa (2005), Coeurdacier and Rey (2012), Caballero, Farhi and Gourinchas (2016), and Gabaix and Maggiori (2015).

The logic of our EMP index is that international capital flow pressures show up in a specific combination of exchange rate movements, foreign exchange intervention, and policy rate response that we jointly express in units of exchange rate depreciation equivalents. The result is like a super-exchange rate index for some purposes. As an example within the context of a fixed exchange rate regime, the theory-based equivalency formulas take pressures in the form of capital flows, mirrored by foreign exchange interventions conducted to prevent an exchange rate response, and solve for the counterfactual exchange rate change that otherwise would have closed the balance of payments gap and prevented the observed flow. This constructed exchange rate change equivalent of foreign exchange interventions is then directly comparable to the capital flow pressure of an otherwise identical country that would instead have allowed the exchange rate to adjust to the pressure.

The constructed conversion factors between exchange rate changes, foreign exchange interventions and policy rate changes provide clear intuitions tied to well known portfolio rebalancing channels through the balance of payments in the short run. The simple EMP framework thus ties into important research on the role of wealth and valuation effects in driving international portfolio adjustments (for example, Gourinchas and Rey 2014; Benetrix, Lane and Shambaugh 2015; Lane and Milesi-Ferretti 2018;Camanho, Hau and Rey 2018); the roles of currency denomination in portfolios of foreign assets and liabilities (Benetrix, Lane and Shambaugh 2015;

[2]Goldberg and Krogstrup (2019) is the earlier working paper version of this paper that developed a new EMP measure and conducted initial empirical explorations. The current version has a significantly revised EMP derivation, updated empirical application, and more comprehensive placement in recent literature on capital flows, home bias, portfolio allocations, risk sensitivities, and safe haven assets.

Maggiori, Neiman and Schreger 2020); the role of home bias in allocation of investment portfolios (Coeurdacier and Rey 2012; Coeurdacier and Gourinchas 2016; Maggiori, Neiman and Schreger 2020; Faia et al. 2022); and the role of the sensitivity of portfolio allocations to changes in risk and return conditions (Bacchetta, Davenport and van Wincoop 2021; Koijen and Yogo 2020; Jiang, Richmond and Zhang 2021 and Camanho, Hau and Rey 2018).

Turning next to the empirical application, an important feature of the EMP is that it is measured in terms of exchange rate equivalents and hence is measured relative to the pressures of a foreign currency. This is in contrast to data on realized capital flows, for which levels are meaningful. As a baseline, we construct the EMP relative to currencies' monetary anchor currency, which in our sample are the USD and the euro respectively, henceforth referred to as reference currencies. We also implement and consider robustness to measuring the EMP against an effective exchange rate based on weights in financial portfolios, and discuss the limitations of both approaches.

We construct monthly series of the EMP for 41 countries, covering data spanning 2000 through 2021. Based on the empirical EMP, we carry out a set of applications that illustrate the importance of taking into account all the components of the EMP when comparing and analyzing capital flow pressures across countries and currencies. While accounting for the different components of capital flow pressures is relevant for the broader empirical literature relating to drivers of capital flows and exchange rates, we focus here on the link between capital flow pressures and also on risk sentiment and global factors.[3]

First, the empirical measure allows us to present and compare the variation in the different components of capital flow pressures across countries and over time. We illustrate how the contributions of the different components to the EMP vary across periods with high stress in global financial markets and more normal times. We find that, on average, countries tend to allow - or to succumb to - more exchange rate variability during periods of heightened risk sentiment, with significant variation across countries. This variation highlights the importance of accounting for the different components of the EMP in cross country time series analysis. The evidence also warns against general assumptions that the majority of countries either maintain fully flexible exchange rates or pegs, consistent with evidence in Frankel (2019)

Second, we revisit the literature on currency risk sensitivities and safe haven currency status, which characterizes currencies as having "safe haven" features if their valuations rise when global risk conditions worsen, as in Brunnermeier, Nagel and Pederson (2008), Ranaldo and Soederlind

[3]Goldberg and Krogstrup 2019 for example revisits the literature on the relative importance of local vs. global factors in driving capital flows across countries, showing the importance of a more comprehensive measure of capital flow pressures across countries.

(2010), Habib and Stracca (2012), and Fatum and Yamamoto (2014).[4] Empirical analyses based purely on observed exchange rate movements may generate results that are both imprecise and subject to attenuation bias, as these miss the fact that many countries respond to currency pressures by intervening in the foreign exchange market or changing the policy rate, in addition to allowing some exchange rate adjustment.[5] To account for attenuation bias in assessing safe haven currencies, we apply the EMP as a super-exchange rate index, and assess its rolling correlation across time with global risk factors, labelling the resulting correlation the Global Risk Response index (GRR). We then characterize currencies that systematically respond to risk-off episodes by either appreciation, policy rate cuts or capital inflows relative to their reference currency as safe haven currencies.

We find that the set of safe haven currencies based on this definition evolves over time, with some countries having safe haven features episodically and others more persistently. Importantly, the group of currencies with safe haven status differs episodically and in strength from those based on currency movements alone. The data confirm the previous literature designating the Swiss franc, the Japanese yen and US dollar as key safe haven currencies, but add the Danish krone and Hong Kong Dollar to the set of safe haven currencies. The latter currencies are characterized by managed exchange rate regimes, where accounting for foreign exchange interventions and policy rate adjustments in the response to risk greatly increase their safe haven characteristics. For example, the Danish krone, which is pegged to the euro and hence exhibits very limited exchange rate variability, exhibits only weak safe haven features based on exchange rate movements, but episodically exhibits stronger safe haven features when also accounting for foreign exchange interventions and policy interest rate changes EMP.

Finally, we revisit the question of what underlying factors can help explain why some currencies exhibit safe haven features, following the definition of safe haven currencies and regression approaches of the literature using realized excess returns computed based on the EMP. The analysis suggests that safe haven features of currencies tend to be persistent, but are not permanent. These features are empirically associated with self-fulling expectations of currency movements based on previous associations between currencies and risk, as well as interest rate levels, suggesting that whether currencies are used as carry trade funding currencies may play an important role. In contrast, we find little evidence of a consistent role for more traditional macroeconomic determinants typically investigated in the literature.

The paper is structured as follows. Section 2 presents the exchange market pressure index

[4] Wong and Fong (2013) is an exception in that they rely on options prices, and so-called risk reversals, to gauge the degree to which financial market participants expect currencies to behave as safe havens.

[5] Empirical studies that use cross-country data on realized capital flows or exchange rate changes to inform the range of key questions in international finance cannot just absorb these considerations in controls like country fixed effects. The use of these instruments varies over time, as exchange rate and monetary regimes evolve (Klein and Shambaugh 2008; Ilzetzki, Reinhart and Rogoff 2017).

and discusses the intuition behind the index. Section 3 focuses on empirical implementation, presenting important data and parameter choices. Section 4 illustrates the variation in the different components of the index across countries and across high stress and normal periods, and provides the application to safe haven currency status and its drivers. The final section discusses the implications of our findings and concludes.

2 Exchange Market Pressure

Prior variants of exchange market pressure indices have been used in studies of currency crises and spillovers of policies across borders, and characterizations of exchange rate regimes. EMP used have typically taken the form of a weighted index of changes in the exchange rate, changes in official foreign exchange reserves and (sometimes) changes in policy interest rates. The Appendix provides an overview of prior EMP construction approaches and applications. Our approach focuses instead on informing the weights of the index through the underlying drivers with a model of supply and demand for currency based on the balance of payments, international portfolio decisions, and wealth accumulation equations at home and abroad. Discussed in the Appendix, our approach leads to significantly different patterns of measured pressures across countries and over time.

In our approach, the balance of payments (BOP) identity is foundational, tracking interest payments on outstanding foreign assets and liabilities, foreign currency flows through trade, gross flows of foreign currency assets and liabilities, and official foreign exchange interventions. Also fundamental are international portfolio allocation decisions, in part driven by the wealth dynamics of domestic and foreign investors. The basic logic of our index derivation is that any given excess supply or demand for a currency - an international capital flow pressure - can be offset by an equivalent amount of foreign exchange intervention (FXI), or by an endogenous exchange rate movement or change in the domestic monetary policy rate sufficient to generate an off-setting private balance of payments flow. The equivalence factors across these components of responses derive directly from the different ways that exchange rates and interest rates enter the balance of payments, along with specifications of international asset demand functions with imperfect asset substitutability and valuation effects on outstanding positions. The equivalencies, for example between quantities of FXI and units of currency depreciation, thus depend on the elasticities of the responses of foreign assets and foreign liabilities to exchange rate and interest rate changes, the currency of invoicing or denomination of international trade and debt positions, and the stocks of foreign asset and liability positions.

2.1 The Balance of Payments

The BOP is expressed in nominal foreign currency equivalents, and reflects all sources of demand and supply of foreign currency arising from cross-border payments needs for specified period. The BOP flows in the period between time $t-1$ and time t are given by

$$FXI_t = NX_t + \left(i^*_{t-1} A_{t-1} - i_{t-1} \frac{L_{t-1}}{e_{t-1}} + i^*_{t-1} R_{t-1} \right) + \left(\frac{1}{e_t} IL_t - IA_t \right) \tag{1}$$

where FXI_t reflects official foreign currency financial transactions, or foreign exchange interventions, in period t, and the exchange rate e_t is defined in units of Home currency per one unit of Foreign currency.

The first term on the right hand side is the net trade balance accumulated in period t, NX_t, which we assume to be invoiced in foreign currency. The second term in parentheses reflects the net foreign investment income balance for period t, which also includes interest and dividend receipts on foreign official reserves accrued at the beginning of period t, R_{t-1}. The stock of foreign currency denominated assets coming into period t is denoted A_{t-1} and domestic currency denominated foreign liabilities are denoted L_{t-1}. For our baseline derivation, we assume that countries borrow internationally exclusively in their domestic currency and exclusively hold foreign currency denominated foreign assets.[6] The interest and dividend payments accruing to foreign assets and liabilities, i^* and i respectively, depend on the country of issuance.[7] Interest and dividend income is assumed to accrue on the beginning of period stock of foreign positions and with the beginning of period interest rate and dividend yields. Payments are converted into foreign currency equivalents when appropriate.

The last term in parentheses captures financial account transactions (capital flows) taking place between time $t-1$ and time t. These are transaction based flows, indicated by notation I, and hence do not include changes in the stocks of foreign assets and liabilities that are due to valuation effects. Portfolio adjustments triggered by changes in asset prices and exchange rates result in transactions-based flows and modelled below. Financial account transactions are expressed in foreign currency equivalents.

[6] The assumption of domestic currency debt issuance does not holds empirically for some countries. An earlier version of the model includes the case where countries borrow and lend in both domestic and foreign currency in Goldberg and Krogstrup (2019). Moreover, a version of the model with foreign liabilities issues only in foreign currency is available upon request.

[7] Country and asset specific risk premia are not modelled, but can be viewed as captured partly by the interest rate level as well as a local risk factor added in the asset demand functions below.

2.2 Gross Asset and Gross Liability Flows

Capital flows are driven by the Home demand for Foreign liabilities and Foreign demand for Home liabilities. We assume imperfect substitutability between domestic and foreign currency denominated assets, consistent with home bias for domestic currency denominated assets, following Blanchard, Giavazzi and Sa (2005) and consistent with the extensive empirical evidence on home bias discussed in Coeurdacier and Rey (2012),Maggiori, Neiman and Schreger (2020), and Faia, Salomao and Veghazy (2022).[8] Home demand for Foreign liabilities is expressed as a share of Home's financial wealth, W_t, while Foreign demand for Home liabilities is expressed as a share of Foreign's total wealth, W_t^*, both expressed in terms of their respective local currencies. The portfolio demand equations are given respectively by:

$$\tilde{A}_t e_t = W_t \cdot [1 - \alpha(uip_t, l_t^*, s_t)] \tag{2}$$

$$\frac{\tilde{L}_t}{e_t} = W_t^* \cdot [1 - \alpha^*(-uip_t, l_t, s_t)] \tag{3}$$

where

$$uip_t = i_t - i_t^* - \frac{E(e_{t+1}) - e_t}{e_t}. \tag{4}$$

uip_t is the deviation from uncovered interest rate parity from the point of view of the investor located in Home. The shares α and α^* capture the shares of residents' portfolios that residents desire to be denominated in their domestic currency. These shares depend on the expected relative risk-adjusted return on Foreign versus Home assets as captured by deviations from uip_t, with $\alpha'_{uip} > 0$ and $\alpha^{*'}_{uip} > 0$ and on risk factors.[9] Local risk factors, l_t and l_t^*, capture country-specific risk. The global risk factor, s_t, is a common factor across countries, but the response of asset demand to the global factor can differ across countries. Risk factors are assumed to be independent of relative expected returns. An increase in risk factors reflects greater risk aversion of investors, such that α'_l, $\alpha^{*'}_{l^*}$, α'_s and $\alpha^{*'}_s > 0$.[10] For both Home and Foreign, the share of financial wealth invested in domestic assets is assumed higher than the domestic role in the global economy, mirroring the empirically relevant feature often described as home bias.

Home and foreign wealth, expressed in domestic currency equivalents, consists of domestic

[8] Maggiori, Neiman and Schreger (2020) show currency denomination of assets as the main factor driving demand and home bias, while Faia, Salomao and Veghazy (2022) find this result is a feature of investment funds, but not insurance and pension bond funds for European investors.

[9] While the derivation in the text does not account for the possible presence of capital flow restrictions, Goldberg and Krogstrup (2019) show how capital flow restrictions can easily be added to the model.

[10] A complementary approach to portfolio reallocations could be through explicit modelling of global bank decisions, for example building on the insights in Shin (2016) and Avdjiev, Bruno, Koch and Shin (2018).

assets D (or D^* in the case of Foreign) and holdings of foreign assets net of issued foreign liabilities:

$$W_t = D_t + e_t A_t - L_t \tag{5}$$
$$W_t^* = D_t^* + \frac{1}{e_t} L_t - A_t$$

For later use, Foreign's stock of wealth in period t is driven by the components of the previous period stock of wealth updated by real growth[11] captured by $\dot{g_t^*}$, valuation effects from asset prices in both Home and Foreign markets, $\dot{p_t}$ and $\dot{p_t}^*$, exchange rate valuation effects,, $\dot{(e_t)}$ as well as international interest and dividend payments taking place in the beginning of period t:[12]

$$W_t^* = \left(1 + \dot{p_t}^* + \dot{g_t^*}\right) D_{t-1}^* + \frac{L_{t-1}}{e_{t-1}} \left(1 + \dot{p_t} - \dot{e_t} + i_{t-1}\right) - A_{t-1} \left(1 + \dot{p_t}^* + i_{t-1}^*\right) \tag{6}$$

where dots denote relative changes between period $t-1$ and t, as in $\dot{e} = \frac{e_t - e_{t-1}}{e_{t-1}}$.

Gross liability flows issued in domestic currency in period t, IL, are modelled as the difference between desired ($\tilde{L}$) and actual ($\bar{L}$) values of gross foreign liabilities updated by valuation effects due to exchange rate and asset price changes:

$$IL_t = \tilde{L_t} - \bar{L_t} \tag{7}$$

where $\frac{\tilde{L_t}}{e_t}$ is Foreign's desired holdings of Home liabilities described in expression (3) and where Foreign's holdings of Home's liabilities coming out of period $t-1$, $\frac{\bar{L_t}}{e_t}$, are updated with valuation changes taking place in period t due to changes in Home asset prices, p_t, and the exchange rate:

$$\frac{\bar{L_t}}{e_t} = \frac{L_{t-1}}{e_{t-1}} \left(1 + \dot{p_t} - \dot{e_t}\right), \tag{8}$$

Gross liability flows expressed in foreign currency equivalents in period t reflect Foreign investors' wish to reallocate Foreign's total wealth in period t, expression (6), between domestic and foreign investments as a response to changes in expected returns and risks, and taking into account changes in the Foreign currency equivalent value of wealth. Inserting expressions (3), (6) and (8) into equation (7), and linearizing around a balance of payments equilibrium characterized

[11] We do not have a real sector in our model, and real growth is instead specified as a real growth rate of domestic assets. The term can be interpreted as net accumulation of real capital stock. Alternatively, in the empirical application, we interpret the real growth term as a proxy for, or related to, real income growth of the domestic economy.

[12] Interest and dividend payments on Home asset holdings, D_t, are not included in aggregate wealth by country, as these both yield from and accrue to residents of the same country.

by $L_t = \tilde{L}_t = \bar{L}_t$, such that $\frac{W_t^* e_t}{L_t} = \frac{1}{1-\alpha^*}$, yields[13]

$$
\begin{aligned}
\frac{dIL_t}{L_t} =& \frac{de_t}{e_{t-1}} \epsilon_e^L + [di_t - di_t^*]\, \epsilon_i^L - \left[\frac{dp_t}{p_{t-1}} - \frac{dp_t^*}{p_{t-1}^*} \right] \left[\alpha^* \frac{L_{t-1}}{L_t} \frac{e_t}{e_{t-1}} \right] \\
&+ \frac{dg_t^*}{g_{t-1}^*} \left[(1-\alpha^*) \frac{D_{t-1}^* e_t}{L_t} \right] - dl_t \left[\frac{\alpha_l^{*'}}{1-\alpha^*} \right] - ds_t \left[\frac{\alpha_s^{*'}}{1-\alpha^*} \right]
\end{aligned}
\tag{9}
$$

where we have defined the elasticity of gross foreign liability flows with respect to Home's interest rate and with respect to the exchange rate, respectively, as[14]

$$
\epsilon_i^L = \frac{dIL_t}{L_t} \frac{1}{de_t} = \frac{\alpha_{uip}^{*'}}{1-\alpha^*} > 0 \tag{10}
$$

$$
\epsilon_e^L = \frac{dIL_t}{L_t} \frac{e_{t-1}}{de_t} = \left[\frac{\alpha_{uip}^{*'}}{1-\alpha^*} \frac{e_{t-1}}{e_t} \frac{E(e_{t+1})}{e_t} + \alpha^* \frac{L_{t-1}}{L_t} \frac{e_t}{e_{t-1}} \right] > 0 \tag{11}
$$

Useful for empirical implementation is the approximation that the value of total foreign liabilities in domestic currency is a slow-moving process and hence $\frac{L_{t-1}}{L_t} \frac{e_t}{e_{t-1}} \approx 1$ and that the future exchange rate is expected to move the same way as the current exchange rate, i.e. $\frac{e_{t-1}}{e_t} \frac{E(e_{t+1})}{e_t} \approx 1$ [15] the expression for the exchange rate elasticity of foreign liabilities flows becomes:

$$
\epsilon_e^L \approx \left[\frac{\alpha_{uip}^{*'}}{1-\alpha^*} + \alpha^* \right] > 0 \tag{12}
$$

The elasticity of gross liability flows to Home's interest rate is unambiguously positive, as a higher interest rate leads to a higher expected return on Home's foreign liabilities, which raises the desired portfolio share of Home's liabilities in Foreign's portfolio through equation (3).

The elasticity of gross liability flows to the exchange rate is also positive, and intuitive. A depreciation today of Home currency in terms of foreign currency (i.e. an increase in e_t) initially reduces the expected future rate of depreciation of Home currency, leading to an increased expected yield and hence a higher desired share of holdings of Home's liabilities through equation (3). This is the first term in (11). The depreciation also reduces the value of Foreign's holdings of Home liabilities and Foreign's overall wealth through exchange rate valuation effects. Lower

[13]The linearization around a balance of payments equilibrium in which there are no private capital flows also implies a level of foreign exchange interventions, exchange rate and policy rate at trend levels. For FXI, this is defined as equal to the net export proceeds and the income balance. This may seem restrictive as a starting point, but the same results could be obtained by linearizing around an equilibrium in which there is a structural level of private capital flows that adds to an associated trend level of FXI. The empirical implications of this linearization assumption is that the first difference in FXI in the linearized expression should me measuring the different of FXI from its trend level. We implement the latter approach in our empirical application.

[14]The elasticity with respect to the interest rate is a semi-elasticity in the way that it is defined here.

[15]For example, see Engel and Wu 2021 for discussion of the performance of alternative assumptions.

overall wealth reduces desired holdings of Home's liabilities, but only by the share $1-\alpha^*$ of the valuation loss from the currency depreciation, whereas the value of Foreign's liabilities have fallen by the full amount. Foreign will hence adjust its portfolio by new purchases of Home's liabilities to make up for the lost portfolio share, all else equal, through the second term in expression (11). The greater the home bias, α^*, the more of the valuation loss of a depreciation will be spread out over Foreign's own domestic assets and the greater the active adjustment of the holding of Home's liabilities. The elasticity of gross liability flows to Home's and Foreign's asset prices, p_t and p_t^* respectively, are positive for the same reasons as the valuation effect of an exchange rate change. By symmetry, gross Home demand for Foreign liabilities and flows expressed in foreign currency equivalents are described by:

$$IA_t = \tilde{A}_t - \bar{A}_t, \tag{13}$$

$$\bar{A}_t e_t = \left(1 + \dot{p_t}^* + \dot{e}_t\right) A_{t-1} e_{t-1} \tag{14}$$

and

$$W_t = \left(1 + \dot{p_t} + \dot{g_t}\right) D_{t-1} + e_{t-1} A_{t-1} \left(1 + \dot{p_t}^* + \dot{e}_t + i_{t-1}^*\right) - L_{t-1} \left(1 + \dot{p_t} + i_{t-1}\right) \tag{15}$$

Taking the same steps as for gross liabilities above, we get

$$\begin{aligned} \frac{d\left(IA_t\right)}{A_t} = {} & \frac{de_t}{e_{t-1}} \epsilon_e^A + \left[di_t - di_t^*\right] \epsilon_i^A + \left[\frac{dp_t}{p_{t-1}} - \frac{dp_t^*}{p_{t-1}^*}\right] \left[\alpha \frac{A_{t-1}}{A_t} \frac{e_{t-1}}{e_t}\right] \\ & + \frac{dg_t}{g_{t-1}} \left[(1-\alpha) \frac{D_{t-1}}{A_t e_t}\right] - dl \left[\frac{\alpha_l'}{1-\alpha}\right] - ds \left[\frac{\alpha_s'}{1-\alpha}\right] \end{aligned} \tag{16}$$

where we define the elasticity of gross foreign asset flows with respect to the interest rate and the exchange rate respectively as[16]

$$\epsilon_i^A = \frac{dIA_t}{A_t} \frac{e_{t-1}}{de_t} = -\frac{\alpha_{uip}'}{1-\alpha} < 0 \tag{17}$$

$$\epsilon_e^A = \frac{dIA_t}{A_t} \frac{e_{t-1}}{de_t} = -\left[\frac{\alpha_{uip}'}{1-\alpha} \frac{e_{t-1}}{e_t} \frac{E(e_{t+1})}{e_t} + \alpha \frac{A_{t-1}}{A_t} \frac{e_{t-1}}{e_t}\right] < 0 \tag{18}$$

Under similar approximations as considered for the elasticities of foreign liabilities flows, that $\frac{A_{t-1}}{A_t} \frac{e_{t-1}}{e_t} \approx 1$ and $\frac{e_{t-1}}{e_t} \frac{E(e_{t+1})}{e_t} \approx 1$, the expression for the exchange rate elasticity of foreign asset flows becomes:

[16]The elasticity with respect to the interest rate is a semi-elasticity in the way that it is defined here.

$$\epsilon_e^A \approx -\left[\frac{\alpha'_{uip}}{1-\alpha} + \alpha\right] < 0 \tag{19}$$

The elasticity of gross foreign assets to an increase in the exchange rate (an appreciation of the foreign currency) is unambiguously negative, for the symmetrical reasons that the exchange rate elasticity of liabilities is positive. A higher value of the foreign currency increases the expected future depreciation, which reduces the desired share of wealth held in foreign assets. At the same time, an appreciation has increased the value of foreign assets more than the value of wealth, and given the desired foreign asset share, some foreign assets should be sold off.

