International Capital Flow Pressures and Global Factors

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Draft version: June 2, 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 evolves over time, varies significantly across countries and across stress events. So called "safe-haven" status also evolves, with status defined relative to reference currencies, and generally not a feature over all time periods. Across countries, country gross external positions, country size and capital account openness increasingly explain risk sensitivities.

JEL Classification: F32, G11, G20.

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

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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 colleagues, especially Pierre-Olivier Gourinchas, for suggestions on features of the model for exchange market pressure, and Nastasija Loncar. We also thank 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), consistently with the Obstfeld, Ostry and Qureshi (2017) arguments about local economies being more challenged during periods with concentrated global risk-off sentiment. 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, 2017). 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

[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).

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 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). 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 financial flow perspective and 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

[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.

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; 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, 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, but there is significant variation across countries. This variation highlights the importance of accounting for the different components of the EMP in cross country time series analysis.

Second, we revisit the literature on safe haven currencies, 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 (2010), Habib and Stracca (2012), and Fatum and Yamamoto (2014).[4] Empirical analyses implemented using only observed exchange rate movements may generate imprecise results, or attenuation bias, when considering countries that respond to currency pressures by intervening in the foreign exchange market or by changing the policy rate.[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

[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.

[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).

(GRR). We then characterize currencies that systematically respond to risk-off episodes by either appreciation, policy rate cuts or capital inflows as safe haven currencies.

We find that the set of safe haven currencies based on this definition evolves over time, with some countries have safe haven features only episodically (e.g. Danish krone) and others more persistently, confirming the previous literature designating the Swiss franc, the Japanese yen and US dollar as the key safe haven currencies. Importantly, we show that the group of currencies with this safe haven status differs episodically from the group identified based on currency movements alone. For example, the Danish krone, which is pegged to the euro and hence exhibits very limited exchange rate variability, does not exhibit safe haven features based on exchange rate movements, but does so episodically when also accounting for foreign exchange interventions when applying the 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 using the EMP. The analysis suggests that safe haven features of currencies are associated with large gross foreign assets positions, economic size, and financial liquidity.[6] While macroeconomic characteristics add explanatory power to specifications in normal times, these features do not differentiate across countries in the pressures on currencies that occur during extreme risk periods. Adding to findings in Forbes and Warnock (2021) and Chari, Dilts Stedman and Forbes (2022), specifically in periods of higher risk and more negative sentiment, the fewer factors associated with strong GRR correlations are concentrated in financial market liquidity.[7]

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

[6]Habib and Stracca (2012) carefully explore which country characteristics are associated with safe haven currency status using an exchange rate based measure and also time series panel regressions. They acknowledge the potential attenuation issue that arises in their empirical analysis, as currencies might appear as safe havens only because policy interventions keep these currencies pegged to the dollar to various degrees. Their method of addressing such attenuation biases is to introduce foreign reserve changes and interest rate changes as control variables in empirical specifications.

[7]Financial market 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.

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 these 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 [8] Our approach follows this lead, but informing the weights of the index as well as 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.

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. The basic logic of our approach 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 quantity, 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. The equivalencies 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 on international trade and debt positions, and the stocks of outstanding 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 in terms of domestic currency arising from cross-border payments needs for specified period. The BOP flows taking place in the period between time $t-1$ and time t (period t), is 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 is defined in units of Home currency per one unit of Foreign currency.

[8] Goldberg and Krogstrup (2019). provide an extensive discussion of prior EMP constructions and applications.

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 the foreign official reserve 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. An alternative specification in which foreign debt is issued in foreign currency is considered in Section B.3.[9] The interest and dividend payments accruing to foreign assets and liabilities, i^* and i respectively, depend on the country of issuance.[10] 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.

2.2 Gross Asset and Gross Liability Flows

Capital flows are driven by the Home demand for Foreign assets 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).[11] 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:

[9] The assumption of domestic currency debt issuance does not holds empirically for some countries. Moreover, the case where countries borrow and lend in both domestic and foreign currency is considered in an earlier version of the EMP derivation in Goldberg and Krogstrup (2019).

[10] 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.

[11] 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.

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

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

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.[12] 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 $\alpha_l^{'}$, $\alpha_{l*}^{*'}$, $\alpha_s^{'}$ and $\alpha_s^{*'} > 0$.[13] 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 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[14] 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

[12]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.

[13]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).

[14]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.

international interest and dividend payments taking place in the beginning of period t:[15]

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

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 by $L_t = \tilde{L}_t = \bar{L}_t$, such that $\frac{W_t^* e_t}{L_t} = \frac{1}{1-\alpha^*}$, yields[16]

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

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[17]

[15] 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.

[16] 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.

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

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

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

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. $\frac{e_{t-1}}{e_t}\frac{E(e_{t+1})}{e_t} \approx 1$ [18] 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 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:

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

[18] for example, see Engel and Wu 2021 for discussion of alternatives

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

and

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

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

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

where we define the elasticity of gross foreign asset flows with respect to the interest rate and the exchange rate respectively as[19]

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

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

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:

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

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.

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

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 16).

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.

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.[20] 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.[21]

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.