2.3 The Exchange Market Pressure Index

Linearizing the BOP, equation (1) with respect to the various drivers of components, yields

$$dFXI_t = dNX_{e,t} + \left(\frac{L_t}{e_t}\frac{dIL_t}{L_t} - A_t\frac{dIA_t}{A_t}\right) \tag{20}$$

Inserting equations (9) and (16), and combining and grouping terms so as to keep those reflecting pressure on the left hand side, and grouping the so-called drivers of these pressures on the right-hand side, the EMP is defined as:

$$\begin{aligned}
EMP_t \equiv & \frac{de_t}{e_{t-1}} + di_t\frac{\pi_i}{\pi_e} - \frac{dFXI_t}{\pi_e} \\
& = ds\frac{1}{\pi_e}\left[\frac{L_t}{e_t}\frac{\alpha_s^{*'}}{1-\alpha^*} - A_t\frac{\alpha_s^{'}}{1-\alpha}\right] + di_t^*\frac{\pi_i}{\pi_e} \\
& \left(\frac{dp_t}{p_{t-1}} - \frac{dp_t^*}{p_{t-1}^*}\right)\frac{1}{\pi_e}\left[\frac{L_{t-1}}{e_{t-1}}\alpha^* + \frac{e_{t-1}}{e_t}A_{t-1}\alpha\right] \\
& + \frac{dg_t}{g_{t-1}}\frac{1}{\pi_e}\left[(1-\alpha)\frac{D_{t-1}}{e_t}\right] - \frac{dg_t^*}{g_{t-1}^*}\frac{1}{\pi_e}\left[(1-\alpha^*)D_{t-1}^*\right] \\
& + dl\frac{1}{\pi_e}\left[\frac{L_t}{e_t}\frac{\alpha_l^{*'}}{1-\alpha^*}\right] - dl^*\frac{1}{\pi_e}\left[A_t\frac{\alpha_l'}{1-\alpha}\right]
\end{aligned} \tag{21}$$

where π_i and π_e represent:

$$\pi_e = \left[dNX_{e,t} + \frac{L_t}{e_t}\epsilon_e^L - A_t\epsilon_e^A\right] > 0 \tag{22}$$

$$\pi_i = \left[\frac{L_t}{e_t}\epsilon_i^L - A_t\epsilon_i^A\right] > 0 \tag{23}$$

and where $dFXI_t$ and de_t are deviations from their trend levels (see footnote 13).

The $\frac{1}{\Pi_{e,t}}$ is the equivalency factor between dollar quantities of central bank foreign exchange intervention and the equivalent units of currency depreciation avoided. The translation of quantities to prices (exchange rates) depends on the previously described sensitivity of unit flows to exchange rate movements through net exports and through portfolio and wealth channels.

A trade balance channel would allow currency depreciation to improve currency inflows through next export revenues, requiring less depreciation to close the BOP in response to a shock. However, we expect that the trade effects $dNX_{e,t}$ are zero in the near term dynamics around global liquidity pressures. The next term corresponds to adjustments in portfolio demands of Foreign and Home investors due to depreciation strengthening the expected returns on Home investments relative to Foreign investments within the uip_t, with this effect greater when portfolio demands are more sensitive. The latter arises when $\frac{\alpha'_{uip}}{1-\alpha}$ and $\frac{\alpha^{*\prime}_{uip}}{1-\alpha^*}$ are larger. Next, depreciation reduces the value of prior holdings of Home liabilities within the Foreign investor portfolio. The larger this effect, the more demand for such Home liabilities will increase to meet targeted Home portfolio weights in Foreign investor portfolios. Likewise, it has a direct translation effect of over-weighting Foreign assets in the Home investor portfolio.

The equivalences between interest rate changes and rates of Home currency depreciation work through the multiplier $\frac{\Pi_{i,t}}{\Pi_{e,t}}$. The numerator is positive, but the incipient pressure on a currency relieved by raising policy rates depends on portfolio sensitivities to uip. If these are very weak, so that α'_{uip} is small, the interest rate rise does not affect net capital inflows much, so little of the incipient pressure on a currency is met by this policy change. By contrast, if portfolio sensitivities to uip are large, this term contributes significantly to the capital account adjustment and would imply substantially more currency depreciation would have been needed to close imbalances.

A note of caution is in order. The EMP is based in a linearized version of the model around equilibrium conditions in the balance of payments and foreign asset and liabilities demand. This allows us to solve the model analytically, resulting in a simple and intuitive expression for the EMP and its drivers, but it comes with the price of potentially ignoring complex interactions outside equilibrium conditions. Such interactions are more likely to be relevant during protracted episodes of financial upheaval. A more general derivation of the expression for the EMP that would allow us to characterize possible interactions precisely would be desirable, but is out of the scope of this paper.

3 Implementing the EMP

The countries included in our sample are chosen based on data availability. We include countries for which the EMP can, at the latest, start in 2002, with most series beginning in 2000.[17]

[17] Even when data is available, we exclude small countries with a population size below half a million or an annual per capita income average since 2002 below USD 1000.

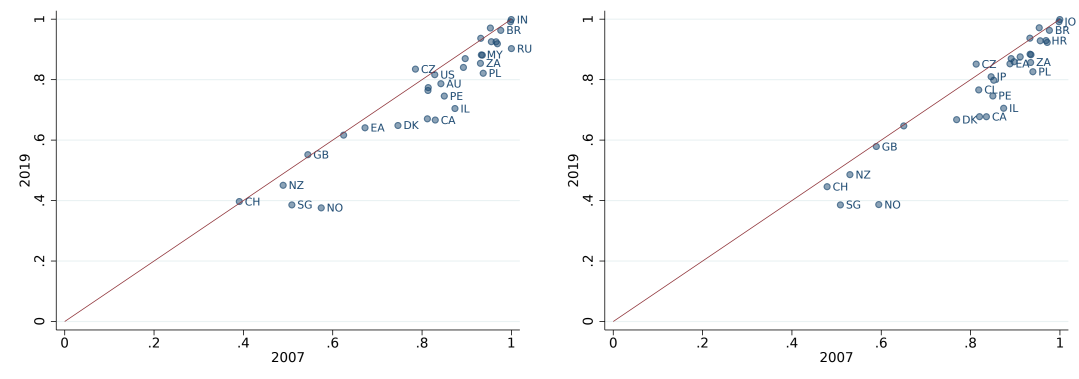
Because the EMP relies on exchange rate variation, we exclude countries that do not have their own currency, or have multiple official exchange rates. The euro area as a whole is included, but individual euro area countries are excluded. Appendix Table A2 presents the country sample while Tables A3 describes the data sources and definitions. Descriptive statistics are provided in Table A5.

The main empirics define all country exchange rates vis-à-vis USD or vis-à-vis the euro as main monetary reference currencies of the country. Klein and Shambaugh (2008) show that in practice, most countries have the US dollar as reference currency, with the exceptions of a number of European non-euro area countries for example inclusive of the UK, Switzerland, Denmark, Sweden and the US itself, which have the euro as main reference currency; Singapore, which has the Malaysian baht as reference currency, and New Zealand which has the Australian dollar as reference currency. For both of the latter, our analytics set reference currencies as the USD. An alternative approach, discussed below, is to define currency movements against a financial exchange rate. We have likewise computed these analytics, but note that current constructions have shortcomings. Because the USD is the main reference currency, we exclude the US from the sample used for certain analytics, while the euro is maintained, as defined with the USD as reference currency. This leads to a sample of 41 countries including the US, and 40 when the US is excluded.

The assumptions used to implement the EMP formula vary by the frequency of the application. As our main application is at monthly frequency we assume that $dNX_{e,t} = 0$. Interest rates, mostly drawn from IMF International Financial Statistics, are adjusted to reflect one period returns, so that - for example - a monthly construction of the EMP uses one year interest rates divided by 12. As the sample period of our analytics includes periods defined by quantitative easing, forward guidance, and the zero lower bound, we use Krippner Shadow short rates (www.ljkmfa.com) for the United States, euro area, Japan, United Kingdom, Switzerland, Canada, Australia and New Zealand.

3.1 International Portfolios

Our approach to α_t and α_t^* follows closely the broader literature on home bias and country portfolio shares, for example Coeurdacier and Gourinchas (2016); Coeurdacier and Rey (2012); Lane and Milesi-Ferretti (2018); Camanho, Hau and Rey (2018); and Maggiori, Neiman and Schreger (2020). The External Wealth of Nations (EWN), updated through 2020 by Milesi-Ferretti, provides annual series for Foreign holdings of Home's Liabilities $\frac{L_t}{e_t}$ and Home holdings of Foreign liabilities A_t, using reported series for portfolio equity, debt, and financial derivatives. We update the Coeurdacier and Rey (2012) measures of home-bias or home portfolio shares α_t on the basis of domestic and foreign holdings of stocks, bonds and bank loans. Using data through



(a) Home Asset Share, 2007 v. 2019 (b) Home Currency Asset Share, 2007 v. 2019

Figure 1: α_t **by Country in 2007 and 2019**
α_t represents the share of a country's portfolio investments held in domestic assets or domestic-currency-denominated assets. Data points below (above) the 45-degree line indicate that the home asset share decreased (increased) between 2007 and 2019. Some country labels are removed for readability.

2008, the α_t values for countries tended to decline in the period preceding the global financial crisis (GFC), but still generally range between 0.60 and 0.90 across countries.

We update series through 2020 for countries in our sample examining equity, bond market, and bank loans while also constructing aggregated measures by country and over time (annual).[18] As shown in Figure 1, the trends toward reduced home bias (declines in our α_t) identified through 2008 by Coeurdacier and Rey (2012) continued for equity portfolio data. All countries show further declines in equity home bias, including for those that had less home bias in the period prior to the GFC. By contrast, home share of debt holdings ended up broadly similar in 2019 compared to 2007, despite some country values either rising or falling modestly. Bank loan share updates, with weaker coverage for our country sample, exhibit more similarity than difference compared with 2007 values. Comparisons of 2007 and 2019 α_t for equities, bank loans, and bond data, and then of summed totals have ranges generally from around 0.40 to close to 95 percent. As availability of inputs to total α_t varies, we assign maximum available content at each point in time to country values used in our applications.

α_t^* is the rest of the world (Foreign) financial assets that are not invested in Home liabilities. For this computation, we sum over the total of domestic and foreign positions for the countries in our full sample at each date. $(1 - \alpha_t^*)$ is computed by countries using the information previously applied for α^t but excluding the Home Country from the denominator and including the associated

[18] We follow Coeurdacier and Rey (2012), computing the annual share of each country's equity investments in domestic equity market, with our update covering 36 of our 41 sample countries. For banking share this update covers 16 of our 41 sample countries. The bond share update covers 24 of the 41 countries. Details are provided in the Appendix.

Home Country Liabilities in the numerator. This share strongly reflects country size and financial market depth in the world financial economy. Many countries face an α_t^* above 0.99, as they are relatively small in the universe of domestic and foreign investment opportunities relative to the rest of the world. Exceptions are countries like the United Kingdom, Switzerland, the euro area aggregate, Japan, Norway, and the United States where recent values are closer to 0.80.

Consistent with the EMP derivation, for our a focus on domestic currency denominated Home liabilities and foreign currency denominated Foreign liabilities we use currency weights from the database of Benetrix, Gautam, Juvenal and Schmitz (2020), which extend through 2017. We maintain the 2017 values through the end of sample, pending further source data updates, and interpolate all annual observations to monthly series.

Portfolio share sensitivities to uip enter elasticities through $\frac{\alpha'_{uip}}{1-\alpha}$. Empirical specification using country aggregate data on components of global liquidity shows that elasticities of flows to domestic policy rates, US policy rates, and risk sentiment vary across market-based finance versus banking flows, in addition to varying over time (Avdjiev, Gambacorta, Goldberg and Schiaffi 2020). Studies using data on foreign shares in investors' portfolios find these shares respond significantly positively to currency depreciation shocks (Hau and Rey 2004; Hau and Rey 2006; Curcuru, Thomas, Warnock and Wongswan 2014).

However, recent literature on portfolio sensitivities largely concludes these elasticities are surprising small. Bacchetta, Davenport and van Wincoop (2021) argue that weak responses might arise as some investor types, for example employer sponsored retirement accounts or mutual funds, infrequently adjust portfolios. Koijen, Richmond and Yogo (2020) find substantial heterogeneity in demand curves of mutual investors for equities, with hedge funds and small active investors more responsive. Koijen and Yogo (2020) and Jiang, Richmond and Zhang (2021) find demand elasticities that differ substantially across asset classes in the international investment space: after controlling for ex ante home bias, elasticities with respect to excess returns are ten times higher for short term debt compared with long term debt and five times higher than for equity. Faia, Salomao and Veghazy (2022) find some rebalancing in response to shocks, with granularity across types of bonds, maturities and investors. Still, this literature finds international asset demand to be fairly inelastic with respect to returns.

Based on the insights of this literature, empirical measures of α_t and α_t^* and their range of variation observed by country over time, we assume specific empirical values for α'_{uip} and ${\alpha^*_{uip}}'$. Accordingly, our application assumes α'_{uip} at 0.01, and ${\alpha^*_{uip}}'$ at 0.0005. Under these assumptions, consider the effect of a 1 percent change in UIP (a change of 0.01), which could arise from domestic interest rates or the expected exchange rate path, on ϵ_e^A. If Home has a domestic portfolio allocation of 0.60 (60 percent) and the foreign allocation share at 0.40, a 100 basis point change in excess returns would raise the home share by 0.025 to 0.625 (62.5 percent). If Home is facing a world α^* of 0.98, the elasticity of response to a 100 basis point increase in UIP is even higher given the wealth and substitution effects. Under these same assumptions, ϵ_i^A is -0.025 and ϵ_i^L is 0.05.

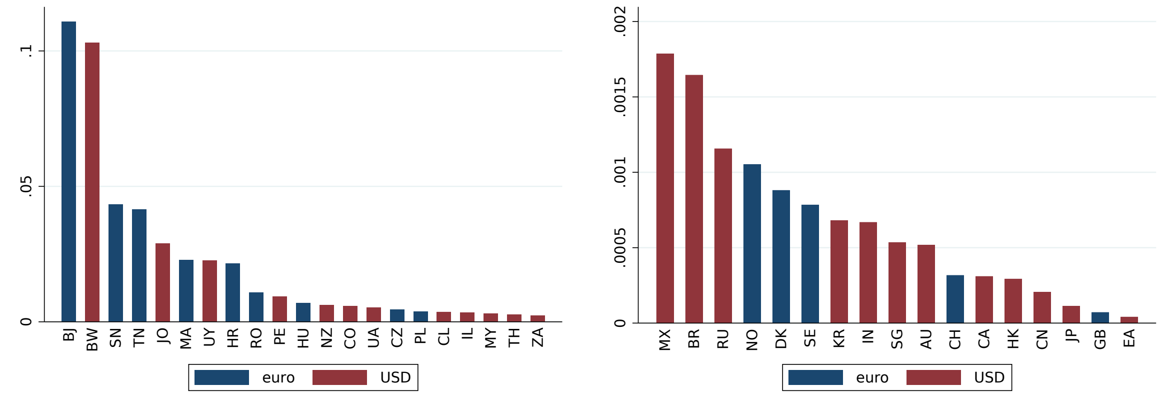
3.2 Implied Conversion Factor on FXI and Interest Rates

Using the portfolio share and elasticities, along with the gross international positions within $\Pi_{e,t}$, we generate the empirical conversion factors that map FXI_t (and di_t) into currency depreciation units within the EMP. Figure 2 presents country-specific $\frac{1}{\Pi_{e,t}}$ based on data for 2019, illustrating how much currency depreciation is implied to be avoided for every 1 billion units of FXI, where red bars correspond to economies with the USD as the reference currency and blue bars correspond to economies with the *euro* as reference currency. With countries indicated by two letter identifiers defined as in Appendix Table A2, emerging market economies concentrated in the left panel have a conversion factor on foreign exchange intervention generally an order of magnitude larger than for advanced economies.

For example, using 2019 data values, the $\frac{1}{\Pi_{e,t}}$ conversion factor suggests that a one billion unit intervention would instead deliver similar effects for Brazil and Mexico, at nearly 0.002 percentage points of avoided currency depreciation, less than half that value for Australia, Singapore and Switzerland, and which a factor at least twice as high as delivered for Japan. The US and euro area intervention equivalent currency effects are even smaller. These relatively small quantitative depreciation equivalents from FXI are consistent with the roles of oral interventions and the larger scale of interventions needed for such countries (measured relative to GDP for Fratzscher, Gloede, Menkhoff, Sarno and Stöher (2019)) weighed against the opportunity cost of holding very large stocks of reserves as discussed in Goldberg, Hull and Stein (2013).

The overall pattern is driven strongly by country gross external asset and liability positions in associated currencies, and by the home asset shares. Another interesting feature stems from the type of data on α shown in Figure 1, which compares home asset shares in 2007 with those in 2019. Higher α and α^* values tend to decrease $\frac{1}{\Pi_{e,t}}$, meaning that the correspondence between a unit change in capital flows and an associated currency depreciation changed over time. As the home asset shares decline, foreign exchange intervention becomes more effective as measured by avoidance of units of currency depreciation.

Another noteworthy observation is that given the assumed values for α'_{uip} and $\alpha^{*}_{uip}{}'$, the model generates relatively small contributions of interest rate changes to the EMP. This primarily occurs because of limited international portfolio reallocations occurring with respect to UIP changes, and is also consistent with evidence that valuation effects can be stronger than other exchange rate effects in some capital account adjustments. Future research could consider in greater detail the specific types of investors involved at the country level and perhaps more



(a) $1/\pi_e > 0.002$ (b) $1/\pi_e < 0.002$

Figure 2: **2019 Average $1/\pi_e$ by Country**
$\frac{1}{\pi_e}$ is the equivalent currency depreciation that would be needed to offset the capital flow gap reflected in sales of foreign currency reserves of 1 billion US dollars or euros in 2019 on average, depending on reference currency. The bars are color-coded by USD (red) and euro (blue) reference currencies.

regionally localized international investment sensitivities and home bias computations.

3.3 Monthly Foreign Exchange Intervention Series and Interest Rates

The most consistently available data across countries are published official reserve holdings. However, changes in official holdings are imperfect measures of FXI for two overall reasons, requiring choices and assumptions to be made that allow for estimation.

First, some central banks also intervene in foreign exchange markets using off balance sheet derivatives instruments such as foreign currency forwards and futures, swaps and options (e.g. Domanski, Kohlscheen and Moreno 2016; Kohlscheen and Andrade 2014). Such instruments are by definition not recording on the central bank balance sheet. Derivatives interventions are in some cases used for targeting specific markets or meeting foreign currency liquidity needs. It is not clear how different types of derivatives instruments map to a spot-intervention equivalent measure. Moreover, the availability of derivatives data is limited. Accordingly, we exclude this adjustment from our measure of FXI. Goldberg, Krogstrup and Loncar (2022) discuss measures of derivatives interventions and include a list of countries for which available data suggest that accounting for derivatives may be important.

Second, changes in official reserve holdings are affected by distorting valuation effects, making them imperfect measures of spot FXI.[19] Measuring foreign exchange intervention (FXI) activity consistently across countries hence requires making choices on what types of interventions to

[19]Exchange rate changes across currencies within an official reserve portfolio can induce valuation effects due to the multiple currencies of assets in the portfolio, as discussed in Dominguez, Hashimoto and Ito (2012).

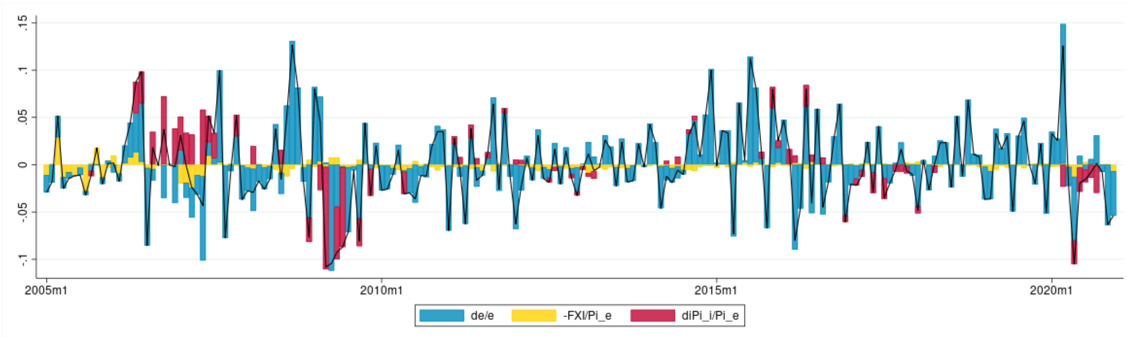
include, and assumptions allowing for estimation of these.

Following Goldberg, Krogstrup and Loncar (2022), we measure spot interventions using a combination of three complementary approaches, depending on sample countries' individual data availability. Thus, published data on official spot interventions are used when available (10 countries in our sample). In the absence of published data, we estimate FXI based on official reserve flows from national balance of payments statistics, when these are available in monthly frequency (an additional 15 countries). Balance of payments data is based on transactions and is hence net of valuation changes, although it does contain interest receipts on foreign assets requiring an additional correction. For the remaining countries and time periods, we adjust changes in official foreign reserve positions for valuation and interest receipts.

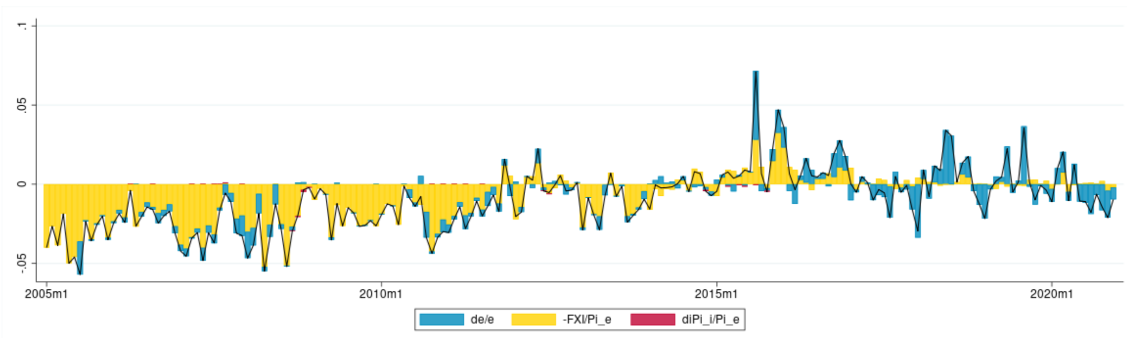
3.4 Monthly EMP Series with Components, Using Reference Currencies

Pulling together the different data elements yields EMP values that vary across countries and time. Some country values are considered vis-a-vis euros, while others are considered vis-a-vis USD. All have different contributions to the "super exchange rate" of observed depreciation versus the incipient pressures avoided through FXI and interest rate changes. Four specific country examples illustrate these points: Colombia using a variety of tools in response to international capital flow pressures; China, heavily utilizing FXI and later allowing greater contributions of exchange rate movements; Thailand as an emerging market applying two-sided FXI; and Switzerland as an advanced country that has actively used all three respective components of the EMP and with a currency value measured and in recent years stabilized relative to the euro.

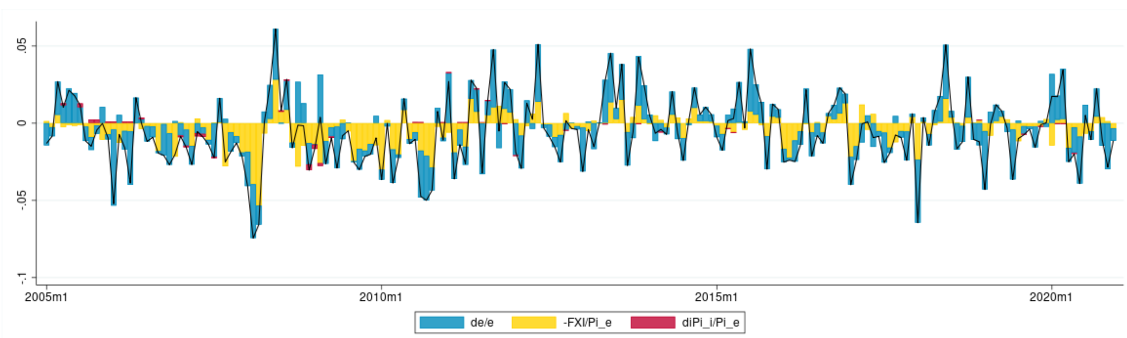
Figure 3 shows that Switzerland's interventions became more active in the years after the global financial crisis, when the policy rate became limited by the proximity of the lower bound. Interventions have resulted in significant growth in Swiss foreign exchange reserves, but the contributions to the EMP from interventions exhibited in Figure 3 are nevertheless relatively modest. This is because Swiss cross border holdings of financial assets are exceptionally large, in turn reducing the weight of the foreign exchange interventions in the Swiss EMP. In other words, Swiss deep and broad financial market and high international position increases the needed size of interventions per unit of prevented exchange rate change, relative to other countries, as also clear from Figure 2. China's interventions have aimed at limiting appreciation against the dollar, but the figure suggests more flexibility in the dollar value of the renminbi since 2015. A caveat on Chinese exchange market pressures is that they do not account for capital flow management measures, see also Goldberg and Krogstrup (2019). The examples in Figure 3 underscore that differences between observed currency movements and the international capital flow pressures captured by the EMP can be substantial for some countries. Attenuation bias when using exchange rate paths or observed capital flows individually as measures of exchange



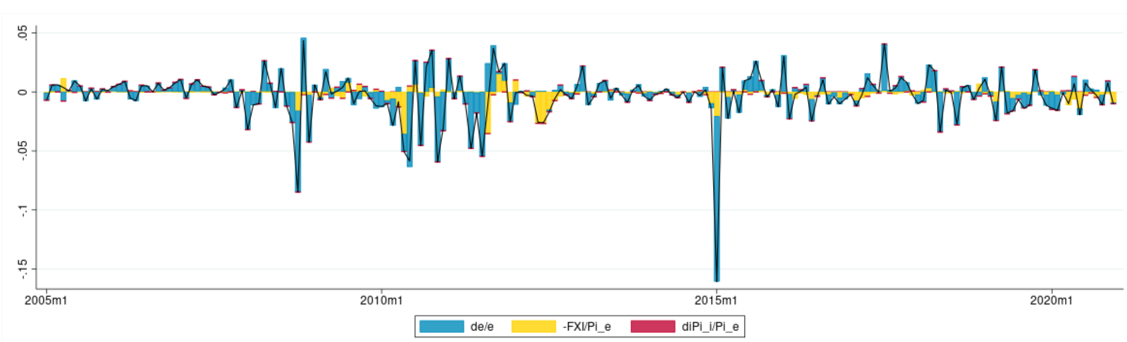
(a) Colombia



(b) China



(c) Thailand



(d) Switzerland

Figure 3: **Individual Components of the EMP (2005-2020)**
Presented are the three components of the baseline EMP, including percentage changes in the exchange rate, changes in FXI scaled by $\frac{1}{\Pi_e}$ and changes in policy rates scaled by $\frac{\Pi_i}{\Pi_e}$. Panel (d) is based on the EMP against the euro, while all others are based on the EMP against the US dollar.

market pressures could hence be material, and may change over time.

3.5 Monthly EMP Series Alternatively Based on a Financial Exchange Rate

The results we have presented rely on bilateral exchange rates defined relative to the USD or euro as reference currencies, consistent with the idea that FXI is conducted using the same respective currencies. As the EMP measures capital flow pressures relative to that experienced by the reference currency, this choice reinforces that we take care when comparing EMP developments across countries with difference reference currencies.

Some valid arguments could be made for instead constructing a financial exchange rate instead to capture the broader set of currencies represented in the financial accounts of an economy. We explore whether this alternative approach might be fruitful by broadly following the construction methods for financial exchange rates as most recently implemented by Benetrix, Gautam, Juvenal and Schmitz (2020) building on Lane and Shambaugh (2010) and Benetrix, Lane and Shambaugh (2015), where annual financial exchange rate series are constructed for countries through 2017. For each country measures of total external assets and liabilities, using country-year level data on external equity, debt, and financial derivatives, are from Lane's and Milesi-Ferretti's External Wealth of Nations dataset (available through 2020).[20] As weights are available from 1990 through 2017, for years after 2017, we maintain the 2017 weight values through the end of our sample, pending the next Benetrix, Gautam, Juvenal and Schmitz (2020) update. [21]

Our analysis of resulting series shows that most of the country bilateral exchange rates against reference currencies and financial exchanges have overall correlations above 0.90. This close co-movement reflects that well documented strong international roles of the dollar in particular, as well as the euro. However, important outliers with lower correlations include Switzerland, Denmark, United Kingdom, Hong Kong, Jordan, Norway, and Sweden. These differences arise because some countries with a euro reference currency still have a substantial share of financial transactions – from a third to over a half – denominated in USD. Moreover other countries like Hong Kong and Jordan that had reference currencies as USD have a substantial share of transactions in other currencies (CNY and euro respectively).

[20] Our application requires creating weights for 10 currency areas not in the IMF/Benetrix et al. (2020) data. Euro Area (EA) aggregate weights are calculated as the (foreign asset and liabilities) weighted average of individual EA countries, with the countries included the same as those used by Coeurdacier and Rey (2012) and, therefore, in our alpha construction. Regional averages (ex: South America, North Africa, etc.) are similarly computed as a weighted average of individual countries in the region.

[21] We differ from their financial exchange rates by excluding a country's domestic currency and non-major currencies, considering currency movements against only USD, EUR, GBP, JPY, and CNY denominated assets and liabilities (for countries other than the US, EA, UK, JP, and CN for which we also exclude the respective domestic currency), with currency weights are normalized to sum to 1 within each country-year and then country-year level values are interpolated (smoothed) at the country-month level. As the construction formula is a recursive series, we set the initial (January 2000) value to 100, in line with the approach of Benetrix, Gautam, Juvenal and Schmitz (2020). Special thanks to Luciana Juvenal for providing their underlying data and construction code.

While the concept of a financial exchange rate is appealing for our application, these series have limitations. In particular, the exposure implied by the available are unlikely to accurately capture financial exposures in foreign positions. These series do not incorporate exposures off balance sheet that can be large enough to make the on-balance sheet exposures misleading. Using the case of Denmark as a specific example, many institutional investors hold dollar assets but swap these into euro in the foreign currency swap and/or forward markets. They do this exactly because the euro is stable against the Danish Kroner due to their monetary policy, and hence stable relative to domestic purchasing power which these investors anchor against. Taking this hedging into account in exposure measurement would hence greatly increase the euro exposure, more in line with the reference currency approach. Using the imprecise on-balance sheet financial exposures exchange rate as a measure of capital flows may hence mis-characterize movements in the exchange rate as inflows when the movements are due to euro-USD exchange rate moves. This potential for mismeasurement is likely to be biased toward under-weighting exposures against the reference currency in particular in countries that manage their currency against the reference currency. We have for this reason maintained the reference currency approach as baseline.

Despite these considerations, we have replicated the EMP construction using these alternative indices. Given the tight correlations for most bilateral reference currencies with the financial exchange rates, the key differences in EMP construction and risk characterizations are for those exception countries indicated above. In the remainder of the text, we indicate key points where these differences are material in lieu of providing both sets of results.

4 The EMP, Risk Sentiment, and the Global Factor

International capital flow pressures are driven by global factors or advanced economy push factors and by local pull factors. A long history of studies of capital flow drivers, and the influential work of Miranda-Agrippino and Rey (2015), point to a large and important global factor particularly associated with US monetary policy and risk sentiment. Some studies point to a close relationship between US monetary policy and risk sentiment (e.g. Kalemli-Özcan 2019), while others argue for a reduced role of the VIX as reflecting the price of risk on bank balance sheets in the post GFC period (e.g. Shin 2016).[22] Drivers of global liquidity flows - whether bank-based funding or market-based funding - also have been shown by Avdjiev, Gambacorta, Goldberg and Schiaffi (2020) to evolve over time as the composition and health of global banks evolves and regulation changes. Moreover, these relationships differ between normal periods and high stress periods, as emphasized by Forbes and Warnock (2021) and Chari, Dilts Stedman and Forbes (2022).

[22]Shin (2016) argues that the broad USD exchange rate became a better metricof risk appetite, reflected in cross-border dollar funding and investment flows (Avdjiev, Bruno, Koch and Shin 2018, Avdjiev, Du, Koch and Shin 2017).

The next sections provide a series of tests of the relationship between the EMP and risk sentiment, and of the overall role of the global factor in international capital flow pressures. We begin with descriptive statistics on the contributions of exchange rates, official intervention, and interest rate changes to the EMP across types of countries, and across normal and high stress periods. We then turn to how the EMP series correlate with risk sentiment, constructing our GRR (Global Risk Response) measure by country and by month. Stress periods are defined using extreme values of a risk sentiment measure. Our baselines use the VIX, while supplemental results utilize the distribution of realizations of the BEX RA measure of risk sentiment (Bekaert, Engstrom and Xu 2021), the euro $VSTOXX$, and the $RORO$ (Risk-On Risk-Off) (Chari, Stedman and Lundblad 2020).

The results underline how international capital flow pressures as measured by our EMP series respond differently to high stress periods across countries and over time. The results are used to categorize countries as having so-called safe-haven status, defined as those exhibiting appreciation pressures against their reference currency when risk sentiment is most strained. Initial results contrast results exclusively based on exchange rates with those based on the EMP to demonstrate how relying only on exchange rate based analytics can grossly miss the international capital flow pressures experienced by some countries as risk conditions evolve. Further results explore the country and currency characteristics that are associated with the sensitivity of the EMP to risk, revisiting the empirical literature on the drivers of so-called safe haven currencies.

4.1 EMP Variance Decomposition and Contributions from Components

The contributions of the different components to the variance of the EMP differ across normal periods and high stress periods. To illustrate this point, we begin by isolating the monthly values of the VIX that are at or above the 90th percentile of the distribution in the period between 2000m1 and 2020m12. This results in a series of months denoted as high stress periods, which include dates around the September 11 (2001) attacks, Corporate scandals in mid 2002 to early 2003, the Global Financial Crisis (GFC), the euro area debt crisis and around the US debt ceiling, as well as the early months of the COVID-19 pandemic.[23] A first exercise shows that the contributions to the EMP of exchange rate movements per se can be quite different in high stress months, even beyond a focus exclusively on the months associated with the GFC or the early COVID-19 pandemic. The decomposition by country is shown across the panels of Figure 4, while the broader characterization across all country-month observations is provided in Table 1.

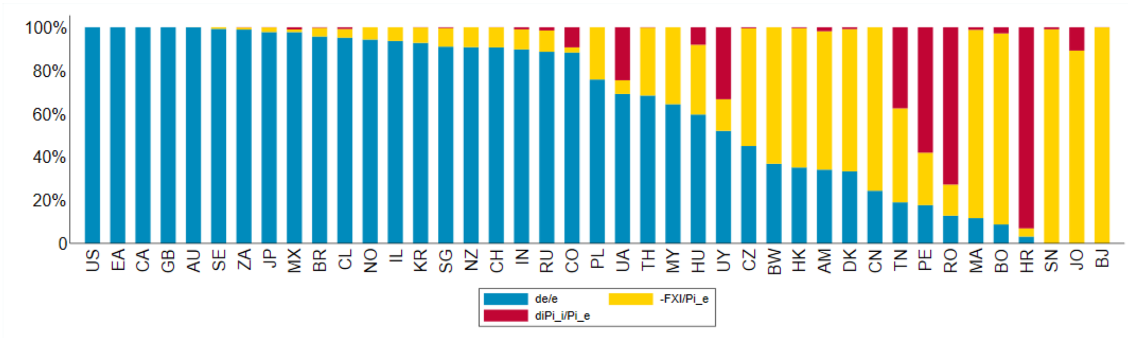
[23] The high stress dates overlap with, but are not identical to 90th percentile dates derived using the $RORO$, BEX risk aversion index, and the $VSTOXX$. The $RORO$ dates, with the index construction based on a broader series of data inputs, are particularly distinct as shown in the Appendix.

Figure 4 shows the distribution across countries of contributions to the variance of the EMP from the individual components of the index across the less extreme VIX dates (normal periods) in comparison with the extreme dates (high stress periods). The lower panels show the distribution under the GFC and the COVID-19 pandemic. All panels use the country ordering of the panel based on less stressful months, labeled as normal periods. Countries are shown from left to right using the ordering of the contribution of direct currency movements within the EMP, keeping across all panels the ordering from the normal periods.

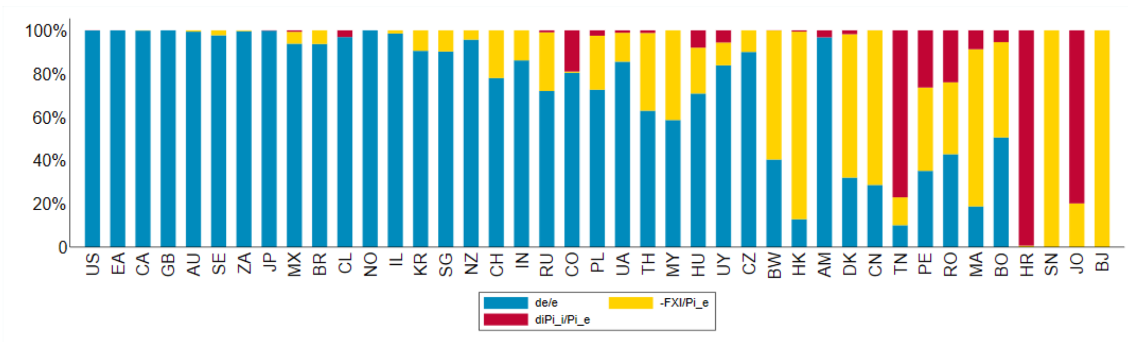
Even in normal periods, more than half of the countries in our sample have exchange market pressure that is not fully reflected by exchange rate movements (depicted in blue). The rest of the pressures are associated particularly with a mixture of currency intervention activity (in yellow) and less so with policy rate adjustments (in red). Another interesting, and perhaps unexpected, observation is that on average exchange rate adjustments capture more - not less - of the international capital flow pressure during stress periods. The share attributed to foreign exchange intervention is weaker for some countries while much stronger for others, with generally weaker contributions of interest rate changes.

These compositional differences without the country identifiers also appear through comparisons of the share of country months that have the pure currency component less than 10 percent, between 10 and 90 percent, and over 90 percent of measured EMP (Table 1). Rank correlation coefficients across countries consider whether the countries that rank highest to lowest in terms of the currency component (de/e) of the total EMP variance are similar across the normal versus high stress periods, also with the specific comparison of the GFC and pandemic. In addition, it shows the prevalence of floaters (here defined as those with exchange rate change contributions in excess of 90 percent) versus countries that manage their exchange rate more actively (where the exchange rate contribution is below 10 percent). The strong weight in the center category resonates with the arguments of Frankel (2019), who used foreign exchange reserve changes as a percentage of base money compared with observed currency appreciations against USD to classify countries as systematic managed floaters.

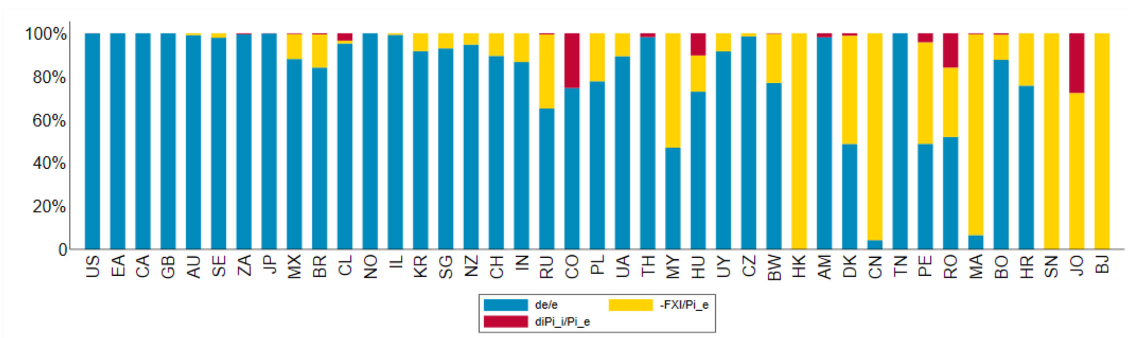
During high-stress episodes, countries on average allow more exchange rate variation to absorb capital flow pressures than during normal times. Some countries might recognize that intervention in the foreign exchange market may not be as effective during periods of extreme stress when currency pressures are large and might entail losing large quantities of official foreign currency reserves, so that they take at least a temporary currency depreciation. While the panels of Figure 4 shows that this is true on average, there are large differences across countries. Some countries, including for example Switzerland, have used FXI to a greater extent during high stress episodes than during normal times. The pattern of rank correlations across periods is similar, but the magnitudes a bit smaller, when financial exchange rates are used in place of



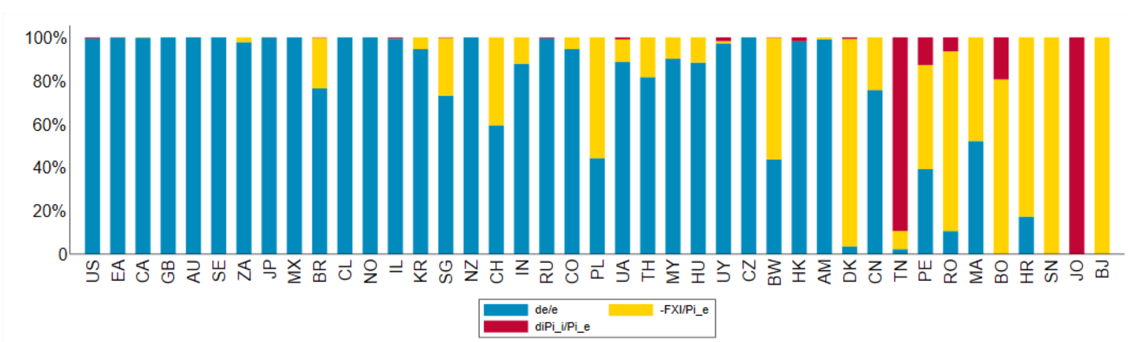
(a) Normal periods



(b) High stress periods



(c) Global Financial Crisis



(d) Covid-19 pandemic

Figure 4: **Individual Components of the EMP During Normal times and Stress Periods**
Contributions from the individual components of the EMP across (a) all periods, (b) all high stress periods, (c) the Global Financial Crisis and (d) the covid-19 pandemic.

	Rank correlations by de/e share	Share of countries by de/e share of total EMP variance		
		< 10 percent	$[10; 90]$ percent	> 90 percent
Normal periods	–	12	44	44
High stress periods	0.91	10	46	44
GFC	0.72	15	39	46
Pandemic	0.77	15	34	51

Table 1: **EMP Decomposition and Country Shares of Exchange Rate Component**
Spearman rank correlations of countries by de/e share of total EMP variance across normal periods and high stress periods, also the cases of the Global Financial Crisis (GFC) and the covid-19 pandemic. Further, the table contains information on the country distribution by de/e share of total EMP variance.

reference exchange rates.

The interest rate component accounts for almost all variation for very few countries. The contribution of the interest rate component is most pronounced in countries with high inflation and policy rates that have not been constrained by the effective lower bound and zero lower bound. Central banks in these countries have been able to use the policy rate more actively in response to capital flow pressures. By contrast, in a country such as Denmark the interest rate component contributes little to the variance of the EMP even though this is the primary tool of the Danish Central Bank.

4.2 Safe Haven Currencies, the EMP and Risk Sensitivity

Some currencies are typically considered safe haven currencies, including the US dollar, the Swiss franc and the Japanese yen. The asset pricing literature on safe-haven currencies often defines these as exhibiting excess returns during risk-off episodes (Ranaldo and Soederlind, 2010, Habib and Stracca, 2012, Fatum and Yamamoto 2014).[24] There is no consensus on what drives currency safe haven status. One view is that ”safe havenness” reflects self-fulfilling expectations. A common expectation among market participants that a currency appreciates during risk off, because it has done so in the past, makes the expectations self-fulfilling and drives demand for these currencies to increase as global risk conditions tighten. There is some evidence that self-fulfilling expectations play a role but is far from the whole story (Habib and Stracca, 2012).

Alternatively, excess returns during risk off episodes can be driven by unwinding of carry trades for low-interest funding currencies, which would also be associated with capital inflows in these currencies (Brunnermeier, Nagel and Pederson, 2008).

Finally, safe haven currencies may be variants of global safe assets (Gourinchas and Jeanne (2012)) that ensure the owner against financial income loss during global risk off, driving demand

[24]This topic is also related to and can inform more recent work on explaining convenience yields and the dominant roles of the the USD internationally, see Gourinchas et al. (2019), Caballero et al. (2016), Du et al. (2018), Goldberg and Tille (2016), Maggiori (2017).

up for the currency during such episodes.

While the self-fulfilling explanation of safe haven currencies depends on the materialization of excess returns *per se*, a currency can exhibit characteristics of a global safe asset or a carry trade funding currency in the sense of receiving inflows during risk off periods, even if it does not exhibit excess returns or currency appreciation during such episodes. In countries where authorities intervene to prevent the currency value from responding to an increase in demand, safe haven demand can also be reflected in FXI or policy rate reductions. Similarly, inflows into a safe haven currency that is fully flexible would result in an increase in excess returns sufficient to prevent the surge in demand from resulting in an actual international capital flow. Indeed, Yesin (2017) shows that episodes of Swiss franc appreciation during risk off are not associated with capital inflows. This means that a focus on either excess currency returns or capital flows, for identifying safe haven currencies alone, risks missing the bigger picture of safe haven currencies and how they evolve over time as currency regimes change.

To conduct a more general empirical assessment of safe haven currencies, we define a safe haven currency as a currency that exhibits capital inflow *pressures* during risk off episodes. We thus make use of the EMP as a "super-exchange rate", or a counterfactual exchange rate movement that captures both observed and incipient pressures on a currency through the balance of payments. We construct rolling correlations between the EMP and the VIX, labelling this correlation as the Global Risk Response (GRR) index. The sign and persistence of these correlations are used to identify safe-haven status currencies versus those that tend to experience capital outflow pressures when the VIX rises.[25]

We define a currency j as exhibiting safe-haven characteristics during period $t-x$ to t, if it tends to appreciate or experience international capital inflow pressures when risk shocks are higher:

$$GRR_t^j = -corr_{t-x,t}(EMP_t^j, s_t) > 0 \tag{24}$$

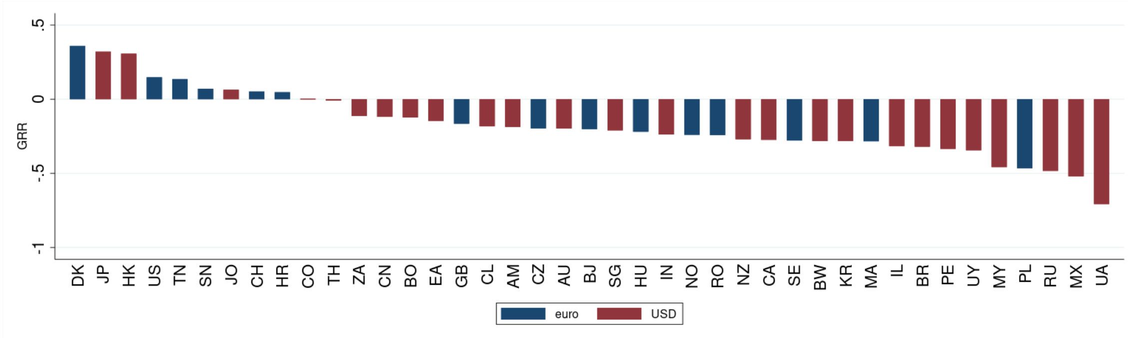
where s_t is captured by variation in the VIX for our baseline specifications, and alternative measures ($VSTOXX$, $BEXRA$, $RORO$) are considered for robustness. The GRR is constructed as a rolling five year correlation with the VIX using 5 years of prior monthly data. Currencies with persistently negative GRR are interpreted as risk-on currencies while those with persistently positive GRR are described as safe havens. The EMP used in these analyses are defined relative to their own reference currencies, so that for example the GRR values for the Swiss franc or Danish kroner could be positive relative to the euro, indicating that relative performance, without specifying their status relative to the USD. Other tests, included in the Appendix, show that

[25] A caveat is that our approach does not allow for distinguishing the element of self-fulfilling expectations as driver of safe haven status that may play out differently in flexible rate regimes relative to managed currencies.