[20] Even when data is available, we exclude very small countries which are defined as having a population size below half a million or an annual per capita income average since 2002 below US dollars 1000.

[21] We start with Klein and Shambaugh (2008) which shows 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, and Sweden, 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.

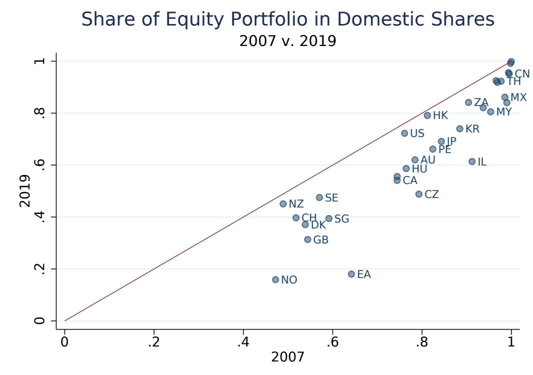
3.1 International Portfolios

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

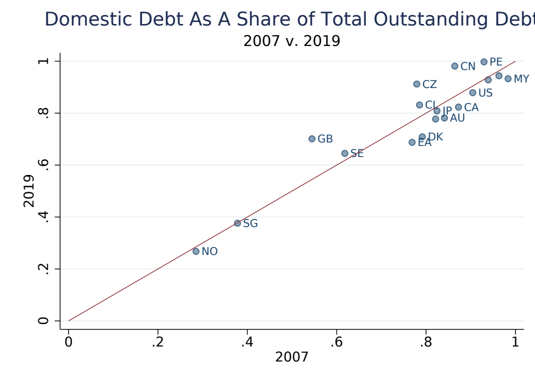
We update series through 2020 for countries in our sample examining equity, bond market, and bank loans while also constructing aggregated measures by country and over time (annual).[22] As shown in Figure 1, the trends toward reduced home bias (declines in our α_t) identified through 2008 by Coeurdacier and Rey (2012) continue for equity portfolio data through 2019. Further declines in equity home bias characterize all countries, 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, likewise 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 analytics (See Appendix for details).

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 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 domestic and foreign opportunities in the rest of the world. The exceptions are countries like the United Kingdom, Switzerland, euro area (treated in aggregate), Japan, Norway, and the United

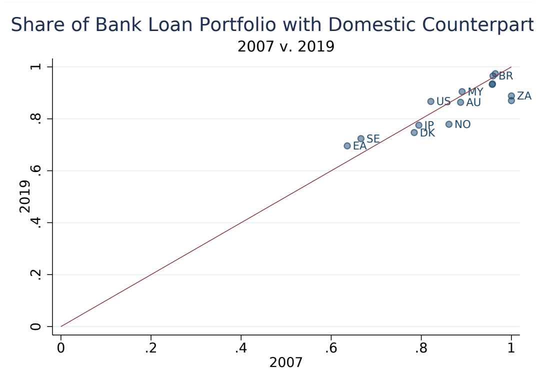
[22] We follow Coeurdacier and Rey (2012) for computing the annual share of each country's equity investments in domestic equity market, with our update covering 36 of our 41 sample countries. For banking share this update covers 16 of our 41 sample countries. The bond share update covers 24 of the 41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



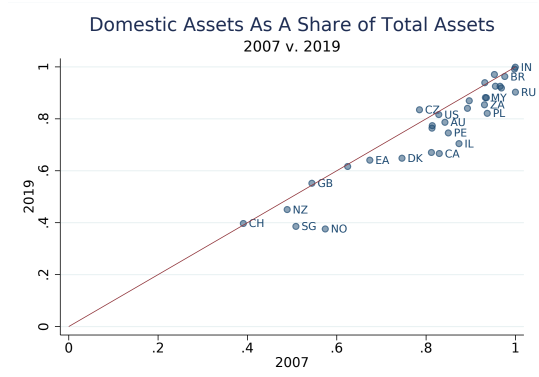
(a) Equity Specific α_t



(b) Bond Specific α_t



(c) Bank Asset Specific α_t



(d) All Asset Classes α_t

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, either for a specific asset class or for equities, debt securities, and banking assets combined. Data points below (above) the 45-degree line indicate that home bias decreased (increased) between 2007 and 2019. Some country labels are removed for readability.

States where recent values are closer to 0.80.