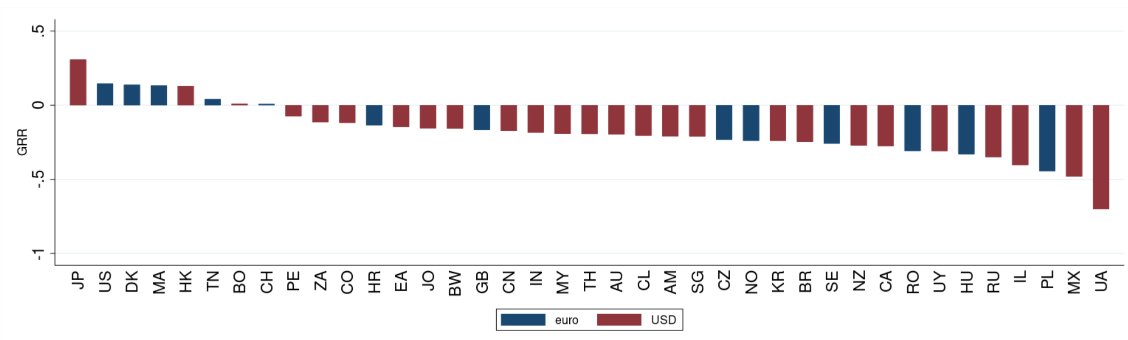
this status does not necessarily transcend reference currency choice.

Overall, we find that a small group of countries exhibit consistent safe-haven status, with $GRR > 0$, based on correlations between the baseline EMP and the VIX. To illustrate how countries stack up, panel (a) of Figure 5 shows the ranking using June 2013 GRR values based on the EMP, while panel (b) shows the scale and rankings of countries exclusively on observed currency depreciation. The Japanese yen, the US dollar (measured against the euro), and the Swiss franc have this status on average over time, while currencies like the Danish krone and the Hong Kong dollar show significantly stronger positive correlations using the EMP. The Swiss franc status is most pronounced when measured relative to the euro (Figure 6). The ranking of countries changes when constructed exclusively using currency depreciation, and the magnitude of the risk response is somewhat smaller for countries that use other tools. While some emerging market economies have positive values, these tend to be noisy and not statistically significant.

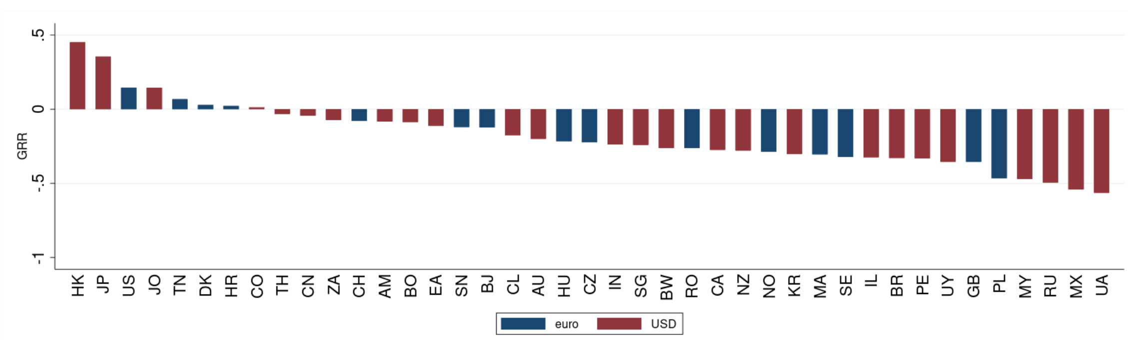
Most countries have EMP series that consistently exhibit negative values of the GRR. As illustrated by Figure 5, within the sample of advanced economies color coded in red the measured variation in the risk response is large, both qualitatively and quantitatively. This is not a feature that is concentrated only in emerging markets. Strong negative values are found in so-called commodity currencies in particular, like the Australian dollar, the Canadian dollar, the Norwegian krone, the South African rand, the Brazilian real, and the Russian ruble. Many other emerging markets and small advanced economies show less pronounced pressures, with smaller negative GRR values. For some countries the indicated strength of these effects is starkly different when measured purely using exchange rates (panel b) instead of the EMP, consistent with the pattern of countries that intervene in currency markets. Countries may have stronger risk-on behavior of currencies than suggested by analyses constructed just with the exchange rate, especially if policy interventions are used systematically to attenuate exchange rate responses.



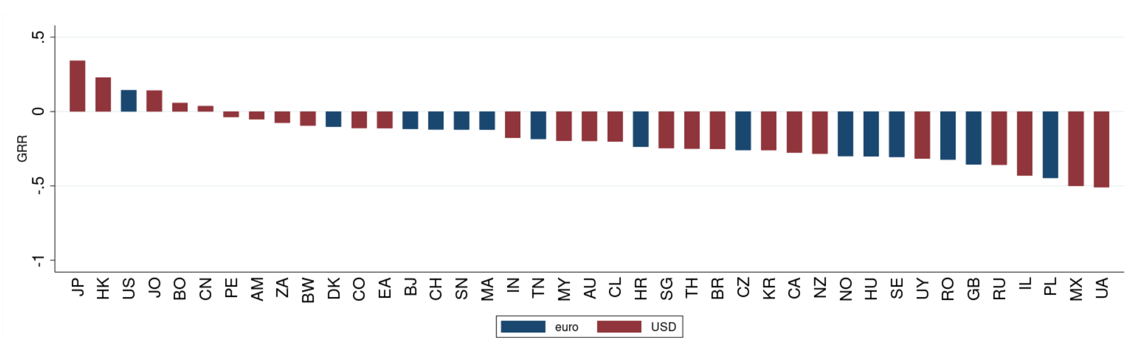
(a) EMP – reference currency



(b) de/e – reference currency



(c) EMP – Financial Exchange Rate



(d) de/e – Financial Exchange Rate

Figure 5: *GRR* **by Country: Near-Term Post-GFC**
Panels (a) and (c) shows the *GRR* based on changes in a country's EMP based on a reference currency and a financial exchange rate, respectively, using data from July 2009 through June 2013. Panels (b) and (d) displays the *GRR* based on changes in a country's bilateral exchange rate against its reference currency and financial exchange rate, respectively, from July 2009 through June 2013. Spearman's rank correlation between panels (a) and (b) is 0.753, and for panels (c) and (d) is 0.760.

We also consider time variation, which shows that the so-called safe haven feature is not time invariant. The GRR exhibits substantial variation over time and across countries,[26] as clearly indicated by Figure 6. Against the USD, the Japanese GRR is significantly and consistently positive, an attribute that lends the yen a characteristic of being one of the so-called safe haven currencies, even when computed vis-a-vis USD.

The Swiss franc, by contrast, is not consistently measured as having safe haven status with $GRR > 0$. This status episodically switches to neutral during Switzerland's period of active exchange rate management between 2012 and 2015, unless only high-stress dates are considered, in which case the Swiss franc remains a safe haven currency even during those episodes (see Appendix Figure A2). The construction of Switzerland's EMP shows a smaller contribution of large FXI than might be expected, in part because the foreign assets it weighs against are so large. Future research can explore this feature, but this observation shifts Switzerland further to the right in the GRR ranking and lowers its correlation with risk relative to other countries. Other countries have positive average GRRs that are occasionally significantly different from zero. Two countries stand out, namely Denmark and Hong Kong, by not usually being considered as having safe haven currencies. Both countries have fixed exchange rate systems and only measure as safe havens when taking into account their interventions in the foreign exchange market.

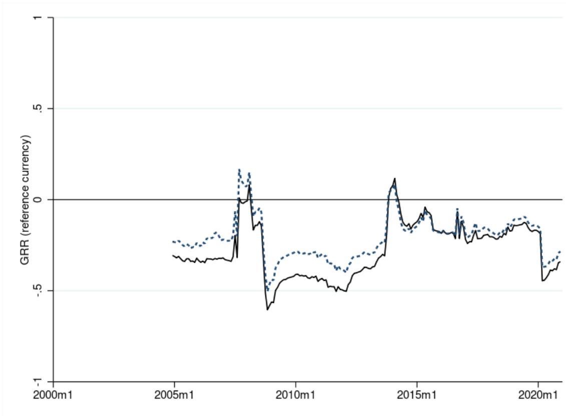
By contrast, the Brazilian EMP behaves like a commodity currency, consistently facing depreciation and capital outflow pressures with declining returns when risk rises. For example, the GRR is consistently negative but with weaker risk response in a period from around 2015 before increasing again closer to 2020.

4.3 Regime differences in EMP Risk Sensitivity

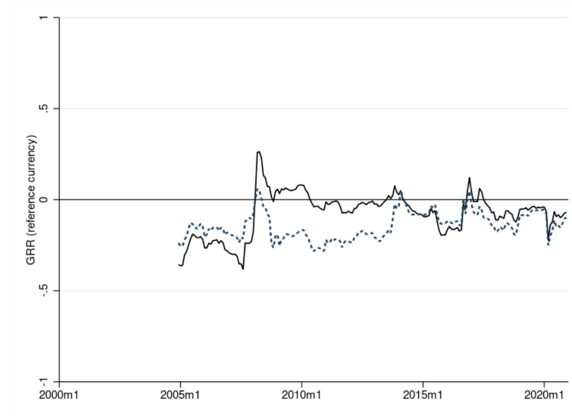
Differences in sensitivities across periods, that have been identified as key stress events, are a feature of important contributions by Forbes and Warnock (2012), Forbes and Warnock (2021), Chari, Stedman and Lundblad (2021) and Chari, Dilts Stedman and Forbes (2022). This recognizes that average VIX sensitivity as reflected in the GRR may not be indicative of sensitivity in extreme risk periods. Instead, nonlinearities in response may characterize countries.

We next introduce tests to explore the sign and scale of differences in risk sensitivity between the full set of monthly observations and excluding the extreme risk periods, continuing with the 90th percentile of the VIX distribution exclusions. We conduct difference in means tests with a focus on all countries, those that have so-called safe-haven status. The results show that the sensitivities of this later group are consistent for all periods and when the extreme stress events are excluded from the computations. By contrast, the other countries have significantly lower

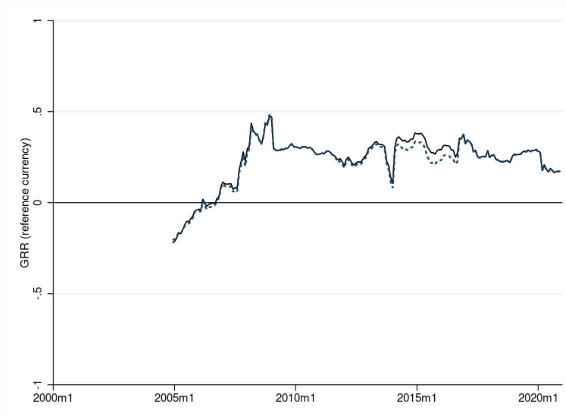
[26] Observations for the GRR are based on 5 years of prior monthly data. If pre-2000 EMP data are unavailable for some countries, some early GRR observations will be missing from the regression sample.



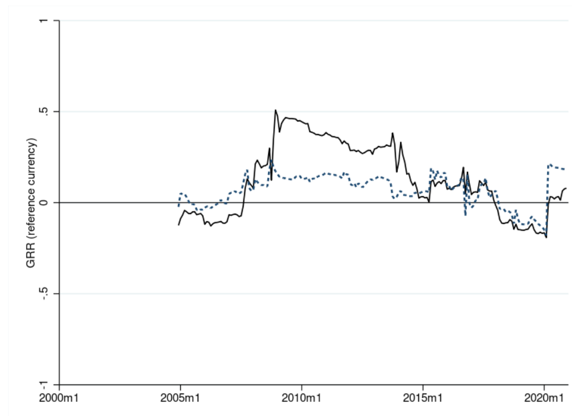
(a) Brazil



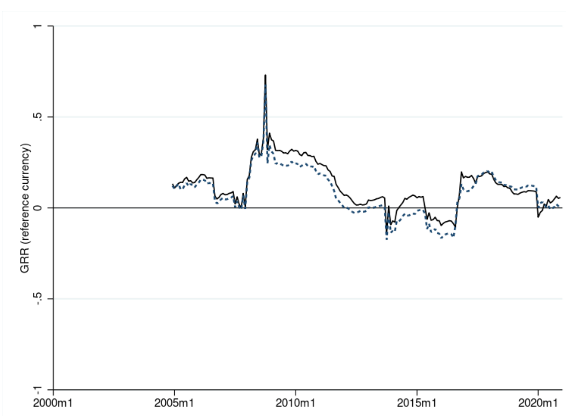
(b) Thailand



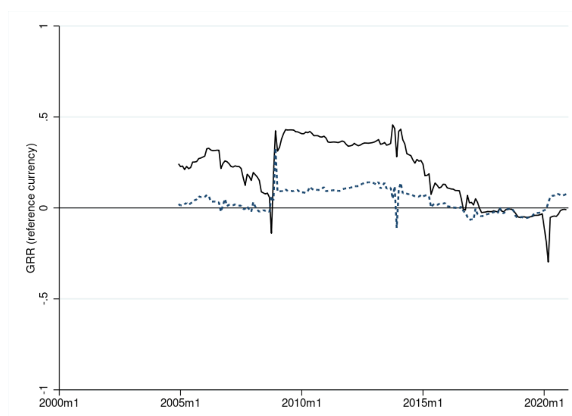
(c) Japan



(d) Hong Kong



(e) Switzerland



(f) Denmark

Figure 6: **Global Risk Response (*GRR*) Comparison, Using the VIX**
GRR using the VIX as the risk sentiment proxy and based on the EMP against the US dollar in panels (a) through (d) and against the euro in panels (e) through (f). The solid line displays GRR computed the EMP. The dashed line displays the GRR computed using realized depreciation rate.

risk sensitivities when the GRR excludes the extreme risk dates. Those sensitivities are closer to zero, and in many countries are noisy enough to not be statistically different from zero.

Further dividing the data base, we test whether average sensitivities have changed, with lessons learned and reforms after the GFC. Shin (2016) argued that the VIX lost its strong power, while Avdjiev, Gambacorta, Goldberg and Schiaffi (2020) and Buch and Goldberg (2020) argue that changes in the regulatory environment made bank-based international capital flows less sensitive to risk events. We observe that overall pressures on currencies, looking across a broad group of countries, continue to have strong sensitivity to risk conditions. Indeed, safe haven countries have stronger correlations post GFC compared with the GFC and earlier. Other countries have similar sensitivities on average. If there are weaker effects, this could arise because a period of time used in estimation has fewer observations of the high stress values that are associated with elevated correlations, or because there is attenuation bias in the studies that use only capital flows or exchange rate movements as dependent variable as these do not fully reflect the incidence of exchange market pressures.

(a) Full Sample

	All	Safe Haven	Excl. Safe Haven
GRR – All Periods	-0.11***	0.15***	-0.14***
GRR – Excluding P90	-0.02***	0.15***	-0.04***
Difference	-0.09***	-0.003	-0.10***

(b) Pre-GFC

	All	Safe Haven	Excl. Safe Haven
GRR – All Periods	-0.09***	0.11***	-0.11***
GRR – Excluding P90	-0.03***	0.09***	-0.05***
Difference	-0.06***	0.01	-0.07***

(c) Post-GFC

	All	Safe Haven	Excl. Safe Haven
GRR – All Periods	-0.08***	0.10***	-0.11***
GRR – Excluding P90	-0.03***	0.12***	-0.05***
Difference	-0.05***	-0.02*	-0.05***

Table 2: **Difference-in-Means Tests for GRR against each country's reference currency.** GRR is computed as -1 times the rolling correlation over 5 years between EMP against reference currency and the VIX. In the excluding P90 analysis, the rolling correlation is calculated excluding months at or above the 90th percentile value of the VIX from 01/2000 to 12/2020. Safe haven currencies are the DKK, HKD, JPY, CHF, and USD. Significance in the first two rows indicate whether the average is different from 0. Asterisks *, ** and *** indicate significance at the 10, 5 percent and 1 percent levels.

4.4 Country and Currency Characteristics Associated with Safe Haven Status

What is behind the EMP's sensitivity to risk and which macroeconomic and financial factors are associated with safe haven currencies on the one hand, and currencies with more extreme risk-on status on the other? We revisit and add to the empirical safe haven literature with a view to explaining why some currencies habitually experience inflows or excess returns when global risk conditions worsen. As we noted, some attenuation bias resulting from only considering exchange rate responses to risk factors may lead to inaccurate results when considering carry trade or safe haven drivers of safe haven currencies, where safe haven patterns can manifest in flows rather than in exchange rate movements. We instead construct and employ a counterfactual excess return based on the EMP as a "super-exchange rate", thereby accounting for policy responses that mute exchange rate movements but reflect flows and currency demand. In the following, we test self-fulfilling drivers, carry trade funding currency drivers and safe asset drivers, as explanations for safe haven currencies. To our knowledge, the previous empirical literature has not explored these different drivers collectively.

A self-fulfilling explanation for a safe haven currency is present if the currency is floating and its EMP response to a risk shock is correlated with the past response to risk shocks, which we measure by the level of lagged GRR. The dummy "Floater" is equal to one when a currency is freely floating, which we define as those for which the share of de/e in the total EMP variance is above 90 percent, see also Table 1.

A currency is more likely to be used as a carry trade funding currency, and hence to have a stronger response of the EMP to a risk shock, if the past interest rate level associated with the currency has been low. We define a low interest rate relevant for carry trade by a lagged interest rate level below the interest rate of its reference currency, and set the dummy CarryTrade to one for such country months, and zero otherwise. Carry trades are typically unwound when risk increases, allowing funding to flow back to the country of origin.

Finally, safe haven dynamics can be driven by safe asset motives if assets issued in the currency are considered safe and liquid. Habib and Stracca (2012) focus on safe asset drivers, and capture these in three conjectures, namely that a currency may be a "safe haven" (or a safe asset) if: i) the issuing country is itself regarded as a safe country and with low financial risk; ii) its financial markets are large and liquid; and iii) it is financially open and global. The variables used for testing the contributions of these categories respectively include i) net foreign assets in percent of GDP, public debt to GDP, inflation levels, and country risk as measured by average interest differential; ii) country size in world economy, stock market capitalization to world GDP, and private domestic credit to GDP; and iii) capital account openness (Chinn Ito) and gross foreign assets and liabilities to GDP. Using monthly data from 1986 to 2009 for 51 currencies, and in specifications inclusive of lagged dependent variables, Habib and Stracca (2012) find the most consistent indicator of safe haven status to be country net financial assets, along with country size and stock market capitalization relative to world GDP.

We test the three categories of drivers of safe haven currencies using monthly data for 40 countries for 2000 through 2020, exploring the sensitivity of the counterfactual excess return to risk in specifications containing a range of controls. We build the testing framework using insights drawn from the analytics of EMP. To recognize the EMP sensitivity to risk sentiment, we notably compare our results based on counterfactual excess return realizations with results using realized excess returns based on exchange rates. We also test whether results are driven by the variation contained in the set of safe haven currencies alone, defining safe-haven currency observations according to average $GRR > 0$ with statistical significance over the full sample period.[27] Finally, we consider differences in sensitivities across normal risk periods versus extreme risk periods.

Following Brunnermeier et al. (2008), we denote by $z_t^{j,e}$ the excess return of currency j relative to its reference currency, and by $z_t^{j,EMP}$ the counterfactual excess return of currency j relative to its reference currency, taking into account policy responses to flows.[28]

$$z_t^{j,e} = i_{t-1}^j - i_{t-1}^* - \frac{e_t^j - e_{t-1}^j}{e_{t-1}^j} \tag{25}$$

$$z_t^{j,EMP} = i_{t-1}^j - i_{t-1}^* - EMP_t^j \tag{26}$$

The baseline estimation equation follows from the EMP model derivation and is given by:

$$z_t^{j,EMP} = \alpha_s ds_t + \beta \Omega_t^j * ds_t + \gamma \Omega_t^j + +\delta di_t^* + \zeta^j + \varepsilon_t^j \tag{27}$$

where ds_t is the global risk shock introduced as the VIX; and di_t^* is the US or euro area policy rate, depending on which reference currency is relevant for a country in the estimation sample. Global risk enters estimation specifications directly and interacted with country-time specific variables, with each country variable also entering specifications in non-interacted form. The Ω_t^j are country-characteristics bundled according to the three hypotheses for interactions across table columns, but included as a full set of controls in all specifications.

The interaction terms with the VIX capture the dependence of risk sensitivity on country or economic characteristics, while we control for the average effect of these characteristics on realized excess returns. Thus, tables show estimated β and omit the presentation of the parameter estimates for γ, δ and the country fixed effect ζ^j. The column organization within tables follows the spirit of the analysis in Habib and Stracca (2012), in that variable grouping are associated with a specific hypothesis. Results are presented in Tables 3 and 4. Further robustness check tables are provided as appendix materials.

The first finding from across the specifications is that, regardless of whether constructed using $z_t^{j,e}$ or $z_t^{j,EMP}$, deteriorated risk sentiment as reflected by positive changes in the VIX, on average lead to international capital outflow pressures and depreciation pressures. The implication is that the average effect of $dVIX$ is negative, as expected for realized excess returns.

[27] Note that future refinements will rely only on ex-ante periods for defining currency status. The full period statistical tests identify the United States, Denmark, Switzerland, Japan, Hong Kong, and Tunisia as satisfying this criteria. The United States and Tunisia do not exhibit this in estimation samples that exclude extreme stress periods. We include the United States but exclude Tunisia in the category of safe-havens.

[28] Min et al. (2016) establish different dynamic linkages between equity and currency returns across six OECD countries during the 2008 financial crisis, a global shock.

Table 3 presents the results of panel regressions including explanatory variables that capture self-fulfilling expectations and carry trade funding currency drivers of safe haven flows. It also controls for differences in safe haven risk sensitivities depending on reference currency. Three results emerge from the Table on drivers of safe haven characteristics. First, Columns I amnd III show that safe haven characteristics of risk responses are relatively stronger when the reference currency is the euro compared to the USD, which is consistent with the USD being itself a safe haven currency. Second, Columns II and IV illustrate that risk sensitivity is highly persistent on average, similar to the correlations over the previous 5 years as reflected in interaction with GRR(t-1). This persistence is only significant when the currency is floating, consistent with the hypothesis that safe haven currencies are driven by self-fulfilling expectations of currency appreciation (rather than capital inflows) during risk-off. This pattern in capital flow pressures is not present for currencies that are not floating and hence do not allow for anticipated excess returns under tightening risk conditions. Third, countries with lower interest rates see a greater tendency for safe haven type capital inflow pressures when risk rises, consistent with low-interest rate currencies being used as carry trade funding currencies. The association with low interest rates can reflect other factors as well, such as low country risk. The analysis cannot distinguish these. Finally, the Table shows that the results are qualitatively similar across specifications based on the EMP and based on exchange rate appreciation, but there are differences across the specifications in terms of the size of parameter estimates and significance that may be driven by reducing the attenuation bias when using the EMP.

Table 4 contains regression results focusing on the set of variables typically associated with countries that issue safe assets. Columns II and VII contain variables capturing country risk (or country safety). Columns III and VIII introduce the set of macro fundamental variables reflecting size of economy and financial market development and depth.[29] Columns IV and IX introduce variables that capture financial openness: an index of capital controls (the Chinn Ito index) and a de facto measure in the form of gross foreign assets to GDP. Finally, Columns V and X combine variables. While these are likely to be co-linear, we mainly view these specifications are tests for incremental explanatory power from combined inclusion. The Table shows that safe asset variables are generally not significantly related to the risk response of currencies in our regressions. In some regressions, but not all, a higher level of public debt is weakly related to a safe haven tendency, which is not consistent with the prediction. Similarly, higher domestic credit and greater gross foreign positions are weakly significant in some regressions and with the right sign, but results are not robust across specifications.

[29] Financial market depth also captures liquidity, has long been identified as a feature of reserve currency status of currencies, for example by Krugman (1984) and later by Goldberg and Tille (2006), Goldberg and Tille (2008), and Goldberg and Tille (2009). Indeed, this liquidity focus also ties into our construction of the EMP, as it relates to the impact of flows through the portfolio demands sensitivities to changes in asset returns.

	$z^e * 1000$		$z^{EMP} * 1000$	
	I	II	III	IV
$dVIX$	-0.514*	-0.540**	-0.579**	-0.693***
	(0.206)	(0.201)	(0.212)	(0.167)
$dVIX * RefUSD$	-1.209***	-0.847***	-1.291***	-0.919***
	(0.306)	(0.250)	(0.316)	(0.239)
$dVIX * GRR_{t-1}$		0.479		0.415
		(0.739)		(0.798)
$dVIX * GRR_{t-1} * Floater$		3.114***		2.765**
		(0.881)		(1.004)
$dVIX * CarryTrade_{t-1}$		0.697**		0.888***
		(0.228)		(0.232)
Constant	19.456**	27.387***	19.307***	28.615***
	(5.994)	(3.653)	(5.595)	(3.565)
Adj. R2	0.032	0.131	0.037	0.120
No.Obs	9787	7526	9237	7454

Table 3: **Safe Haven Drivers: Panel Regressions**

Results from monthly panel regressions from 2000m1 - 2020m12 excluding the United States. z^e*1000 and z^{EMP}*1000 are dependent variables, winsorized at the 1st and 99th percentile. No.Obs gives the number of regression observations. Asterisks *, ** and *** indicate significance at the 10, 5 percent and 1 percent levels.

Tables 4 and A12 show that results for safe asset regressions do not change much when dividing the sample into safe haven and non-safe haven countries, or when considering only high-stress dates, or low-stress dates. All in all, these groupings of explanatory variables contribute little to explaining differences in effects of $dVIX$ on realized excess returns. Safe asset drivers of safe havenness of currencies do not receive much support from our data. Additional Appendix results show similar qualitative results in specifications with alternative fixed effects inclusions.

To conclude, regression specifications using the counterfactual excess return based on the EMP allow us to capture safe haven as well as risk off patterns in currencies across exchange rate regimes. Our analysis of the drivers of such patterns confirms some of the determinants that can be associated with safe haven status of a currency, namely persistence and self-fulfilling expectations and carry trade funding currency status. In contrast, determinants associated with safe assets found little support in the data, with the size of the public debt and gross foreign positions occasionally and weakly showing significant associations. Financial market development and financial openness changes over time, with country fixed effects in specifications, do not differentiate risk behavior of realized excess returns.

	$z^e * 1000$					$z^{EMP} * 1000$				
	I	II	III	IV	V	VI	VII	VIII	IX	X
$dVIX$	-1.348***	-1.524***	-2.015***	-1.611**	-1.823**	-1.491***	-1.600***	-2.384***	-1.860***	-2.193***
	(0.192)	(0.374)	(0.336)	(0.456)	(0.559)	(0.204)	(0.417)	(0.392)	(0.425)	(0.579)
$dVIX * NFA/GDP_{t-1}$		0.141			-0.327		0.157			-0.367
		(0.203)			(0.266)		(0.202)			(0.282)
$dVIX * Infl_{t-1}$		-8.274			-6.559		-10.364			-6.963
		(4.768)			(4.995)		(6.378)			(6.535)
$dVIX * PubDebt/GDP_{t-1}$		0.007*			0.007*		0.007			0.006
		(0.003)			(0.003)		(0.003)			(0.003)
$dVIX * ShareofWorldGDP_{t-1}$			2.035		1.043			1.037		0.590
			(5.501)		(6.441)			(5.311)		(6.059)
$dVIX * StockmarketCap/GDP_{t-1}$			0.000		0.001			0.000		0.001
			(0.001)		(0.001)			(0.001)		(0.001)
$dVIX * Dom.Credit/GDP_{t-1}$			0.007		0.000			0.009*		0.003
			(0.004)		(0.005)			(0.004)		(0.005)
$dVIX * (GFA + GFL)/GDP_{t-1}$				0.110*	0.126				0.119*	0.128
				(0.047)	(0.074)				(0.053)	(0.075)
$dVIX * ChinnIto_{t-1}$				-0.020	-0.064				0.077	0.026
				(0.586)	(0.567)				(0.591)	(0.591)
Constant	34.669***	22.201**	46.370***	89.194***	54.993**	34.853***	32.203***	51.722***	83.202***	70.467***
	(0.057)	(6.400)	(7.467)	(20.268)	(17.325)	(0.065)	(5.906)	(7.232)	(16.994)	(16.993)
Adj. R2	0.027	0.129	0.032	0.063	0.148	0.031	0.088	0.039	0.053	0.104
No.Obs	9787	8780	8859	8877	8624	9237	8380	8347	8448	8226

Table 4: **Safe Haven Drivers: Panel Regressions**

Results from monthly panel regressions of equations 25 and 26 from 2000m1 - 2020m12 excluding the United States. z^e*1000 and z^{EMP}*1000 are dependent variables, winsorized at the 1st and 99th percentile. No.Obs gives the number of regression observations. All specifications include country fixed effects and control for di^*. Specifications with interaction terms with $dVIX$ include the corresponding non-interaction controls which can include NFA/GDP_{t-1}, $Infl_{t-1}$, $PubDebt_{t-1}$, $StockmarketCap_{t-1}$, $ShareofWorldGDP_{t-1}$, $DomCredit/GDP_{t-1}$, $(GFA+GFL)/GDP_{t-1}$, $ChinnIto_{t-1}$ (not shown). Asterisks *, ** and *** indicate significance at the 10, 5 percent and 1 percent levels.

4.5 Additional Robustness

We conduct a range of robustness checks, with details on the findings included in the Appendix. First, we consider robustness to alternative measures of risk sentiment, replacing the VIX respectively with the $BEXRA$ risk sentiment, $VSTOXX$, and $RORO$ indices of Chari et al. 2020). We extended the $RORO$ series through 2022, relative to the April 2020 end date in Chari et al. 2020, and used a monthly sum of the daily series for a measure more comparable to the VIX type of monthly construction. For each of these robustness checks we generate distinct GRR series, and determine measure-specific high stress dates, as described in our appendices. As the $RORO$ series has a later start date (2003), the 90^{th} and 95^{th} percentiles of stress contain more values in the pre COVID-19 years. These series also tend to exhibit greater period to period variability. We then perform analytics to test for differentiation in risk sensitivity, replicating all of the regression tables with the alternative series.

The $BEXRA$ risk sentiment and $VSTOXX$ generate some differences in high stress dates, but otherwise a pattern of findings and conclusions broadly similar to those we have reported. Many of the $RORO$-based results are similar to the broader pattern of results in the paper. However, we observe that some countries exhibit starkly different correlations between the EMP and the $RORO$, compared with correlations constructed using the narrower stock-market based indices like the VIX, as the appendix illustrates. Additional differences from the other results emerge when the GRR-excluding P90 is compared with All Periods, and when countries are ranked by GRR at different points in time. Additional tables of results are available on request.

Finally, our analytics on EMP construction rely on different combinations of α and $\alpha^{'}$, and of α^{*} and $\alpha^{*'}$. We have followed the literature in α construction, and drawn lessons from especially a recent literature in $\alpha^{'}$ construction. In our view, especially $\alpha^{'}$ might be too low, suggesting international portfolio demand response to expected excess returns might be too weak. In addition, our approach to considering foreign demand for domestic debt assets defines Foreign to be the entire rest of world. The share of world investor wealth allocated to any single country portfolio is small, and the response is bounded accordingly. To the extent that investor patterns may be more concentrated and elasticities to returns higher, this will change the contributions of interest rates and foreign exchange intervention to the overall EMP. Future work can explore alternative approaches to measuring foreign investor behavior and the potential to magnify the response of foreign portfolio flows, delivering stronger interest rate and FXI contributions.

5 Conclusions

This paper has proposed a new measure of capital flow pressures in the form of an exchange market pressure index, taking into account actual capital flows resulting in exchange rate movements, as well as incipient flows that are instead manifested in official foreign exchange intervention or monetary policy rate changes. The EMP has a super exchange rate interpretation, as foreign exchange intervention and monetary policy changes are mapped into currency depreciation equivalents. The measure allows for comparison of international capital flow pressures across countries and across time, allowing for the different exchange rate and monetary policy regimes that are in place.

We have computed the EMP for a broad panel of countries and over time, providing an empirical measure of monthly variation in international capital flow pressures. The implementation approach closely follows and extends recent empirical advances in international finance. The empirical applications across 40 countries and over 20 years of monthly data demonstrate the EMP usefulness as a measure of capital flow pressures, avoiding the type of attenuation bias that arises when exchange rates or capital flows are independently used in cross-country and time-series empirical analyses. The EMP construction can also be timely, available monthly without the longer lags needed for other measures of international capital flow pressures.

In our empirical application, we have focused on global factors in driving capital flow pressures, contributing to the literature describing differences local capital flow pressures and currency responses to global risk conditions in particular. We have characterized cross country differences in the components' contributions to the EMP, and illustrated how capital flow pressures are highly responsive to global risk conditions across countries.

A particular feature of the response of capital flow pressures to global factors is exhibited by so-called safe haven currencies, which we have explored in more detail with our EMP at hand. We have shown that using the EMP instead of focusing on exchange rate movements alone matters for the set of currencies that exhibit safe haven characteristics relative to a reference currency. This set of currencies should not be viewed as a permanent feature. Large differences occur across countries and over time in the international capital flow pressures that occur when risk sentiment changes.

Our exploration of the data has suggested that the currency features associated with safe haven currency status include low interest rates consistent with funding currency use, and self-fulfilling expectations based on prior safe haven characteristics. On the other hand, macroeconomic country features relating to safe assets, such as country risk measures, country size, foreign asset positions, financial openness and liquidity, are not found to be robustly and significantly associated with safe haven currency status.

References

Adler, Gustavo, Noemie Lisack, and Rui Mano. 2015. "Unveiling the Effects of Foreign Exchange Intervention; A Panel Approach." IMF Working Papers 15/130, International Monetary Fund.

Aizenman, Joshua, Mahir Binici, and Michael M. Hutchison. 2014. "The Transmission of Federal Reserve Tapering News to Emerging Financial Markets." NBER Working Papers 19980, National Bureau of Economic Research, Inc.

Aizenman, Joshua, Menzie D. Chinn, and Hiro Ito. 2016. "Monetary Policy Spillovers and the Trilemma in the New Normal: Periphery Country Sensitivity to Core Country Conditions." *Journal of International Money and Finance*, 68 298–330.

Aizenman, Joshua, Jaewoo Lee, and Vladyslav Sushko. 2012. "From the Great Moderation to the Global Crisis: Exchange Market Pressure in the 2000s." *Open Economies Review*, 23(4): 597–621.

Avdjiev, Stefan, Valentina Bruno, Catherine Koch, and Hyun Song Shin. 2018. "The Dollar Exchange Rate as a Global Risk Factor: Evidence from Investment." Working Paper 695, Bank for International Settlements.

Avdjiev, Stefan, Wenxin Du, Catherine Koch, and Hyun Song Shin. 2017. "The dollar, bank leverage and the deviation from covered interest parity." Working Paper 592, Bank for International Settlements.

Avdjiev, Stefan, Leonardo Gambacorta, Linda S. Goldberg, and Stefano Schiaffi. 2020. "The Shifting Drivers of Global Liquidity." *The Journal of International Economics*, 125.

Bacchetta, Philippe, Margaret Davenport, and Eric van Wincoop. 2021. "Can Sticky Portfolios Explain International Capital Flows and Asset Prices?" Working Paper DP16772, Center for Economic and Policy Research.

Bekaert, Geert, Eric C. Engstrom, and Nancy R. Xu. 2021. ""The Time Variation in Risk Appetite and Uncertainty"." *Management Science*.

Benetrix, Agustin, Philip Lane, and Jay Shambaugh. 2015. "International Currency Exposures, Valuation Effects, and the Global Financial Crisis." *Journal of International Economics*, 96(S1): 98–109.

Benetrix, Agustin S., Deepali Gautam, Luciana Juvenal, and Martin Schmitz. 2020. "Cross-Border Currency Exposures. New evidence based on an enhanced and updated dataset." Trinity Economics Papers tep0120, Trinity College Dublin, Department of Economics.

Blanchard, Olivier, Francesco Giavazzi, and Filipa Sa. 2005. "International Investors, the U.S. Current Account, and the Dollar." *Brookings Papers on Economic Activity*, 36(1): 1–66.

Blanchard, Olivier J, Gustavo Adler, and Irineu E de Carvalho Filho. 2015. "Can Foreign Exchange Intervention Stem Exchange Rate Pressures from Global Capital Flow Shocks?." IMF Working Papers 15/159, International Monetary Fund.

Botman, Dennis P. J., Irineu E. Carvalho Filho, and Raphael W. Lam. 2013. "The Curious Case of the Yen as a Safe Haven Currency: A Forensic Analysis." IMF Working Papers 13/228, International Monetary Fund.

Branson, William H., and Dale W. Henderson. 1985. "The specification and influence of asset markets." In *Handbook of International Economics*. eds. by R. W. Jones, and P. B. Kenen, 2 of Handbook of International Economics: Elsevier, , Chap. 15 749–805.

Brooks, Robin, and Michael Cahill. 2016. "Fear of Floating: Foreign Exchange Intervention in Asia." Global Economics Paper 229, Goldman Sachs.

Brunnermeier, Markus, Stefan Nagel, and Lasse Pederson. 2008. "Carry Trades and Currency Crashes." *NBER Macroeconomics Annual 2008*, 23(1): .

Bruno, Valentina, and Hyun Song Shin. 2014. "Cross-border banking and global liquidity." BIS Working Papers 458, Bank for International Settlements.

Buch, Claudia, and Linda Goldberg. 2020. "Global Banking: Toward an Assessment of Benefits and Costs." *Annual Review of Financial Economics*, 12(1): 141–175.

Caballero, Ricardo J., Emmanuel Farhi, and Pierre-Olivier Gourinchas. 2016. "Safe Asset Scarcity and Aggregate Demand." *American Economic Review*, 106(5): 513–518.

Camanho, Nelson, Harald Hau, and Helene Rey. 2018. "Global Portfolio Rebalancing and Exchange Rates." NBER Working Paper Series 14165.

de Carvalho Filho, Irineu. 2013. "Risk-off Episodes and Swiss Franc Appreciation: the Role of Capital Flows." Working Papers 13.07, Swiss National Bank, Study Center Gerzensee.

Cerutti, Eugenio, Stijn Claessens, and Andrew K Rose. 2019. "How Important is the Global Financial Cycle? Evidence from Capital Flows." *IMF Economic Review*, 67(1): 24–60.

Chari, Anusha, Karlye Dilts Stedman, and Kristin Forbes. 2022. "Spillovers at the Extremes: The Macroprudential Stance and Vulnerability to the Global Financial Cycle." *Journal of International Economics*, 136(1): .

Chari, Anusha, Karlye Dilts Stedman, and Christian Lundblad. 2020. "Capital Flows in Risky Times: Risk-on/Risk-off and Emerging Market Tail Risk." Working Paper 27927, National Bureau of Economic Research.

Chari, Anusha, Karlye Dilts Stedman, and Christian Lundblad. 2021. "Taper Tantrums: Quantitative Easing, Its Aftermath, and Emerging Market Capital Flows." *Review of Financial Studies*, 34(3): .

Coeurdacier, Nicolas, and Pierre-Olivier Gourinchas. 2016. "When Bonds Matter: Home Bias in Goods and Assets." *Journal of Monetary Economics*, 82 119–137.

Coeurdacier, Nicolas, and Hélène Rey. 2012. "Home Bias in Open Economy Financial Macroeconomics." *Journal of Economic Literature*, 51(1): 63–115.

Curcuru, Stephanie E., Charles P. Thomas, Francis E. Warnock, and Jon Wongswan. 2014. "Uncovered Equity Parity and rebalancing in international portfolios." *Journal of International Money and Finance*, 47(C): 86–99.

Domanski, Dietrich, Emanuel Kohlscheen, and Ramon Moreno. 2016. "Foreign exchange market intervention in EMEs: what has changed?." *BIS Quarterly Review.*

Dominguez, Kathryn, Yuko Hashimoto, and Takatoshi Ito. 2012. "International Reserves and the Global Financial Crisis." *Journal of International Economics*, 88(2): 388–406.

Du, Wenxin, Alexander Tepper, and Adrien Verdelhan. 2018. "Deviations from Covered Interest Rate Parity." *Journal of Finance*, 73(3): 915–957.

Eichengreen, Barry, Andrew K. Rose, and Charles Wyplosz. 1994. "Speculative Attacks on Pegged Exchange Rates: An Empirical Exploration with Special Reference to the European Monetary System." NBER Working Papers 4898, National Bureau of Economic Research, Inc.

Eichengreen, Barry, Andrew Rose, and Charles Wyplosz. 1996. " Contagious Currency Crises: First Tests." *Scandinavian Journal of Economics*, 98(4): 463–484.

Engel, Charles, and Steve Pak Yeung Wu. 2021. "Forecasting the U.S. Dollar in the 21st Century." Working Paper 28447, National Bureau of Economic Research.

Faia, Ester, Juliana Salomao, and Alexia Ventula Veghazy. 2022. "Granular Investors and International Bond Prices: Scarcity-Induced Safety." manuscript, European Central Bank.

Fatum, Rasmus, and Yohei Yamamoto. 2014. "Intra-safe haven currency behavior during the global financial crisis." Globalization and Monetary Policy Institute Working Paper 199, Federal Reserve Bank of Dallas.

Forbes, Kristen. 2002. "Are Trade Linkages Important Determinants of Country Vulnerability to Crises." In *Preventing Currency Crises in Emerging Markets.* eds. by Sebastian Edwards, and Jeffrey Frankel, Chicago, IL, USA: University of Chicago Press, 77–124.

Forbes, Kristin J., and Francis E Warnock. 2021. "Capital Flow Waves—or Ripples? Extreme Capital Flow Movements Since the Crisis." *Journal of International Money and Finance*, 116(C): .

Forbes, Kristin, and Francis Warnock. 2012. "Capital flow waves: Surges, stops, flight, and retrenchment." *Journal of International Economics*, 88 235 – 251.

Frankel, Jeffrey. 2019. ""Systematic Managed Floating"." *Open Economies Reviews*, 30(2): 255–295.

Fratzscher, Marcel. 2012. "Capital flows, push versus pull factors and the global financial crisis." *Journal of International Economics*, 88(2): 341–356.

Fratzscher, Marcel, Oliver Gloede, Lukas Menkhoff, Lucio Sarno, and Tobias Stöher. 2019. "When is Foreign Exchange Intervention Effective? Evidence from 33 Countries." *American Economics Journal: Macroeconomics*, 11(1): 132–156.

Gabaix, Xavier, and Matteo Maggiori. 2015. "International Liquidity and Exchange Rate Dynamics." *Quarterly Journal of Economics*, 130(3): .

Gagnon, Joseph E. 2016. "Foreign Exchange Intervention since the Plaza Accord: The Need for Global Currency Rules." In *International Monetary Cooperation: Lessons from the Plaza Accord After Thirty Years.* eds. by C. Fred Bergsten, and Russell Green, Washington, DC, USA: Peterson Institute for International Economics, 193–215.

Ghosh, Atish, Jonathan Ostry, and Mahvash Qureshi. 2018. "Taming the Tide of Capital Flows." *MIT Press*, 1.

Girton, Lance, and Dale W. Henderson. 1976. "Financial capital movements and central bank behavior in a two-country, short-run portfolio balance model." *Journal of Monetary Economics*, 2(1): 33 – 61.

Girton, Lance, and Don Roper. 1977. "A monetary model of exchange market pressure applied to the postwar Canadian experience." *Americal Economic Review*, 67 537 – 548.

Goldberg, Linda, Cindy Hull, and Sarah Stein. 2013. "Do Industrialized Countries Hold the Right Foreign Exchange Reserves?" *Current Issues in Economics and Finance*, 19(1): .

Goldberg, Linda, and Signe Krogstrup. 2019. "International Capital Flow Pressures." Working Paper 24286, National Bureau for Economic Research.

Goldberg, Linda, Signe Krogstrup, and Nastasija Loncar. 2022. " Measuring Foreign Exchange Interventions." *Forthcoming Memo, Danmarks Nationalbank*, xx(x): .

Goldberg, Linda S., and Cédric Tille. 2016. "Micro, macro, and strategic forces in international trade invoicing: Synthesis and novel patterns." *Journal of International Economics*, 102(C): 173–187.

Goldberg, Linda, and Cédric Tille. 2006. "The International Role of the Dollar and Trade Balance Adjustment."Technical Report 71, Group of Thirty.

Goldberg, Linda, and Cédric Tille. 2008. "Vehicle Currency Use in International Trade." *Journal of International Economics*, 76(2): 177–192.

Goldberg, Linda, and Cédric Tille. 2009. "Macroeconomic interdependence and the international role of the dollar." *Journal of Monetary Economics*, 56(7): 990–1003.

Gourinchas, Pierre-Olivier, and Olivier Jeanne. 2012. "Global safe assets." BIS Working Papers 399, Bank for International Settlements.

Gourinchas, Pierre-Olivier, and Hélène Rey. 2014. "External Adjustment, Global Imbalances, Valuation Effects." In *Handbook of International Economics.*: Elsevier B.V., 585–645.

Gourinchas, Pierre-Olivier, Hélène Rey, and Maxime Sauzet. 2019. "The International Monetary and Financial System." *Annual Review of Economics*, 11 859–893.

Habib, Maurizio M., and Livio Stracca. 2012. "Getting beyond carry trade: What makes a safe haven currency?." *Journal of International Economics*, 87(1): 50–64.

Hau, Harald, and Hélène Rey. 2004. "Can Portfolio Rebalancing Explain the Dynamics of Equity Returns, Equity Flows, and Exchange Rates?" *American Economic Review*, 94(2): 126–133.

Hau, Harald, and Hélène Rey. 2006. "Exchange Rates, Equity Prices, and Capital Flows." *Review of Financial Studies*, 19(1): 273–317.

Henderson, Dale W., and Kenneth Rogoff. 1982. "Negative net foreign asset positions and stability in a world portfolio balance model." *Journal of International Economics*, 13(1-2): 85–104.

Ilzetzki, Ethan, Carmen M. Reinhart, and Kenneth S. Rogoff. 2017. "The Country Chronologies to Exchange Rate Arrangements into the 21st Century: Will the Anchor Currency Hold?." NBER Working Papers 23135, National Bureau of Economic Research, Inc.