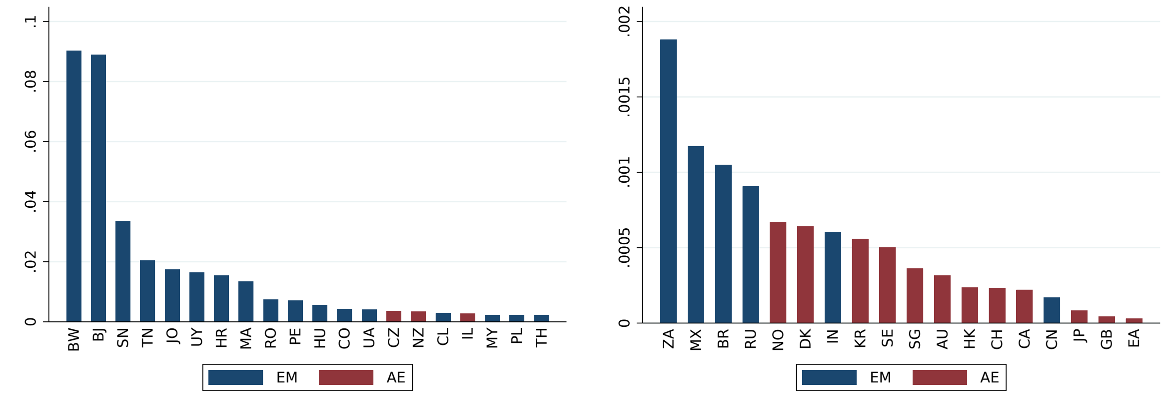
Portfolio share sensitivities to uip enter elasticities through $\frac{\alpha'_{uip}}{1-\alpha}$. Empirical specification using country aggregate data on components of global liquidity shows that elasticities of flows to domestic policy rates, US policy rates, and risk sentiment vary across market-based 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. From the theory side, 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 the range of variation observed by country over time in the α_t and α^*_t, we assume specific empirical values for α'_{uip} and ${\alpha^*_{uip}}'$. Accordingly, our baseline 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^A_e. 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^A_i is -0.025 and ϵ^L_i 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 USD or euro



(a) $1/\pi_e > 0.002$

(b) $1/\pi_e < 0.002$

Figure 2: **2019 $1/\pi_e$ 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, depending on reference currency. The bars are color-coded by AE (red) and EM (blue) countries.

respectively of FXI, where red bars correspond to advanced economies and blue bars to emerging market economies. As the left panel shows, the conversion factor generally is an order of magnitude larger for emerging market economies compared with advanced economies. For example, using 2019 data values, the $\frac{1}{\Pi_{e,t}}$ conversion factor suggests that a one billion US dollar intervention would instead deliver similar effects for Brazil and Mexico, at 0.001 percentage points, less than half that value for Australia, Singapore and Switzerland (in euros), and which is at least twice as high as delivered for Japan. The US and euro area intervention effects would be even smaller. These relatively small quantitative payoffs from intervention are consistent with the observations that the roles of oral interventions and larger scale of interventions for such countries (measured relative to GDP for Fratzscher, Gloede, Menkhoff, Sarno and Stöher (2019)), and also weighted against the opportunity cost of holding very large stocks of reserves for the largest economies as discussed in Goldberg, Hull and Stein (2013).

The overall pattern is driven strongly by country gross external asset and liability positions, and by the home bias shares. Another interesting feature stems from the type of data on α shown in Figure 1, which compares home bias 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 is weaker. As the home bias shares declined, the framework suggests foreign exchange intervention becoming more effective as measured by avoidance of units of currency depreciation.

One noteworthy observation is that the model, along with the assumed values for α'_{uip} and ${\alpha^*_{uip}}'$, ultimately generate relatively small contributions of interest rate changes to the EMP.

This primarily occurs because of limited international portfolio reallocations with respect to *uip* changes. In line with the broader literature on such sensitivities, future research could consider in greater detail the specific types of investors involved at the country level and perhaps more regionally localized international investment sensitivities and home bias computations.

3.3 Monthly Foreign Exchange Intervention Series

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 includes a list of countries for which available data suggest 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.[23] Measuring foreign exchange intervention (FXI) activity consistently across countries hence requires making choices on what types of interventions to 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.

[23] 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).

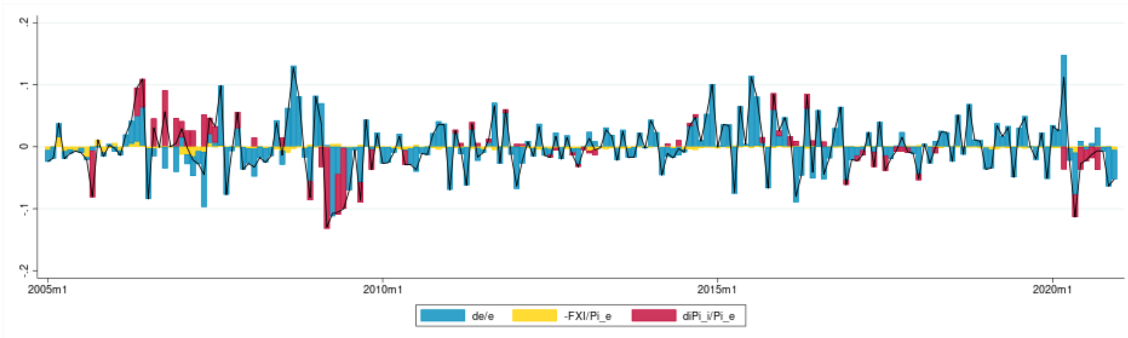
3.4 Monthly EMP Series with Components

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.

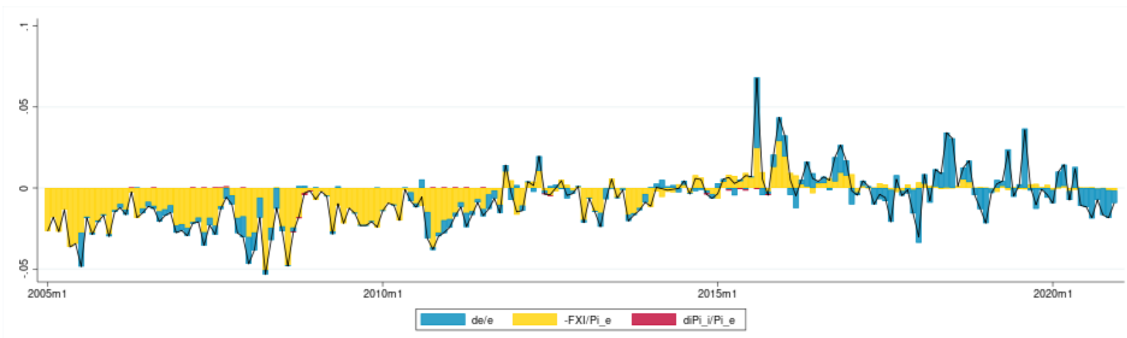
Figure 3 shows that Switzerland's interventions became more active in the years after the global financial crisis, when the policy rate became limited by the proximity of the lower bound. Interventions have resulted in significant growth in Swiss foreign exchange reserves, but the contributions to the 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 market pressures could hence be material, and may change over time.

4 The EMP, Risk Sentiment, and the Global Factor

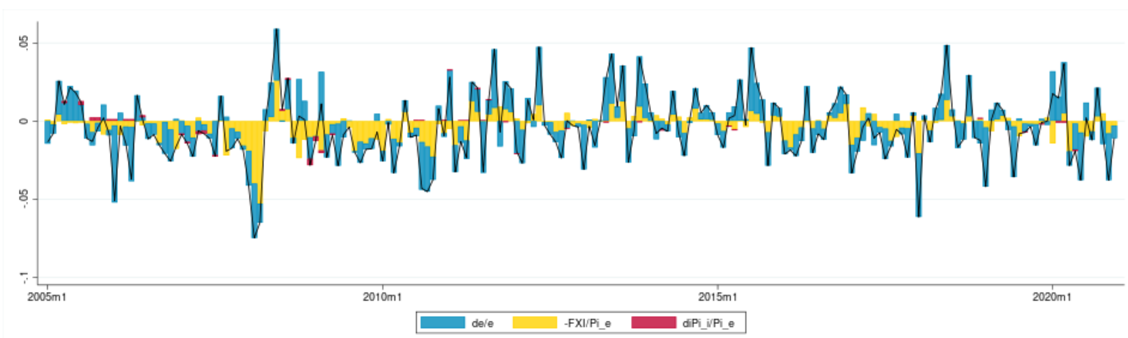
International capital flow pressures are driven by global factors or advanced economy push factors and by local pull factors. A long history of studies of capital flow drivers, and the influential work of Miranda-Agrippino and Rey (2015), point to a large and important global factor particularly associated 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



(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.

GFC period (e.g. Shin 2016).[24] 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).

The next sections provide the results of 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. Stress periods are defined using extreme values of a risk sentiment measure. Our baseline uses the VIX, while alternative applications are based on the distribution of realizations of the BEX measure of risk sentiment (Geert Bekaert and Xu 2021), the euro $VSTOXX$, and the $RORO$ (Risk-On Risk-Off) (Chari, Dilts Stedman and Forbes 2022). The results underline how capital flow pressures respond differently to high stress periods across countries and over time. The analyses allow us to categorize countries as having so-called safe-haven status, exhibiting appreciation pressures against their base currency when risk sentiment is most strained. The results also show that relying only on exchange rate based analytics can grossly miss the international capital flow pressures experienced by some countries as risk conditions evolve. We then 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, as addressed in Habib and Stracca (2012).

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, we isolate 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.[25] Using the stress month span of observations, we also provide compositional comparisons of the high stress months associated with the GFC in

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

[25]The high stress dates overlap with, but are not identical to 90th percentile dates derived using the $RORO$, BEX risk aversion index, and the $VSTOXX$. Robustness checks to the alternative date choice according to these series are performed.

contrast to the high stress months during the COVID-19 pandemic.

Figure 4 illustrates 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 less stressful dates (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.