Jiang, Zhengyang, Robert Richmond, and Tony Zhang. 2021. "A Portfolio Approach to Global Imbalances." working paper, NYU Stern School of Business.

Kalemli-Özcan, Şebnem. 2019. "U.S. Monetary Policy and International Risk Spillovers." proceedings of the jackson hole symposium, Federal Reserve Bank of Kansas City.

Kaminsky, Gabriela, and Carmen Reinhart. 1999. "The twin crises: The Causes of Banking and Balance-of-Payments Problems." *American Economic Review*, 89(3): 473 – 500.

Klein, Michael W., and Jay C. Shambaugh. 2008. "The dynamics of exchange rate regimes: Fixes, floats, and flips." *Journal of International Economics*, 75(1): 70–92.

Kohlscheen, Emanuel, and Sandro C. Andrade. 2014. "Official FX interventions through derivatives." *Journal of International Money and Finance*, 47(C): 202–216.

Koijen, Ralph S., Robert J. Richmond, and Motohiro Yogo. 2020. "Which Investors Matter for Equity Valuations and Expected Returns?" Working Paper 27402, National Bureau of Economic Research.

Koijen, Ralph S., and Motohiro Yogo. 2020. "Exchange Rates and Asset Prices in a Global Demand System." Working Paper 27342, National Bureau of Economic Research.

Kouri, Pentti J.K. 1981. "Balance of Payments and the Foreign Exchange Market: A Dynamic Partial Equilibrium Model." Working Paper 644, National Bureau of Economic Research.

Krippner, Leo. 2016. "Documentation for measures of monetary policy."

Krugman, Paul E. 1984. "The International Role of the Dollar: Theory and Prospect." In *Exchange Rate Theory and Practice*. eds. by John F. O. Bilson, and Richard C. Marston, Chicago, IL, USA: University of Chicago Press, 261–278.

Lane, Philip R., and Gian Maria Milesi-Ferretti. 2018. "The External Wealth of Nations Revisited: International Financial Integration in the Aftermath of the Global Financial Crisis." *IMF Economic Review*, 66 189–222.

Lane, Philip R., and Jay C. Shambaugh. 2010. "Financial Exchange Rates and International Currency Exposures." *American Economic Review*, 100(1): 518–540.

Li, Jie, R. Rajan, and Thomas Willett. 2006. "Measuring Currency Crises Using Exchange Market Pressure Indices: The Imprecision of Precision Weights)." unpublished manuscript.

Maggiori, Matteo. 2017. "Financial Intermediation, International Risk Sharing, and Reserve Currencies." *American Economics Review*, 107(10): 3038–3071.

Maggiori, Matteo, Brent Neiman, and Jesse Schreger. 2020. "International Currencies and Capital Allocation." *Journal of Political Economy*, 128(6): 2019–2066.

Menkhoff, Lukas. 2013. "Foreign Exchange Intervention in Emerging Markets: A Survey of Empirical Studies." *The World Economy*, 36(9): 1187–1208.

Milesi-Ferretti, Gian-Maria, and Cédric Tille. 2011. "The Great Retrenchment: International Capital Flows during the Global Financial Crisis." *Economic Policy*, 66 285–330.

Min, Hong-Ghi, Judith A. McDonald, and Sang-Ook Shin. 2016. "What Makes a Safe Haven? Equity and Currency Returns for Six OECD Countries during the Financial Crisis." *Annals of Economics and Finance*, 17(2): 365–402.

Miranda-Agrippino, Silvia, and Hélène Rey. 2015. "World Asset Markets and the Global Financial Cycle." NBER Working Papers 21722, National Bureau of Economic Research, Inc.

Obstfeld, Maurice, Jonathan Ostry, and Mahvash Qureshi. 2017. "A Tie that Binds: Revisiting the Trilemma in Emerging Market Economies." IMF Working Papers 17/130, IMF Working Papers.

Patnaik, Ila, Joshua Felman, and Ajay Shah. 2017. "An exchange market pressure measure for cross country analysis." *Journal of International Money and Finance*, 73(Part A): 62 – 77.

Ranaldo, Angelo, and Paul Soederlind. 2010. "Safe Haven Currencies." 14(3): 385–407.

Rey, Hélène. 2015. "Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence." Working Paper 21162, National Bureau of Economic Research.

Sachs, Jeffrey, Aaron Tornell, and Andres Velasco. 1996. "Financial Crises in Emerging Markets: The Lessons from 1995." Working Paper 5576, National Bureau of Economic Research.

Shin, Hyun Song. 2016. "The bank/capital markets nexus goes global."Technical report, Bank for International Settlements.

Tanner, Evan. 2002. "Exchange Market Pressure, Currency Crises, and Monetary Policy: Additional Evidence From Emerging Markets." IMF Working Papers 02/14, International Monetary Fund.

Weymark, Diana N. 1995. "Estimating exchange market pressure and the degree of exchange market intervention for Canada." *Journal of International Economics*, 39(3-4): 273–295.

Wong, Alfred, and Tom Fong. 2013. "Gauging the Safehavenness of Currencies." Working Papers 132013, Hong Kong Institute for Monetary Research.

Yesin, Pinar. 2017. "Capital Flows and the Swiss Franc." *Swiss Journal of Economics and Statistics*, 153(4): 403–436.

Appendix

A Early EMP Variants

Primarily used in studies of currency crises and spillovers of policies across borders, prior variants of an exchange market pressure index take the form of a weighted index of changes in the exchange rate, changes in official foreign exchange reserves and (sometimes) changes in policy interest rates:

$$EMP_t = w_e \left(\frac{\Delta e_t}{e_{t-1}}\right) - w_R \left(\frac{\Delta R_t}{S_t}\right) + w_i(\Delta i_t) \tag{28}$$

where the index pertains to a particular country, $\left(\frac{\Delta e_t}{e_{t-1}}\right)$ is the percentage change in the exchange rate e_t, defined as domestic currency per unit of foreign currency at time t over a Δt interval. ΔR_t is the change in the central bank's foreign exchange reserves as a proxy for foreign exchange interventions. S_t scales these reserve changes, and Δi_t represents the change in the policy interest rate. w_k are the weights at which components $k = (e, R, i)$ enter the index. The weighting choices w_k utilized in the literature are presented in Appendix Table A1. These weights are largely intended to filter out noisy signals generated by movements in exchange rates and official reserves. The scaling choice S_t are intended to indicate the relative magnitude or importance of official foreign exchange purchases or sales relative to the relevant country features. The weights and scaling factors reflect the desire to have a practical basic measure to apply across countries and time.

Despite delivering ease of implementation, these prior choices are not neutral for the realization of the index. The scaling of reserves affects the contribution of the amplitude of the reserves changes to the EMP. Girton and Roper (1977) and Weymark (1995) scale the changes in reserves by the monetary base. The logic stems from questionable assumptions about the role of domestic money in international financial markets, including perfect capital mobility and perfect substitutability across assets issued by different countries and in different currencies.[1] Kaminsky and Reinhart (1999) instead scale by the level of reserves and Eichengreen, Rose and Wyplosz (1994) use a narrow monetary aggregate. Scaling by the initial level of reserves results in a higher amplitude of scaled reserve changes when the initial level of reserves is low, relative to when it is high. Scaling by a monetary aggregate makes the scaling sensitive to the variation of money multipliers over time and across countries.

Prior approaches to weighting the different components of the index likewise vary in both economic relevance and conceptual underpinnings. Such conceptual underpinnings are extremely

[1] Models based on money market equilibrium conditions are problematic, even if updated, since central banks have engaged in quantitative easing or other policies that change the monetary base without relating to broader money or the foreign exchange market.

Study	EMP **Definition**[a]	**Weighting Scheme**[b]	**Exchange Rate Definition**
Girton and Roper (1977)	$\frac{de}{e} + \frac{dR}{M0}$	Equal	Nominal bilateral against US dollars
Eichengreen, Rose and Wyplosz (1994)[c] and Forbes (2002)	$w_e \frac{de}{e} + w_i d(i - i^*) - w_R \frac{(dR - dR^*)}{M1}$	Precision	Nominal bilateral against DM/US dollars
Weymark (1995)	$\frac{de}{e} + w_R \frac{dR}{M}$	Model based price and interest elasticities	Nominal bilateral against US dollars
Sachs, Tornell and Velasco (1996)	$w_e \frac{de}{e} - w_R \frac{(dR - dR^*)}{R}$	Precision	Nominal bilateral against US dollars
Kaminsky and Reinhart (1999)	$w_e \frac{de}{e} + w_R \frac{dR}{R}$	Precision	Real effective
Aizenman, Lee and Sushko (2012)[d]	$w_e \frac{de}{e} + w_i d(i - i^*) - w_R \frac{(dR - dR^*)}{R}$	Equal and Precision	Nominal bilateral against US dollars
Aizenman, Chinn and Ito (2016)	$w_e \frac{de}{e} + w_i d(i - i^*) - w_R \frac{(dR - dR^*)}{R}$	Precision	Nominal bilateral against reference currency
Patnaik, Felman and Shah (2017)	$\frac{de}{e} - w_R dR$	Exchange rate elasticity to US dollars $1bn of interventions	Nominal bilateral against US dollars
Frankel (2019)	$\Delta log(H_t) + (\Delta Res)/MB_t$	Equal	Nominal bilateral against US dollar/SDR

[a] e is the exchange rate, R is central bank foreign currency reserves measured in US dollars, i is the interest rates, $M0$ is the monetary base, $M1$ is narrow money. Asterisks denote foreign or global variables.
[b] Precision weights as defined in text. w_e, w_R, and w_i are weights on exchange rate, reserves, and interest rate, respectively.
[c] Bilateral rates against Deutsche Mark used. (Eichengreen, Rose and Wyplosz (1996) instead apply bilateral rate against US dollars).
[d] Both Reserves and $M0$ used for scaling reserves.
[e] $\Pi_{e,t}$ and $\Pi_{i,t}$ are based on exchange rate sensitivities of gross external asset and liability positions and income balances. Reference currency as in Klein and Shambaugh (2008).

Table A1: **Earlier Exchange Market Pressure Indices in the Literature**

important as the EMP, taken literally, fundamentally adds together price dynamics (changes in exchange rates and policy rates) and flow quantity dynamics (official foreign exchange intervention). Weymark (1995) suggests that the change in reserves should be weighted by the elasticities of money demand to interest rates and prices to the exchange rate, as these are the main channels of balance of payments adjustment in monetary models. Tanner (2002) and Brooks and Cahill (2016) apply equal weights to exchange rate and official reserves, giving movements in official reserves prominant weight even for countries with fully floating exchange rates.[2]

[2]In this latter case, observed official reserve movements are unlikely to reflect actual interventions and instead are more likely due to portfolio valuation effects.

Patnaik, Felman and Shah (2017) propose an EMP index that includes observed exchange rates and foreign exchange intervention, with a scaling factor proportional to the size and liquidity of the foreign exchange market. Weights are based on an estimated sensitivity of the exchange rate to changes in official reserves.[3] Most other studies remain "agnostic" as to whether such elasticities can be appropriately estimated or make sense, and instead employ precision weights. Precision weights essentially weight the components of the index by the inverse of their sample variance, which ensures that the variation in all the elements of the EMP contribute equally, and hence, that none of the components individually dominate the index.[4] However, exchange rate policy regimes should substantively influence the relative role of the components, as noted by Li, Rajan and Willett (2006). Precision weights give more weight to the component with less variation. In pegged exchange rate systems, this tends to be the exchange rate, yet the changes in reserves clearly contain more information on exchange market pressures when the exchange rate is pegged.

We have replicated four types of approaches to include the features of Girton and Roper (1977), Eichengreen, Rose and Wyplosz (1994), Kaminsky and Reinhart (1999), Aizenman, Binici and Hutchison (2014). For the replication we utilize our measure of foreign exchange intervention to focus on the broader issue of the EMP construction, avoiding the additional issue in those studies of well known problems with using changes in foreign exchange reserves as the proxy for foreign exchange intervention. We find that each of these series generate vastly different results from each other, and from our measure. The changes are meaningful for the relative contributions of FXI to a measure of pressures. For example, expressed in our EMP format, Kaminsky and Reinhart (1999) and more generally the approach using precision weights tend to significantly downweight the contribution of foreign exchange intervention relative to currency movements across many countries. These differences show up in the levels of observed pressures, and show up significant differences across all of the measures in the GRR ranking of countries in how pressures respond to measures of risk sentiment.

[3] A separate strain of literature assesses the correspondence between central bank foreign exchange interventions in a pegged system and exchange rate changes in a floating rate system, or the effectiveness of foreign exchange interventions in affecting the exchange rate, e.g. Menkhoff (2013) and Blanchard, Adler and de Carvalho Filho (2015). These studies find a positive correspondence between increases in central bank foreign asset holdings in pegged regimes and exchange rate appreciation in a floating regime. The estimated correspondences carry information about net capital flow responsiveness to the exchange rate, but are translated into quantitative proxies for elasticities of gross private foreign investment positions. Patnaik, Felman and Shah (2017) show how the correspondence varies across countries, and explain this variation with cross country differences in trade, GDP and net FDI stocks as proxies for local currency market turnover.

[4] Eichengreen, Rose and Wyplosz (1994) offer a thorough discussion of the advantages and drawbacks of using this weighting scheme.

B Data Sources, Definitions and Descriptive Statistics

16 Advanced economies	25 Emerging Markets
United States (US), Japan (JP), Switzerland (CH), United Kingdom (GB), Denmark (DK), Norway (NO), Sweden (SE), Canada (CA), Euro area (EA), Czech Republic (CZ), Israel (IL), South Korea (KR), Singapore (SG), Hong Kong (HK), Australia (AU), New Zealand (NZ)	South Africa (ZA), Benin (BJ), Bolivia (BO), Botswana (BW), Brazil (BR), Chile (CL), Colombia (CO), Mexico (MX), Peru (PE), Uruguay (UY), Jordan (JO), India (IN), Malaysia (MY), Thailand (TH), Morocco (MA), Tunisia (TN), Armenia (AM), Senegal (SN), Russia (RU), China (CN), Ukraine (UA), Hungary (HU), Croatia (HR), Poland (PL), Romania (RO)

Table A2: **Country Sample**

We have used the largest possible set of countries and excluded countries based on the following set of criteria: (1) data availability does not allow for construction of the EMP starting in 2002m12 at the latest, (2) very small countries, defined as countries with population size of less than 0.5 million and with GDP per capita of less than 1000 US dollars and (3) a number of individual countries for idiosyncratic reasons: Venezuela (lack of clarity on the relevant exchange rate measure reflecting market pressures), Turkey, Paraguay, Belarus, Dominican Republic, Indonesia, Moldova, Philippines, observations prior to 2002m1 for Morocco.

Variable	Definition	Source and Description	Missing Country-Years
e	Baseline bilateral exchange rate.	End-of-month mid-point between bid and ask, domestic per unit of foreign. National central banks, the Federal Reserve and IMF International Financial Statistics.	
R	Official foreign exchange reserves (total reserves minus gold)	In billions of reference currency units, end of period, monthly. Dollar value from IMF International Financial Statistics.	Jordan (2017m11- m12, 2018-2020)
FXI	Estimate or data on official foreign exchange interventions, constructed as described in Goldberg et al. (2022).	In billions of reference currency units, monthly flow. Data from national central banks, IMF International Financial Statistics, Balance of Payments, International Investment Position and the Exchange Reserves and Foreign Currency Liquidity Template.	Armenia (2000-2001) Brazil (2000-2001), Hong Kong (2000), India (2000), Jordan, (2017m11- m12, 2018-2020), Ukraine (2000-2001)
i, i^*	Monetary policy or short-term rate	In percentage points, end of period, monthly. IMF International Financial Statistics or national Central Banks. Constructed as IFS policy rate line 60 if available, else policy rate from national central bank if available, else 3-month money market interest rate from IFS (line 60b) if available, else short-term treasury bond rate (IFS line 60c) if available, else deposit rates from IFS (only needed for parts of the sample period for China and Argentina). For countries that have introduced negative policy interest rates, the relevant policy rate prior to the introduction of a negative rate is merged with the relevant rate post introduction for Denmark, Japan and EU.	Benin (2000-2001m11, 2017m4-2020), Senegal (2000-2001m11, 2017m4-2020)
A_t	Gross external assets defined as the sum of portfolio equity assets, debt assets, and financial derivatives assets	In US dollars, end of period, annual from 1970 to 2020. External Wealth of Nations Database based on Lane and Milesi-Ferretti (2018).	Morocco (2000-2001)
$\frac{L_t}{e_t}$	Gross external liabilities defined as the sum of portfolio equity liabilities, debt liabilities, and financial derivatives liabilities	In US dollars, end of period, annual from 1970 to 2020. External Wealth of Nations Database based on Lane and Milesi-Ferretti (2018).	
i_{SSR}, i^*_{SSR}	Shadow policy rate in for the US, EA, JP, UK, CH, CA, AU and NZ	In percentage points, end of period, monthly. Krippner (2016).	

Table A3: **Data Sources and Definitions**

Variable	Definition	Source and Description	Missing Country-Years
α_t	Shares of residents' portfolios that residents desire to be denominated in domestic currency	Home Asset Share is calculated as the sum of domestic equities, bonds, and banking assets as a share of total equities, bonds, and banking assets. If asset class data is unavailable, the measure is calculated on the available asset data. Data sourced from the World Bank Development Indicators, IMF International Financial Statistics, and Bank for International Settlements. In US dollars, end of period, annual. Authors' calculations based on Coeurdacier and Rey (2012).	
α_t^*	Share of ROW's portfolios invested outside of a given country	α_t^* is calculated as the sum of a country's foreign equity, bond, and banking liabilities divided by the sum of all other country's equities, bonds, and banking assets. If asset class data is unavailable, the measure is calculated on the available asset data. Data sourced from the World Bank Development Indicators, IMF International Financial Statistics, and Bank for International Settlements. In US dollars, end of period, annual. Authors' calculations.	
GDP	Gross domestic product	In US dollars, quarterly. IMF International Financial Statistics.	Armenia (2000-2013), Colombia (2000m1-m2), Croatia (2000m1-m2), Senegal (2000-20008m2), Tunisia (2000m1-m2), Ukraine (2000-2001m2)
VIX	CBOE Volatility Index	End of period, monthly. Extended backwards in time by the VXO from 1986m1 to 1989m12. Chicago Board Options Exchange.	
$RORO$	Risk on risk off measure	Monthly average of daily data from 2003 to 2021. Construction code sourced from Chari, Stedman and Lundblad (2020) with own update through 2021.	
BEX RA	Risk appetite and uncertainty series, monthly, 1986 to 2021, sourced from Bekaert, Engstrom and Xu (2021).		
VSTOXX	Euro Stoxx Volatility Index	Daily data from 1999 to 2021, sourced from Qontigo.	

Table A4: **Data Sources and Definitions Continued**

(a) Safe Havens

	Mean	Max	Min	Std. Dev	Obs
EMP_{ref}	-0.000	0.089	-0.077	0.018	1199
de/e	-0.000	0.089	-0.140	0.019	1260
FXI_{USD}	1.377	103.225	-36.000	7.770	1248
di	-0.000	0.005	-0.020	0.002	1260
A, billions USD	4.451	22.224	0.157	5.320	1260
L/e, billions USD	5.320	34.290	0.204	7.890	1260
α	0.715	0.909	0.366	0.149	1260
α^*	0.961	0.999	0.777	0.057	1260
Interest Diff	-0.005	0.050	-0.069	0.025	1260
NFA/GDP_{t-1}	0.750	5.820	-0.559	1.263	1260
Infl_{t-1}	0.012	0.065	-0.050	0.016	1260
Public debt, in % of GDP_{t-1}	76.304	256.405	0.000	71.947	1234
Country $\text{GDP}_{t-1}/WorldGDP_{t-1}$	0.070	0.310	0.003	0.095	1260
Stock market capitalization, in % of GDP_{t-1}	274.976	1713.299	46.905	339.801	1260
$GFA + GFL/GDP_{t-1}$	5.204	17.781	-4.316	4.052	1260
Private domestic credit, in % of GDP_{t-1}	169.497	218.944	77.481	21.035	1260
ChinnIto	1.000	1.000	0.995	0.000	1260

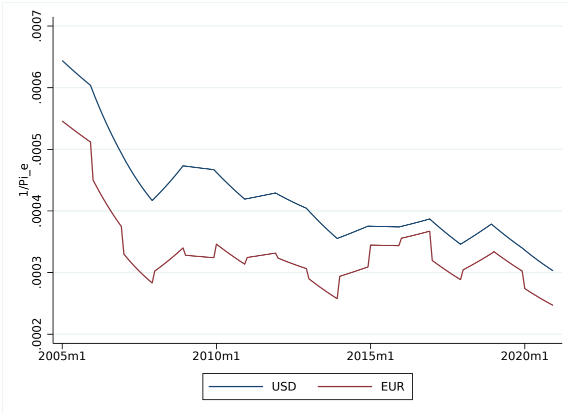
(b) Non-Safe Havens

	Mean	Max	Min	Std. Dev	Obs
EMP_{ref}	-0.001	0.100	-0.079	0.026	8268
de/e	0.001	0.541	-0.169	0.027	9070
FXI_{USD}	0.437	83.865	-129.204	5.215	8950
di	-0.000	0.340	-0.388	0.013	8933
A, billions USD	0.911	22.615	0.000	2.962	9048
L/e, billions USD	1.097	26.498	0.001	3.487	9072
α	0.861	1.000	0.371	0.147	9072
α^*	0.994	1.000	0.878	0.017	9072
Interest Diff	0.045	1.184	-0.054	0.059	8935
NFA/GDP_{t-1}	0.059	4.861	-0.967	0.600	8058
Infl_{t-1}	0.038	0.589	-0.048	0.044	8820
Public debt, in % of GDP_{t-1}	48.576	154.898	3.879	23.700	8969
Country $\text{GDP}_{t-1}/WorldGDP_{t-1}$	0.010	0.171	0.000	0.020	8196
Stock market capitalization, in % of GDP_{t-1}	65.798	393.036	-0.067	59.675	8316
$GFA + GFL/GDP_{t-1}$	1.706	15.719	0.227	2.359	8058
Private domestic credit, in % of GDP_{t-1}	70.513	195.146	0.699	44.001	8773
ChinnIto	0.651	1.000	0.000	0.355	9072

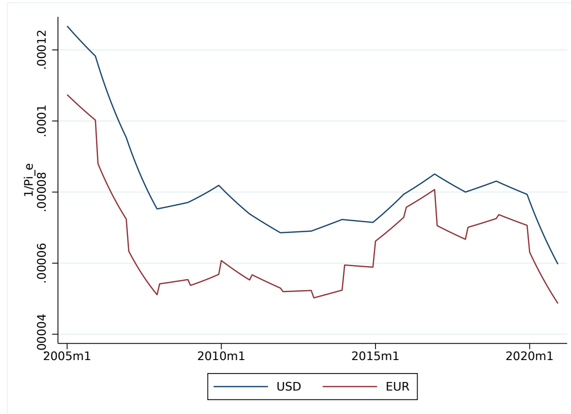
Table A5: **Data Sample and Descriptive Statistics**
The data are in monthly frequency and span 2000m1 to 2020m12. Safe havens are assumed as United States, Japan, Switzerland, Hong Kong, and Denmark.