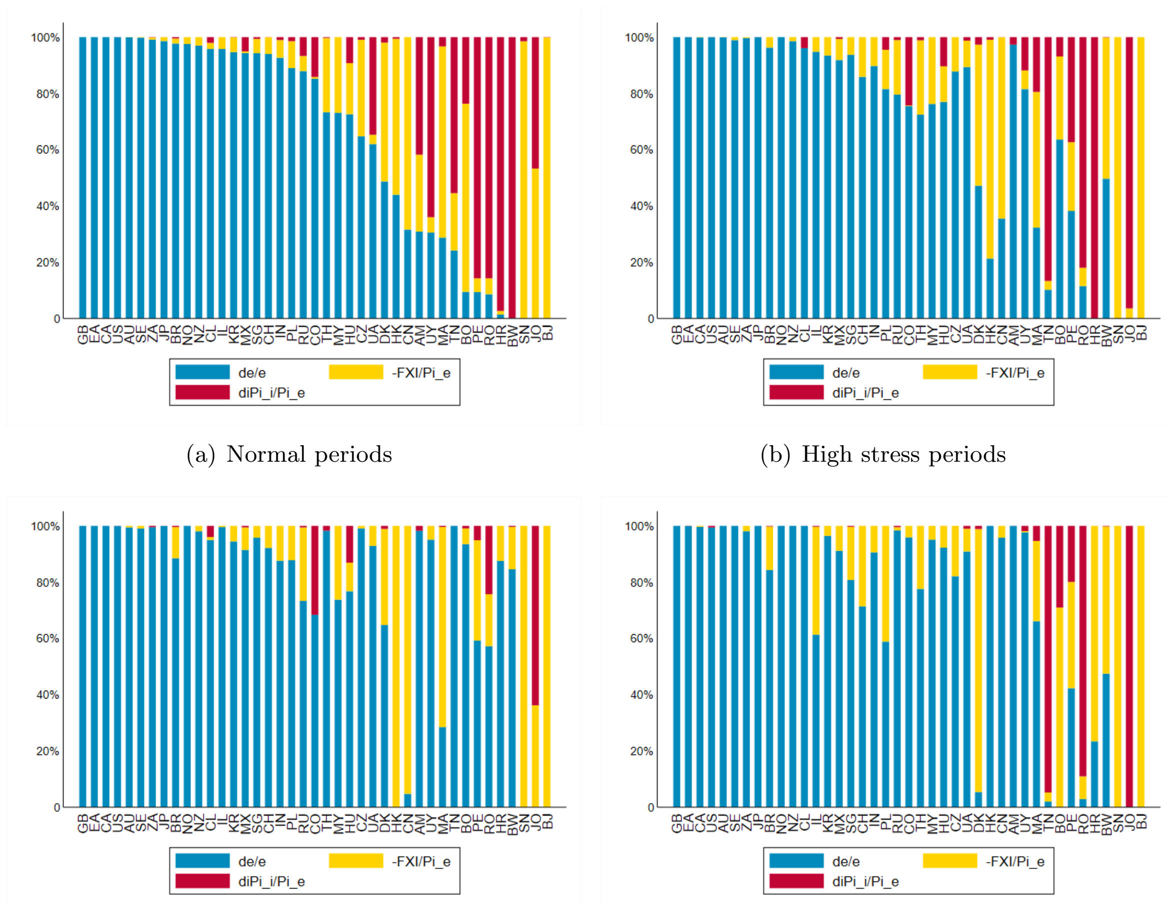
Even in normal periods, more than half of the countries in our sample have exchange market pressure that is not fully reflected by exchange rate movements (depicted in blue). The rest of the pressures are associated with a mixture of currency intervention activity (in yellow) and policy rate adjustments (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.

Another way to view these compositional differences are through direct share comparisons. Table 1 presents rank correlation coefficients across countries, considering 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).

	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	-	19	37	44
High stress periods	0.91	10	49	41
GFC	0.71	12	32	56
Pandemic	0.73	17	27	56

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.

Table 1 reinforces the differences in ways in which capital flow pressures manifest during normal times and during high-stress episodes. During high-stress episodes, countries on average allow more exchange rate variation to absorb capital flow pressures than during normal times.



(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 all normal periods (a), all high stress periods (b), the Global Financial Crisis (c) and the covid-19 pandemic (d) using the 90th percentile distribution of the VIX.

The Czech Republic, for example, has FXI accounting for a larger share of the variation in the EMP during normal times compared to high stress episodes. 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. The panels of Figure 4 shows that this is true on average. However, there are large differences across countries and some countries, including for example Switzerland, has used FXI to a greater extent during high stress episodes than during normal times.

The interest rate component accounts for almost all variation for a small group of 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, meaning that the central banks in these countries have been able to use the policy rate more actively in response to capital flow pressures. This difference becomes apparent when considering a country such as Denmark, for which the contribution to the variance of the EMP from the interest rate component is very small even though this is the primary tool of the Danish Central Bank.

4.2 EMP Correlations with Risk Sentiment

The current section turns specifically to correlations between international capital flow pressures and risk conditions. The asset pricing literature on safe-haven currencies defines these as exhibiting excess returns during risk-off episodes (Brunnermeier, Nagel and Pederson, 2008; Ranaldo and Soederlind, 2010; Habib and Stracca, 2012). Underlying this definition is a presumption that excess currency returns are driven by an increased demand for the currency during such risk-off episodes. However, in countries where authorities intervene to prevent the currency value from responding to an increased demand, this safe-haven demand is also reflected in FXI or policy rate reductions, so that a focus on observed exchange rate movements alone is subject to attenuation bias. This gets back to our view 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 persistent of these correlations are used to identify so-called safe-haven status currencies versus those that strongly depreciate against the dollar when the VIX rises.

Specifically, a currency j exhibits safe-haven demand characteristics on average during the period from $t - x$ to t, if it tends to appreciate or experience positive international capital flow pressures when risk shocks are higher

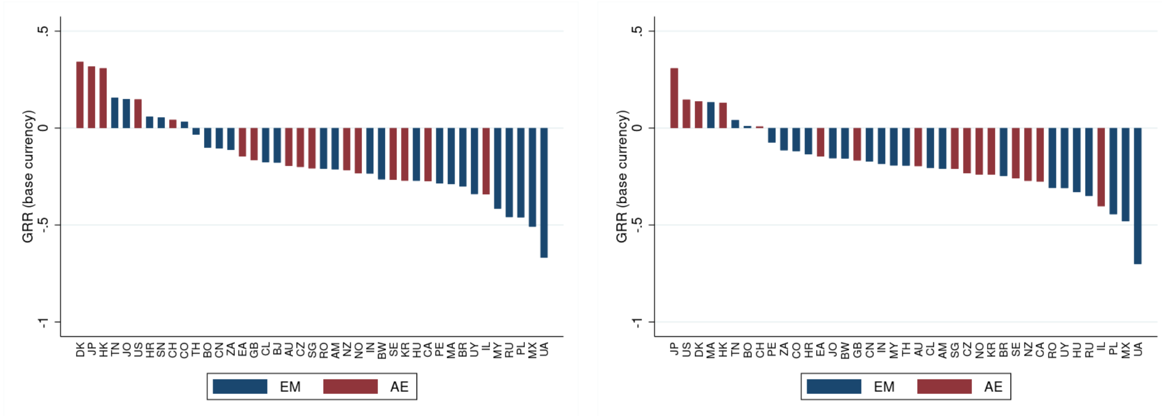
$$GRR_t^j = -corr_{t-x,t}(EMP_t^j, s_t) > 0 \tag{24}$$

where s_t is captured by variation in the VIX for our baseline specifications. 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 CHF or Danish Kroner could be positive relative to the euro, indicating that relative performance, without specifying status relative to the USD.

Overall, across the full sample of 41 countries, 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 countries like Denmark and Hong Kong 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.

Almost all 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 particularly found in so-called commodity currencies 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.

We also consider time variation, which shows that the so-called safe haven feature is not time



(a) EMP

(b) de/e

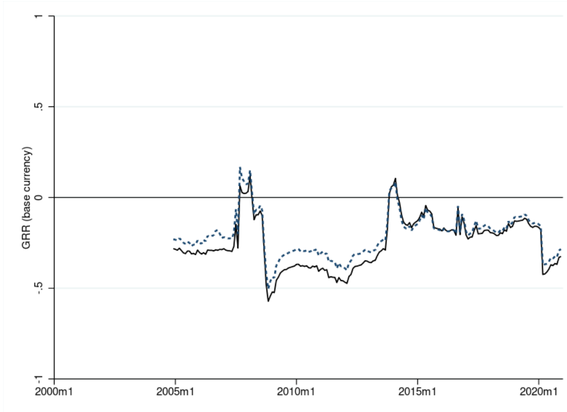
Figure 5: GRR **by Country: June 2013**
Panel (a) shows the GRR based on the EMP against each country's base currency in June 2013. Panel (b) displays the GRR based on changes in exchange rates between country's currency and base currency in June 2013. Spearman's rank correlation between panels (a) and (b) of 0.770.

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 compared vis-a-vis USD.

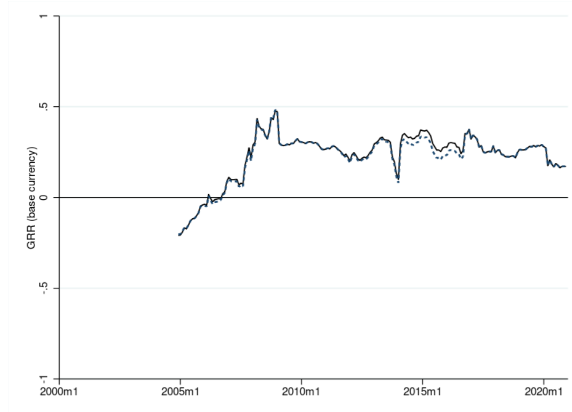
The Swiss franc, by contrast is not consistently measured as safe haven status with $GRR > 0$. This status episodically switches to neutral during Switzerland's period of active exchange rate management between 2012 and 2015. The construction of Switzerland's EMP shows a smaller contribution of large 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.

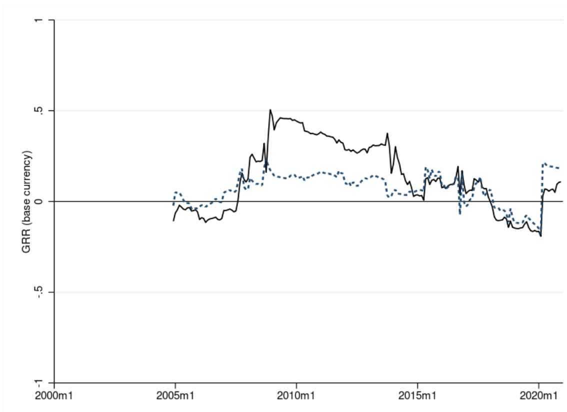
[26] Observations for the GRR are based on 5 years of prior monthly data. If pre-2000 EMP data are unavailable for some countries, some early GRR observations will be missing from the regression sample.