B.1 Home α Computations

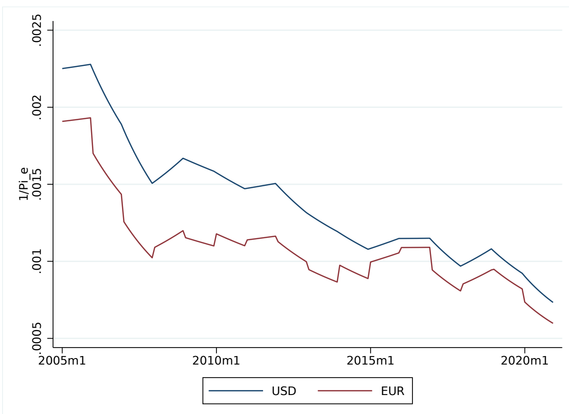
Home bias is calculated as each country's domestic assets a share of total (domestic+foreign) assets at time t. Following Coeurdacier and Rey (2012), we consider three asset categories: equity, debt, and bank loans. Domestic equity is calculated as the difference between domestic



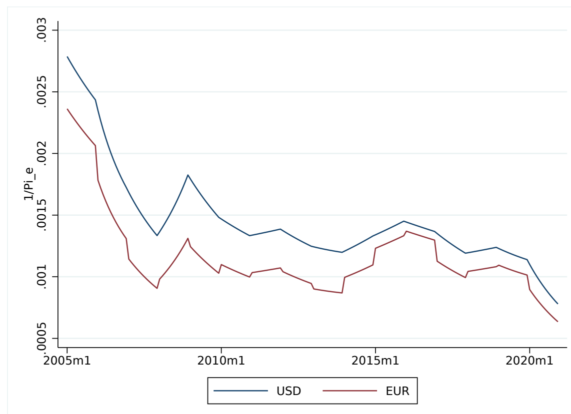
(a) Switzerland



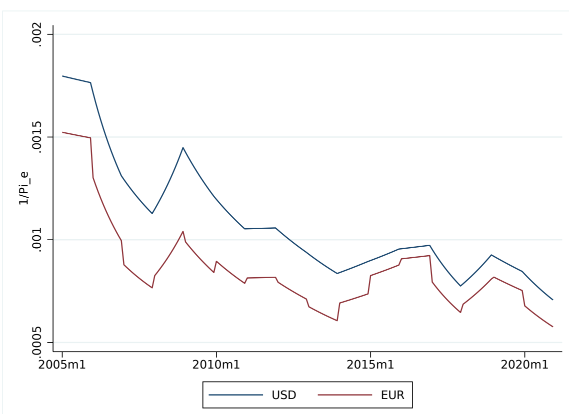
(b) United Kingdom



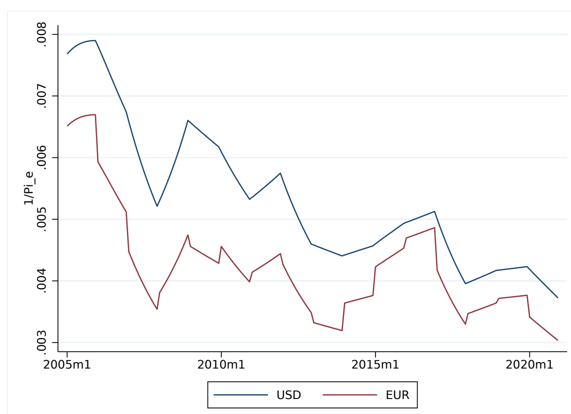
(c) Denmark



(d) Norway



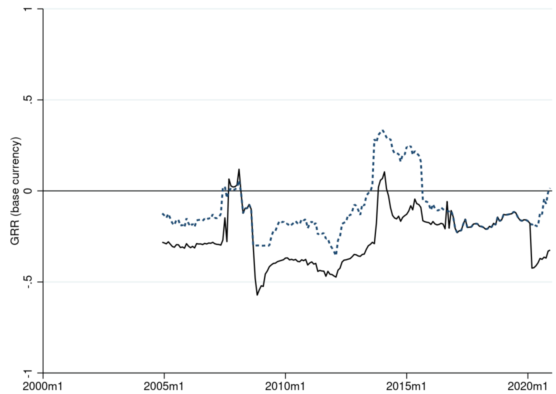
(e) Sweden



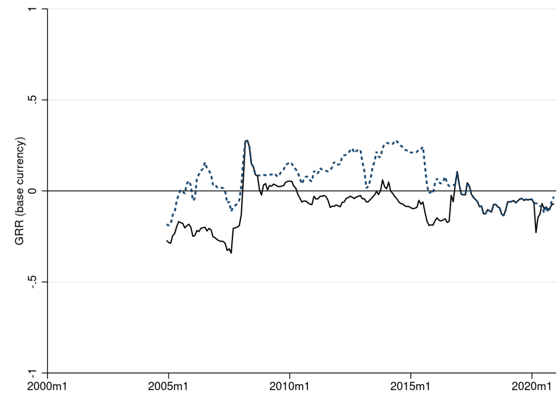
(f) Poland

Figure A1: $\frac{1}{Pi_e}$ **Comparison using U.S. Dollar vs Euro Reference Currency**
Efficacy of foreign exchange intervention against the U.S. Dollar and Euro over time for select countries.

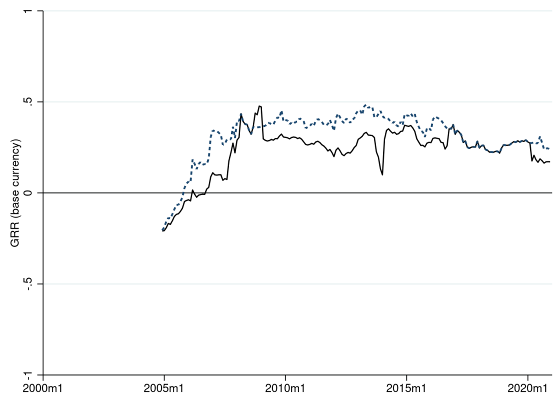
equity market capitalization and foreign equity liabilities; domestic debt is the difference between total outstanding bonds and foreign held domestic bonds; domestic banks owed by domestic counterparties sums the claims on the central banks, central governments, and other sectors.The denominator considers the total assets for each country at time t. Total debt is calculated as domestic equity market capitalization minus foreign equity liabilities plus foreign equity assets. Total debt is calculated as outstanding bonds minus foreign held domestic bonds plus domestic holdings of foreign bonds. Continually, banking assets considers the sum of domestic banking assets and foreign banking assets. Domestic equity market capitalization data is from the World Bank's World Development Indicators database and foreign equity assets and liabilities data are from the IMF's International Financial Statistics (IFS) database. All data is at the country-year level and reported in US Dollars.This update of Coeurdacier and Rey (2012) covers 36 of our 41 sample countries. Data on outstanding bonds was sourced from the BIS. Debt liabilities and debt assets were sourced from the International Monetary Fund's International Financial Statistics database. The datasets are reported at the country quarter level in millions of USD. Analysis uses aggregated country-year levels. This covers 24 of the 41 countries in the sample. For banking share, we obtain data on claims on the central bank, central government, and other sectors from the Other Depository Corporations Survey via the IMF's International Financial Statistics (IFS). We source data on foreign banking assets of domestic banks of each country from the BIS's Locational Banking Statistics (LBS) database. All data is at the country-year level. BIS data is reported in US Dollars, and IMF data is converted to US Dollars using end-of-period exchange rates. This update of Coeurdacier and Rey (2012) covers 16 of our 41 sample countries.



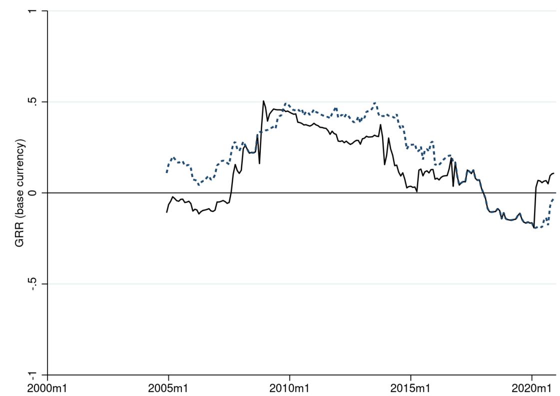
(a) Brazil



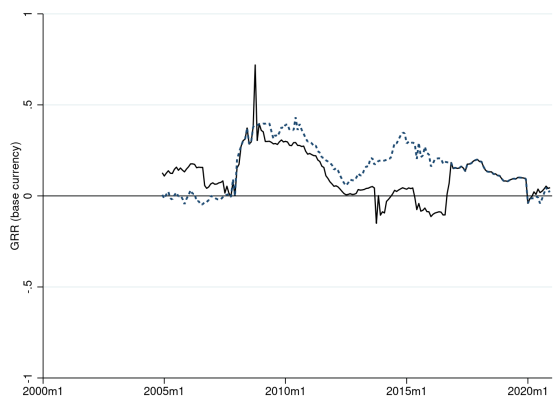
(b) Thailand



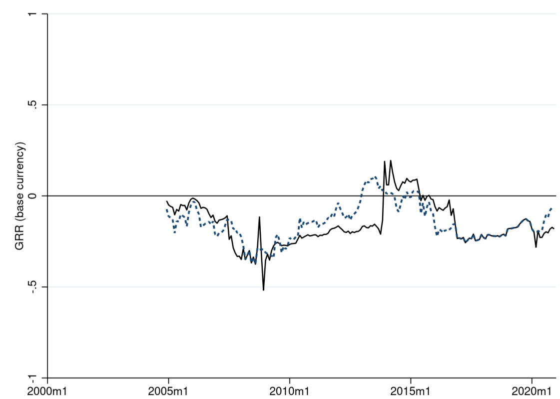
(c) Japan



(d) Hong Kong



(e) Switzerland



(f) United Kingdom

Figure A2: **Global Risk Response (GRR): Normal times v. ex-High Stress Periods**
GRR based on the EMP against the US dollar in panels (a) through (d) and against the Euro in panels (e) through (f) over 5 years of monthly data. The solid line displays the GRR calculated using all observations from 2000 to 2020. The dashed line displays the GRR calculated excluding observations at or above the 90th percentile of the VIX over 01/2000 to 12/2020.

	$z^{EMP} * 1000$ – Safe Havens					$z^{EMP} * 1000$ – Non-Safe Havens				
	I	II	III	IV	V	VI	VII	VIII	IX	X
$dVIX$	0.069	0.013	0.525	0.401	0.584	-2.516***	-3.591***	-2.620***	-2.289**	-1.956*
	(0.276)	(0.497)	(1.926)	(0.298)	(1.465)	(0.309)	(0.658)	(0.617)	(0.791)	(0.898)
$dVIX * NFA/GDP_{t-1}$		-0.220			-0.866		-0.471			-0.775**
		(0.182)			(0.851)		(0.280)			(0.293)
$dVIX * Infl_{t-1}$		7.092			8.776		-4.483			-6.644
		(6.050)			(21.285)		(7.213)			(6.132)
$dVIX * PubDebt/GDP_{t-1}$		0.002			-0.005*		0.025*			0.015
		(0.003)			(0.002)		(0.010)			(0.010)
$dVIX * ShareofWorldGDP_{t-1}$			6.203		33.401***			-8.006		-9.861
			(3.389)		(3.869)			(9.354)		(9.944)
$dVIX * StockmarketCap/GDP_{t-1}$			-0.000		-0.000			-0.009		-0.011*
			(0.000)		(0.004)			(0.005)		(0.005)
$dVIX * Dom.Credit/GDP_{t-1}$			-0.003		-0.011			0.010		0.000
			(0.010)		(0.010)			(0.009)		(0.008)
$dVIX * (GFA + GFL)/GDP_{t-1}$				-0.067	0.299***				0.139	0.341***
				(0.038)	(0.082)				(0.094)	(0.089)
$dVIX * ChinnIto_{t-1}$				0.000	0.000				-0.764	-1.108
				(.)	(.)				(0.990)	(0.763)
Constant	-5.533	-5.777	-2.204	0.000	0.000	38.752***	33.660***	58.892***	82.014***	68.272***
	(8.341)	(7.861)	(20.832)	(.)	(.)	(4.787)	(6.580)	(10.918)	(13.957)	(15.161)
R2	0.028	0.007	0.002	0.001	0.023	0.036	0.099	0.045	0.059	0.119
No.Obs	840	839	840	840	839	7478	6706	6686	6772	6577

Table A6: **Panel Regressions with Risk Sensitivity– Excluding High Stress and Excluding Fixed Effects**

Results from monthly panel regressions of equations 25 and 26 from 2000m1 - 2020m12 excluding the United States and months where the VIX is at or above its 90th percentile value of the period. z^{EMP}*1000 is the dependent variable, winsorized at the 1st and 99th percentile. Safe haven countries include Denmark, Hong Kong, Japan, and Switzerland. No.Obs gives the number of regression observations. All specifications include a control for di^*. Specifications with interaction terms with $dVIX$ include the corresponding non-interaction controls which can include NFA/GDP_{t-1}, $Infl_{t-1}$, $PubDebt_{t-1}$, $StockmarketCap_{t-1}$, $ShareofWorldGDP_{t-1}$, $DomCredit/GDP_{t-1}$, $(GFA + GFL)/GDP_{t-1}$, $ChinnIto_{t-1}$ (not shown). Asterisks *, ** and *** indicate significance at the 10, 5 percent and 1 percent levels.

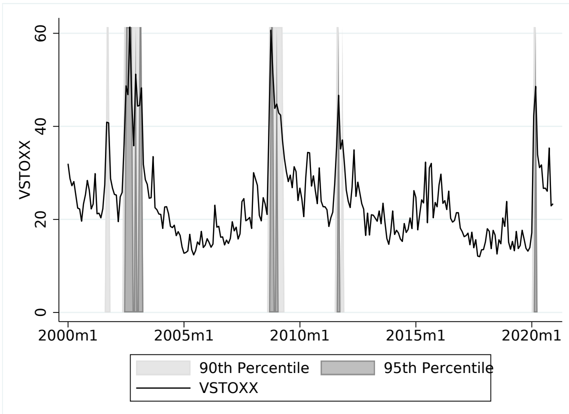
	$z^{EMP} * 1000$ – Safe Havens					$z^{EMP} * 1000$ – Non-Safe Havens				
	I	II	III	IV	V	VI	VII	VIII	IX	X
$dVIX$	0.185	0.158	3.117	0.242	0.000	-1.277***	-1.124*	-1.632***	-1.288***	-1.137
	(0.273)	(0.551)	(2.104)	(0.348)	(.)	(0.142)	(0.474)	(0.349)	(0.301)	(0.901)
$dVIX * NFA/GDP_{t-1}$		-0.051			2.529		-0.019			-0.060
		(0.176)			(1.644)		(0.136)			(0.194)
$dVIX * Infl_{t-1}$		13.334			36.645		-7.703			-7.531
		(15.330)			(26.766)		(4.454)			(6.001)
$dVIX * PubDebt/GDP_{t-1}$		-0.001			0.004		0.002			0.001
		(0.002)			(0.003)		(0.006)			(0.007)
$dVIX * ShareofWorldGDP_{t-1}$			-5.372		-11.227			3.417		5.867
			(2.913)		(10.390)			(3.691)		(4.311)
$dVIX * StockmarketCap/GDP_{t-1}$			0.000		-0.009			-0.001		-0.001
			(0.000)		(0.005)			(0.002)		(0.002)
$dVIX * Dom.Credit/GDP_{t-1}$			-0.017		-0.005			0.004		-0.001
			(0.011)		(0.015)			(0.004)		(0.005)
$dVIX * (GFA + GFL)/GDP_{t-1}$				-0.008	0.099				0.056	0.038
				(0.028)	(0.104)				(0.040)	(0.066)
$dVIX * ChinnIto_{t-1}$				0.000	0.377				-0.205	0.009
				(.)	(2.330)				(0.498)	(0.478)
Constant	-0.905	-1.104	-1.044	-0.933	-1.702	44.262***	47.155***	47.993***	47.177***	48.027***
	(8.351)	(8.876)	(8.619)	(8.348)	(9.195)	(5.138)	(5.372)	(5.448)	(5.355)	(5.466)
R2	0.010	0.015	0.047	0.011	0.081	0.099	0.107	0.104	0.101	0.108
No.Obs	99	99	99	99	99	820	736	722	737	711

Table A7: **Panel Regressions with Risk Sensitivity– Only High Stress and Excluding Fixed Effects**

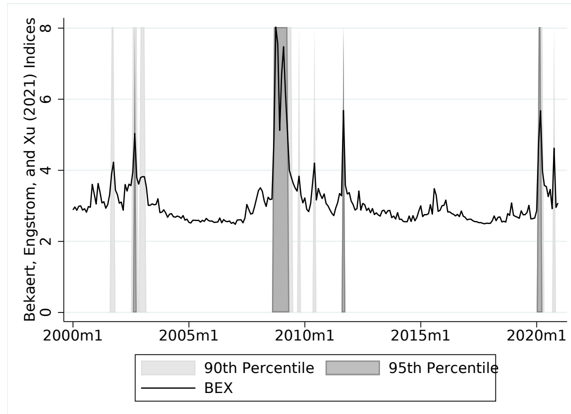
Results from monthly panel regressions of equations 25 and 26 from 2000m1 - 2020m12 for only months where the VIX is at or above its 90th percentile value of the period, excluding the United States. z^{EMP}*1000 is the dependent variable, winsorized at the 1st and 99th percentile. Safe haven countries include Denmark, Hong Kong, Japan, and Switzerland. No.Obs gives the number of regression observations. Asterisks *, ** and *** indicate significance at the 10, 5 percent and 1 percent levels.

C Robustness

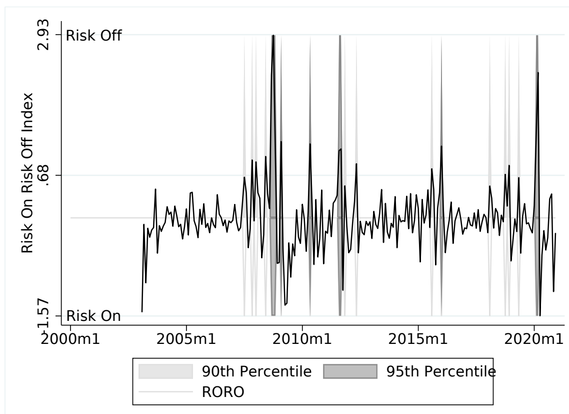
C.1 Robustness to Alternative Risk Measures



(a) VSTOXX



(b) BEX RA



(c) RORO

Figure A3: **High Risk Periods As Defined By Alternative Risk Measures**
The Euro Stoxx 50 Volatility Index (VSTOXX) is in daily frequency and spans from 2000 to present day. End of period values were chosen to aggregate to the monthly level. BEX RA, a risk aversion index from Bekaert et al. (2021), is in monthly frequency and spans from 1986 to 2021. RORO, sourced from Chari et al. (2020), is in daily frequency and spans from 2003 to present day. Highlighted periods represent intervals where the risk measure at or above the 90th percentile.

(a)

Event Time	Event Name	90th Percentile	95th Percentile
		BEX	
2001	9/11 Attacks	9/2001 ; 10/2001	
2002–2003		8/2002-9/2002; 10/2002; 12/2002; 1/2003-2/2003	9/2002
2008–2009	Great Financial Crisis	9/2008- 12/2008; 1/2009-6/2009; 10/2009	9/2008- 4/2009
2010	Euro Area Crisis	6/2010	
2011	US Debt Ceiling & European Crisis	9/2011	9/2011
2020–2021	COVID-19	2/2020-4/2020; 10/2020	2/2020-3/2020

(b)

Event Time	Event Name	90th Percentile	95th Percentile
		VSTOXX	
2001	9/11 Attacks	9/2001-10/2001	
2002–2003		6/2002-3/2003	7/2002-10/2002;12/2002;2/2003-3/2003
2008–2009	Great Financial Crisis	9/2008-4/2009	10/2008-11/2008; 1/2009
2011	US Debt Ceiling & European Crisis	8/2011-9/2011; 11/2011	9/2011
2020–2021	COVID-19	2/2020-3/2020	3/2020

(c)

Event Time	Event Name	90th Percentile	95th Percentile
		RORO	
2007		7/2007; 11/2007	
2008–2009	Great Financial Crisis	1/2008; 3/2008; 6/2008; 9/2008-11/2008; 2/2009	1/2008; 9/2008-10/2008; 2/2009
2010	Euro Area Crisis	5/2010	5/2010
2011	US Debt Ceiling & European Crisis	8/2011-9/2011; 11/2011	8/2011-9/2011
2012		5/2012	5/2012
2015		8/2015	
2016		1/2016	
2018		10/2018; 12/2018	
2019		5/2019	
2020–2021	COVID-19	2/2020-3/2020	2/2020-3/2020

Table A8: **High Stress Dates Using Alternative Risk Measures**

Event dates are determined by months within 01/2000 to 12/2020 that are at or above the 90th percentile value for each of the alternative risk measures. These time periods are then corresponded with major global events.

(a) VSTOXX

Full Sample	All	Safe Haven	Excl. Safe Haven
GRR- AllPeriods	-0.121***	0.150***	-0.144***
GRR- Excluding P90	-0.002	0.149***	-0.016***
Difference	-0.118***	0.001	-0.129***

Pre-GFC	All	Safe Haven	Excl. Safe Haven
GRR- AllPeriods	-0.080***	0.023	-0.091***
GRR- Excluding P90	0.008**	0.011	0.008**
Difference	-0.088***	0.012	-0.099***

Post-GFC	All	Safe Haven	Excl. Safe Haven
GRR- AllPeriods	-0.101***	0.183***	-0.123***
GRR- Excluding P90	-0.043***	0.194***	-0.061***
Difference	-0.058***	-0.010	-0.062***

(d) BEX

Full Sample	All	Safe Haven	Excl. Safe Haven
GRR- AllPeriods	-0.133***	0.101***	-0.154***
GRR- Excluding P90	-0.022***	0.117***	-0.035***
Difference	-0.111***	-0.016	-0.119***

Pre GFC	All	Safe Haven	Excl. Safe Haven
GRR- AllPeriods	-0.087***	0.008	-0.097***
GRR- Excluding P90	-0.019***	-0.022	-0.018***
Difference	-0.068***	0.029	-0.079***

Post GFC	All	Safe Haven	Excl. Safe Haven
GRR- AllPeriods	-0.122***	0.139***	-0.142***
GRR- Excluding P90	-0.061***	0.153***	-0.078***
Difference	-0.061***	-0.014	-0.065***

(g) RORO

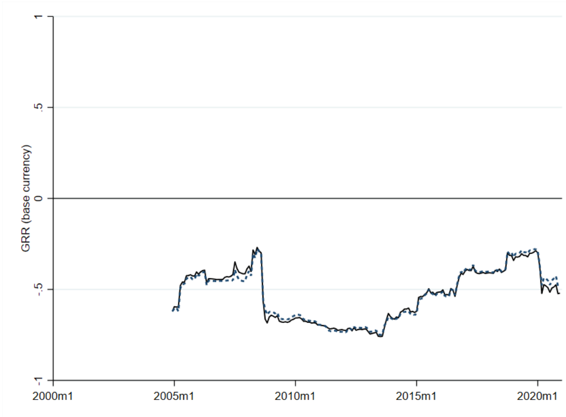
Full Sample	All	Safe Haven	Excl. Safe Haven
GRR- AllPeriods	-0.233***	0.271***	-0.278***
GRR- Excluding P90	-0.162***	0.223***	-0.196***
Difference	-0.071***	0.048***	-0.081***

Pre GFC	All	Safe Haven	Excl. Safe Haven
GRR- AllPeriods	-0.104***	0.230***	-0.140***
GRR- Excluding P90	-0.083***	0.190***	-0.113***
Difference	-0.021***	0.040**	-0.027***

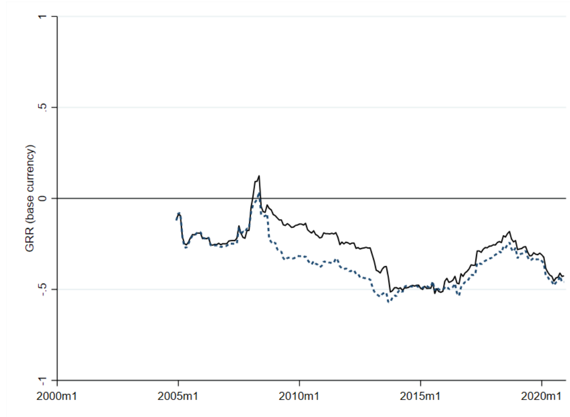
Post GFC	All	Safe Haven	Excl. Safe Haven
GRR- AllPeriods	-0.271***	0.222***	-0.310***
GRR- Excluding P90	-0.219***	0.271***	-0.258***
Difference	-0.052***	-0.049***	-0.053***

Table A9: **GRR Difference in Means Tests for GRR with Alternative Risk Indices**

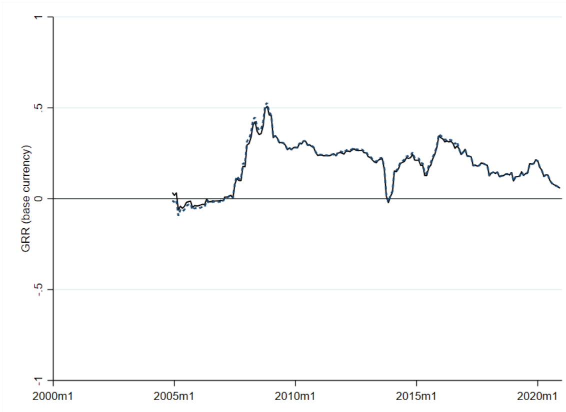
GRR is computed as -1 times the rolling correlation over 5 years between EMP against reference currency and the alternative risk measure. In the excluding P90 analysis, the rolling correlation is calculated excluding months, between 01/2000 to 12/2020, that are at or above the 90th percentile value of the alternative risk measure. Safe haven currencies are the DKK, HKD, JPY, CHF, and USD. Significance in the first two rows indicate whether the average is different from 0. Asterisks *, ** and *** indicate significance at the 10, 5 percent and 1 percent levels.