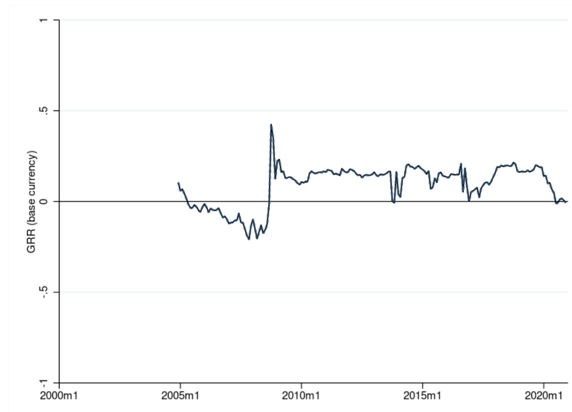
(a) Brazil



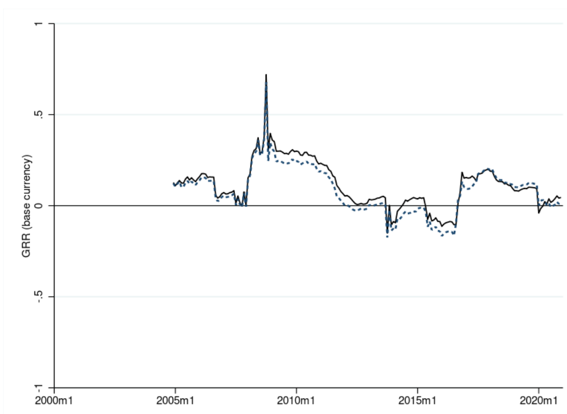
(b) Japan



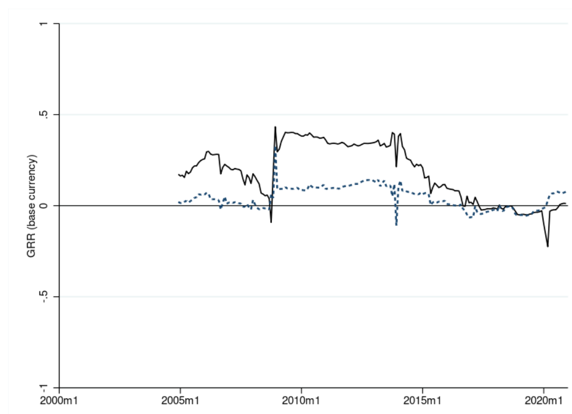
(c) Hong Kong



(d) United States



(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 (c) and against the euro in panels (d) through (f). The solid line displays GRR computed the EMP. The dashed line displays the GRR computed using realized depreciation rate.

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 (2017) 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 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 base currency.** GRR is computed as -1 times the rolling correlation over 5 years between EMP against base 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 Characteristics Associated with Safe Haven Currencies

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 the empirical safe haven literature with a view to explaining why some currencies habitually experience inflows and hence higher excess returns when global risk conditions worsen, while other currencies tend to experience outflows and falling or negative excess returns during such episodes. The literature assesses currency demand and safe haven status based on the response of the price of a currency, namely its excess return, based on observed interest rates and exchange rates (e.g. Habib and Stracca 2012, Brunnermeier et al. 2008, Ranaldo and Soederlind 2010, Fatum and Yamamoto 2014).[27] The attenuation bias resulting from only

[27] 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. FILL IN insert citations on convenience yields, dollar dominance, empirics including Gourinchas et al. 2019, Caballero, Farhi and Gourinchas 2016, Du et al. 2018, Goldberg and Tille 2006, Goldberg and Tille 2015, Maggiori 2017.

considering exchange rate responses to risk factors may, however, lead to inaccurate results for episodes or for countries for which policy responses that mute exchange rate responses to flows are in use. We instead construct a 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.

Habib and Stracca (2012) focus on three conjectures, namely that a currency may be a "safe haven" if: i) the issuing country is itself regarded as safe and with low 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 similar conjectures using monthly data for 41 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 driving by the variation contained in the safe haven currencies, defining safe-haven currency observations according to average $GRR > 0$ with statistical significance over the full sample period.[28] 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 base currency, and by $z_t^{j,EMP}$ the counterfactual excess return of currency j relative to its base currency, taking into account policy responses to flows.[29]

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

[28]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.

[29]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.

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

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 base 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. Columns II and VII contain regression results including the set of variables typically associated with country risk (or country safety). Columns III and VIII introduce the set of macro fundamental variables reflecting size of economy and financial market development. 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.

Table 3 includes the full set of 41 countries, with two panels that consider similarities and differences in results when realized excess returns are computing using $z_t^{j,e}$ (panel a) and using $z_t^{j,EMP}$ (panel b). Table 4 includes realized excess return results based only on $z_t^{j,EMP}$, with countries divided into so-called safe havens (panel a) and all other countries or non-safe havens (panel b). These same distinctions are used in Tables 5 and 6, in which the risk sensitivity results are computed outside of the high stress monthly observations, and then exclusively over those high stress monthly observations, defined as the upper 10th percentile of the VIX distribution. Further robustness check tables are provided as appendix materials.