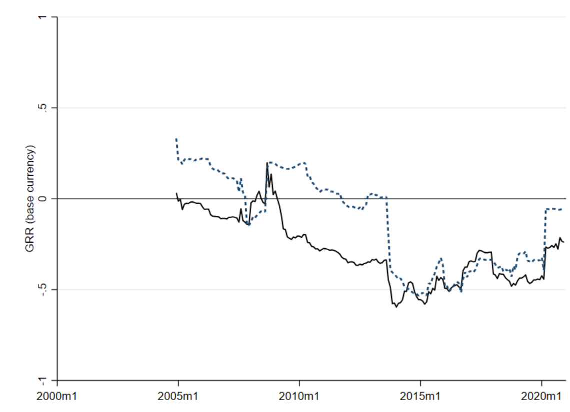
(a) Brazil



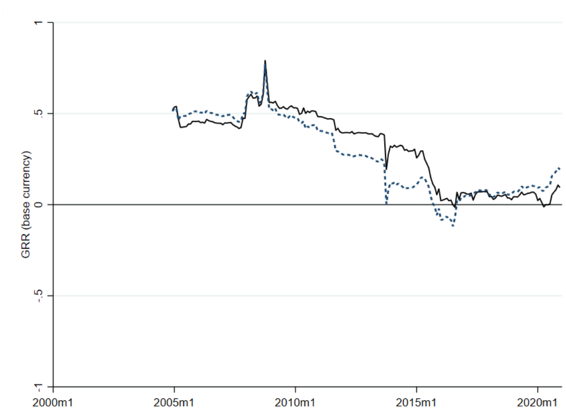
(b) Thailand



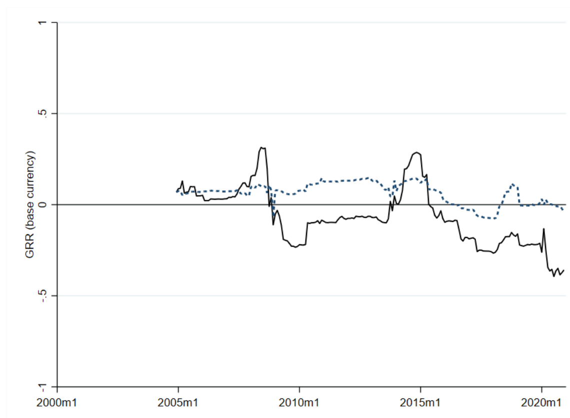
(c) Japan



(d) Hong Kong

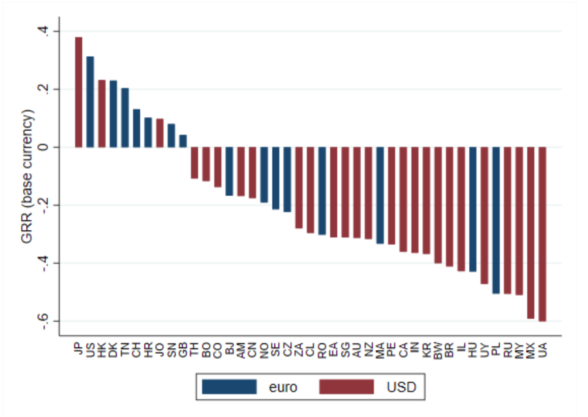


(e) Switzerland

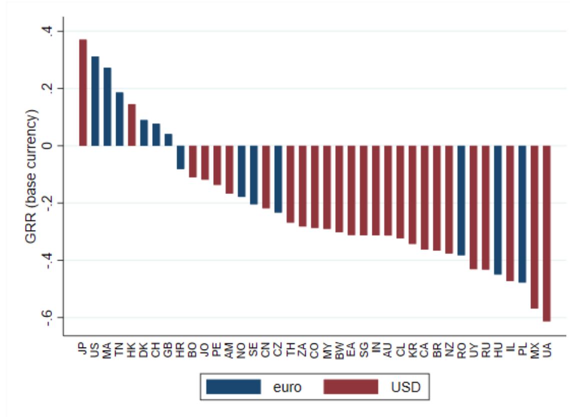


(f) Denmark

Figure A4: **GRR Time Series with RORO Index**
GRR using the $RORO$ as the risk sentiment proxy and based on the EMP against the US dollar in panels (a) through (d) and against the euro in panels (e) through (f). The solid line displays GRR computed with the EMP. The dashed line displays the GRR computed using realized depreciation rate.

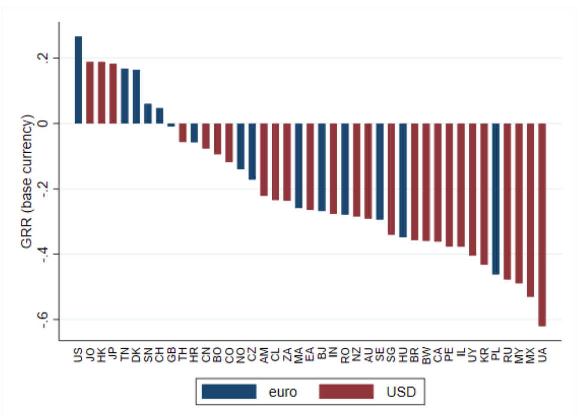


(a) EMP

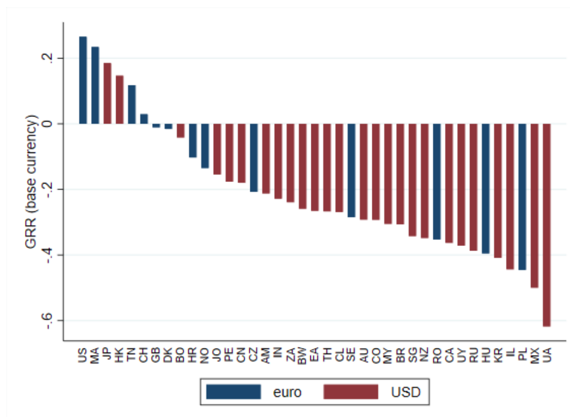


(b) de/e

Figure A5: **GRR calculated with the VSTOXX Index, Near-Term Post-GFC**

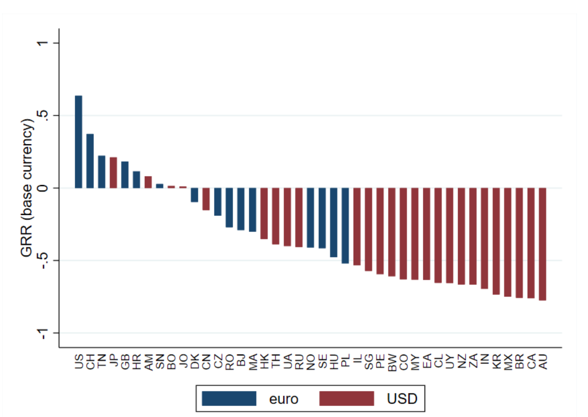


(a) EMP

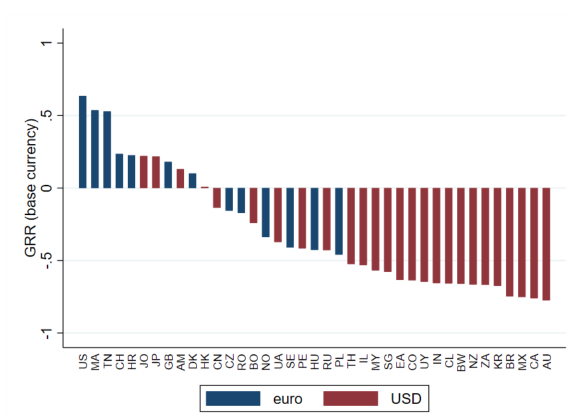


(b) de/e

Figure A6: **GRR calculated with the BEX RA, Near-Term Post-GFC**



(a) EMP



(b) de/e

Figure A7: **GRR calculated with the RORO Index, June 2013**

	$z^{EMP} * 1000$ – Safe Havens					$z^{EMP} * 1000$ – Non-Safe Havens				
	I	II	III	IV	V	VI	VII	VIII	IX	X
$dVIX$	0.041	0.048	2.109	0.275	0.891	-1.698***	-2.210***	-1.993***	-1.693***	-1.891*
	(0.238)	(0.503)	(1.927)	(0.315)	(1.311)	(0.203)	(0.519)	(0.432)	(0.418)	(0.827)
$dVIX * NFA/GDP_{t-1}$		-0.137			0.046		-0.270			-0.344
		(0.176)			(0.793)		(0.180)			(0.241)
$dVIX * Infl_{t-1}$		7.184			20.518		-6.271			-6.436
		(10.561)			(24.520)		(5.922)			(6.940)
$dVIX * PubDebt/GDP_{t-1}$		0.001			-0.002		0.013*			0.011
		(0.002)			(0.001)		(0.006)			(0.007)
$dVIX * ShareofWorldGDP_{t-1}$			2.715		18.726*			-0.153		0.282
			(4.488)		(4.744)			(5.485)		(6.551)
$dVIX * StockmarketCap/GDP_{t-1}$			-0.000		-0.003			-0.003		-0.004
			(0.000)		(0.003)			(0.003)		(0.004)
$dVIX * Dom.Credit/GDP_{t-1}$			-0.012		-0.012			0.006		0.000
			(0.010)		(0.010)			(0.006)		(0.006)
$dVIX * (GFA + GFL)/GDP_{t-1}$				-0.034	0.237				0.074	0.094
				(0.027)	(0.109)				(0.053)	(0.068)
$dVIX * ChinnIto_{t-1}$				0.000	0.000				-0.281	-0.177
				(.)	(.)				(0.584)	(0.579)
Constant	-4.926***	0.171	-2.197	1.567	-28.303	39.329***	35.611***	59.227***	87.339***	72.773***
	(0.148)	(2.608)	(5.645)	(3.502)	(13.847)	(0.072)	(7.062)	(8.343)	(15.894)	(17.096)
Adj. R2	0.022	0.033	0.031	0.030	0.056	0.038	0.096	0.045	0.059	0.113
No.Obs	939	938	939	939	938	8298	7442	7408	7509	7288

Table A10: **Safe Haven Drivers: Panel Regressions, By Safe Haven Status**

Results from monthly panel regressions of equations 25 and 26 from 2000m1 - 2020m12 excluding the United States. z^{EMP}*1000 is the dependent variable, winsorized at the 1st and 99th percentile. Safe haven countries include Denmark, Hong Kong, Japan, and Switzerland. No.Obs gives the number of regression observations. All specifications include country fixed effects and control for di^*. Specifications with interaction terms with $dVIX$ include the corresponding non-interaction controls which can include NFA/GDP_{t-1}, $Infl_{t-1}$, $PubDebt_{t-1}$, $StockmarketCap_{t-1}$, $ShareofWorldGDP_{t-1}$, $DomCredit/GDP_{t-1}$, $(GFA + GFL)/GDP_{t-1}$, $ChinnIto_{t-1}$ (not shown). Asterisks *, ** and *** indicate significance at the 10, 5 percent and 1 percent levels.

	$z^{EMP}*1000$ – Safe Havens					$z^{EMP}*1000$ – Non-Safe Havens				
	I	II	III	IV	V	VI	VII	VIII	IX	X
$dVIX$	0.069	0.179	0.659	0.588	0.505	-2.516***	-3.587***	-2.623***	-2.281**	-1.968*
	(0.276)	(0.461)	(1.758)	(0.349)	(1.451)	(0.309)	(0.657)	(0.617)	(0.793)	(0.894)
$dVIX*NFA/GDP_{t-1}$		-0.222			-0.133		-0.468			-0.773*
		(0.187)			(0.616)		(0.281)			(0.294)
$dVIX*Infl_{t-1}$		1.996			14.304		-4.498			-6.483
		(6.007)			(18.514)		(7.189)			(6.135)
$dVIX*PubDebt/GDP_{t-1}$		0.002			-0.007		0.024*			0.015
		(0.002)			(0.003)		(0.010)			(0.010)
$dVIX*ShareofWorldGDP_{t-1}$			11.693		40.417**			-7.932		-9.704
			(5.020)		(4.602)			(9.324)		(9.943)
$dVIX*StockmarketCap/GDP_{t-1}$			-0.001		-0.003			-0.009		-0.011*
			(0.000)		(0.003)			(0.005)		(0.005)
$dVIX*Dom.Credit/GDP_{t-1}$			-0.003		-0.007			0.010		0.000
			(0.009)		(0.010)			(0.009)		(0.008)
$dVIX*(GFA+GFL)/GDP_{t-1}$				-0.071	0.227				0.137	0.338***
				(0.040)	(0.092)				(0.094)	(0.090)
$dVIX*ChinnIto_{t-1}$				0.000	0.000				-0.760	-1.086
				(.)	(.)				(0.991)	(0.762)
Constant	-5.146***	1.326	-1.708	2.387	-34.439	38.591***	33.758***	57.809***	86.948***	71.269***
	(0.074)	(2.457)	(4.464)	(4.058)	(18.170)	(0.100)	(6.807)	(8.396)	(16.347)	(17.315)
Adj. R2	0.026	0.036	0.041	0.037	0.067	0.036	0.098	0.044	0.059	0.117
No.Obs	840	839	840	840	839	7478	6706	6686	6772	6577

Table A11: **Safe Haven Drivers: Panel Regressions, By Safe Haven Status – Excluding High Stress**

Results from monthly panel regressions of equations 25 and 26 from 2000m1 - 2020m12 excluding the United States and months where the VIX is at or above its 90th percentile value of the period. z^{EMP}*1000 is the dependent variable, winsorized at the 1st and 99th percentile. Safe haven countries include Denmark, Hong Kong, Japan, and Switzerland. No.Obs gives the number of regression observations. All specifications include country fixed effects and control for di^*. Specifications with interaction terms with $dVIX$ include the corresponding non-interaction controls which can include NFA/GDP_{t-1}, $Infl_{t-1}$, $PubDebt_{t-1}$, $StockmarketCap_{t-1}$, $ShareofWorldGDP_{t-1}$, $DomCredit/GDP_{t-1}$, $(GFA+GFL)/GDP_{t-1}$, $ChinnIto_{t-1}$ (not shown). Asterisks *, ** and *** indicate significance at the 10, 5 percent and 1 percent levels.

	$z^{EMP} * 1000$ – Safe Havens					$z^{EMP} * 1000$ – Non-Safe Havens				
	I	II	III	IV	V	VI	VII	VIII	IX	X
$dVIX$	0.185	0.210	3.124	0.249	0.533	-1.270***	-1.089*	-1.751***	-1.290***	-1.269
	(0.273)	(0.624)	(2.480)	(0.351)	(1.863)	(0.142)	(0.482)	(0.363)	(0.305)	(0.954)
$dVIX * NFA/GDP_{t-1}$		-0.105			0.966		-0.028			-0.103
		(0.213)			(2.010)		(0.138)			(0.201)
$dVIX * Infl_{t-1}$		10.050			31.295		-8.773			-8.433
		(13.906)			(31.117)		(4.763)			(6.432)
$dVIX * PubDebt/GDP_{t-1}$		-0.000			0.002		0.002			0.002
		(0.002)			(0.001)		(0.006)			(0.008)
$dVIX * ShareofWorldGDP_{t-1}$			-2.533		5.462			1.999		4.387
			(5.360)		(11.530)			(4.260)		(4.860)
$dVIX * StockmarketCap/GDP_{t-1}$			0.000		-0.006			-0.000		-0.000
			(0.000)		(0.006)			(0.002)		(0.002)
$dVIX * Dom.Credit/GDP_{t-1}$			-0.017		-0.011			0.006		0.001
			(0.013)		(0.015)			(0.004)		(0.005)
$dVIX * (GFA + GFL)/GDP_{t-1}$				-0.009	0.280				0.062	0.036
				(0.028)	(0.136)				(0.042)	(0.070)
$dVIX * ChinnIto_{t-1}$				0.000	0.000				-0.206	0.035
				(.)	(.)				(0.506)	(0.496)
Constant	-0.813	-1.069	-1.116	-0.840	-1.530	43.518***	46.448***	47.529***	46.432***	47.514***
	(0.710)	(1.164)	(0.709)	(0.728)	(1.159)	(0.257)	(0.306)	(0.304)	(0.270)	(0.330)
Adj. R2	0.000	-0.022	0.012	-0.010	0.020	0.097	0.102	0.099	0.098	0.098
No.Obs	99	99	99	99	99	820	736	722	737	711

Table A12: **Safe Haven Drivers: Panel Regressions, By Safe Haven Status– Only High Stress**

Results from monthly panel regressions of equations 25 and 26 from 2000m1 - 2020m12 for only months where the VIX is at or above its 90th percentile value of the period, excluding the United States. z^{EMP}*1000 is the dependent variable, winsorized at the 1st and 99th percentile. Safe haven countries include Denmark, Hong Kong, Japan, and Switzerland. No.Obs gives the number of regression observations. All specifications include country fixed effects. Asterisks *, ** and *** indicate significance at the 10, 5 percent and 1 percent levels.

	$z^e * 1000$					$z^{EMP} * 1000$				
	I	II	III	IV	V	VI	VII	VIII	IX	X
$dRORO$	-0.300***	-0.467**	-0.421**	-0.412*	-0.565*	-0.316***	-0.456**	-0.462**	-0.381	-0.503*
	(0.067)	(0.159)	(0.130)	(0.203)	(0.234)	(0.075)	(0.165)	(0.164)	(0.198)	(0.226)
$dRORO * NFA/GDP_{t-1}$		0.025			-0.153		-0.020			-0.272
		(0.071)			(0.095)		(0.086)			(0.137)
$dRORO * Infl_{t-1}$		0.583			1.126		-0.172			0.257
		(2.842)			(2.973)		(2.926)			(2.983)
$dRORO * PubDebt/GDP_{t-1}$		0.003			0.001		0.003			0.002
		(0.001)			(0.001)		(0.001)			(0.001)
$dRORO * ShareofWorldGDP_{t-1}$			2.607*		2.809*			2.560*		2.635*
			(1.142)		(1.191)			(1.123)		(1.226)
$dRORO * StockmarketCap/GDP_{t-1}$			0.000		-0.000			-0.000		0.000
			(0.000)		(0.001)			(0.000)		(0.001)
$dRORO * Dom.Credit/GDP_{t-1}$			0.001		-0.001			0.001		-0.001
			(0.002)		(0.002)			(0.002)		(0.002)
$dRORO * (GFA + GFL)/GDP_{t-1}$				0.034	0.079**				0.035	0.097**
				(0.018)	(0.027)				(0.021)	(0.034)
$dRORO * ChinnIto_{t-1}$				0.046	0.064				-0.028	-0.042
				(0.258)	(0.208)				(0.273)	(0.227)
R2 Adj.	0.020	0.086	0.023	0.033	0.105	0.016	0.069	0.020	0.025	0.083
No.Obs	8688	7969	7871	8028	7812	8646	7929	7833	7988	7774

Table A13: **Panel Regressions with RORO Index**

Results from monthly panel regressions of equations 25 and 26 from 2000m1 - 2020m12. No.Obs gives the number of regression observations. All specifications include country fixed effects and control for di^*. Specifications with interaction terms with $dRORO$ include the corresponding non-interaction controls which can include NFA/GDP_{t-1}, $Infl_{t-1}$, $PubDebt_{t-1}$, $StockmarketCap_{t-1}$, $ShareofWorldGDP_{t-1}$, $DomCredit/GDP_{t-1}$, $(GFA{+}GFL)/GDP_{t-1}$, $ChinnIto_{t-1}$ (not shown). Asterisks *, ** and *** indicate significance at the 10, 5 percent and 1 percent levels.

	$z^{EMP} * 1000$ – Safe Havens					$z^{EMP} * 1000$ – Non-Safe Havens				
	I	II	III	IV	V	VI	VII	VIII	IX	X
$dRORO$	0.185	0.455**	0.012	-0.632*	-0.491	-0.403***	-0.565**	-0.428*	-0.326	-0.397
	(0.116)	(0.084)	(0.326)	(0.207)	(0.389)	(0.077)	(0.195)	(0.176)	(0.199)	(0.289)
$dRORO * NFA/GDP_{t-1}$		-0.254			0.256		0.007			-0.389
		(0.144)			(0.560)		(0.086)			(0.230)
$dRORO * Infl_{t-1}$		-3.747			-3.259		0.557			0.152
		(2.567)			(4.161)		(3.016)			(3.147)
$dRORO * PubDebt/GDP_{t-1}$		-0.002**			-0.005		0.003			0.001
		(0.000)			(0.002)		(0.003)			(0.003)
$dRORO * ShareofWorldGDP_{t-1}$			1.475		1.491			-0.965		0.318
			(1.160)		(4.596)			(3.087)		(3.816)
$dRORO * StockmarketCap/GDP_{t-1}$			0.000		-0.005			0.000		0.000
			(0.003)		(0.003)			(0.000)		(0.001)
$dRORO * Dom.Credit/GDP_{t-1}$			0.000		0.004			0.000		-0.002
			(0.004)		(0.008)			(0.002)		(0.002)
$dRORO * (GFA + GFL)/GDP_{t-1}$				-0.007	-0.010				0.029	0.144
				(0.016)	(0.085)				(0.017)	(0.080)
$dRORO * ChinnIto_{t-1}$				0.916	1.077				-0.220	-0.221
				(0.376)	(0.596)				(0.270)	(0.230)
R2 Adj.	0.009	0.043	0.044	0.044	0.125	0.025	0.080	0.028	0.035	0.095
No.Obs	1284	1284	1284	1284	1284	7362	6645	6549	6704	6490

Table A14: **Panel Regressions with RORO Index– By Safe Haven Status**

Results from monthly panel regressions of equations 25 and 26 from 2000m1 - 2020m12. No.Obs gives the number of regression observations. All specifications include country fixed effects and control for di^*. Specifications with interaction terms with $dRORO$ include the corresponding non-interaction controls which can include NFA/GDP_{t-1}, $Infl_{t-1}$, $PubDebt_{t-1}$, $StockmarketCap_{t-1}$, $ShareofWorldGDP_{t-1}$, $DomCredit/GDP_{t-1}$, $(GFA{+}GFL)/GDP_{t-1}$, $ChinnIto_{t-1}$ (not shown). Asterisks *, ** and *** indicate significance at the 10, 5 percent and 1 percent levels.