The first finding from across the specifications in Table 3 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.

	$z^e * 1000$					$z^{EMP} * 1000$				
	I	II	III	IV	V	VI	VII	VIII	IX	X
$dVIX$	-1.167***	-1.429***	-1.851***	-1.539***	-1.768**	-1.275***	-1.543***	-2.058***	-1.651***	-1.922***
	(0.189)	(0.344)	(0.322)	(0.426)	(0.512)	(0.206)	(0.377)	(0.357)	(0.404)	(0.536)
$dVIX * NFA/GDP_{t-1}$		0.102			-0.304		0.144			-0.288
		(0.213)			(0.260)		(0.218)			(0.279)
$dVIX * Infl_{t-1}$		-7.417			-5.614		-8.506			-6.524
		(4.624)			(4.788)		(5.211)			(5.241)
$dVIX * PubDebt/GDP_{t-1}$		0.008*			0.006*		0.008*			0.006*
		(0.003)			(0.003)		(0.003)			(0.003)
$dVIX * ShareofWorldGDP_{t-1}$			6.212*		5.493			6.878*		6.121*
			(2.613)		(2.719)			(2.675)		(2.614)
$dVIX * StockmarketCap/GDP_{t-1}$			0.000		0.001			0.000		0.001
			(0.001)		(0.001)			(0.001)		(0.001)
$dVIX * Dom.Credit/GDP_{t-1}$			0.006		-0.000			0.006		0.001
			(0.004)		(0.005)			(0.004)		(0.005)
$dVIX * (GFA + GFL)/GDP_{t-1}$				0.086	0.109				0.101*	0.113
				(0.044)	(0.076)				(0.048)	(0.076)
$dVIX * ChinnIto_{t-1}$				0.202	0.089				0.145	0.008
				(0.570)	(0.504)				(0.590)	(0.530)
Constant	30.245***	14.648*	45.548***	85.670***	52.928**	29.844***	20.033***	47.278***	77.159***	58.505***
	(0.051)	(5.859)	(7.891)	(20.650)	(15.724)	(0.060)	(5.577)	(7.052)	(16.721)	(14.986)
Adj. R2	0.022	0.136	0.033	0.063	0.159	0.025	0.097	0.036	0.052	0.117
No.Obs	10024	9011	9104	9121	8857	9830	8871	8920	8963	8717

Table 3: **Panel Regressions with Risk Sensitivity**

Results from monthly panel regressions of equations 25 and 26 from 2000m1 - 2020m12. 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.

	$z^{EMP} * 1000$ – Safe Havens					$z^{EMP} * 1000$ – Non-Safe Havens				
	I	II	III	IV	V	VI	VII	VIII	IX	X
$dVIX$	0.441	0.304	2.285	0.804	1.217	-1.558***	-2.080***	-1.668***	-1.446***	-1.487
	(0.240)	(0.460)	(1.460)	(0.322)	(1.085)	(0.195)	(0.457)	(0.395)	(0.395)	(0.746)
$dVIX * NFA/GDP_{t-1}$		-0.153			0.696		-0.208			-0.262
		(0.138)			(0.717)		(0.185)			(0.245)
$dVIX * Infl_{t-1}$		11.404			18.538		-4.590			-6.485
		(7.126)			(15.080)		(4.746)			(5.672)
$dVIX * PubDebt/GDP_{t-1}$		0.002			0.001		0.012			0.010
		(0.002)			(0.002)		(0.006)			(0.006)
$dVIX * ShareofWorldGDP_{t-1}$			3.979*		6.016*			2.264		2.161
			(0.891)		(2.004)			(5.153)		(5.861)
$dVIX * StockmarketCap/GDP_{t-1}$			-0.000		-0.004			-0.002		-0.003
			(0.000)		(0.002)			(0.003)		(0.003)
$dVIX * Dom.Credit/GDP_{t-1}$			-0.012		-0.010			0.002		-0.002
			(0.008)		(0.007)			(0.005)		(0.005)
$dVIX * (GFA + GFL)/GDP_{t-1}$				-0.063	0.123				0.068	0.087
				(0.026)	(0.110)				(0.044)	(0.066)
$dVIX * ChinnIto_{t-1}$				0.000	0.000				-0.443	-0.322
				(.)	(.)				(0.554)	(0.565)
Constant	-0.486***	-6.109	3.420	5.454	-27.717	34.154***	24.067**	53.794***	79.007***	58.507***
	(0.015)	(3.083)	(13.043)	(2.070)	(20.085)	(0.067)	(6.955)	(7.954)	(15.555)	(15.203)
Adj. R2	0.016	0.038	0.030	0.025	0.046	0.034	0.111	0.042	0.061	0.129
No.Obs	1230	1216	1230	1230	1216	8600	7655	7690	7733	7501

Table 4: **Panel Regressions with Risk Sensitivity– By Safe Haven Status**

Results from monthly panel regressions of equations 25 and 26 from 2000m1 - 2020m12. z^{EMP}*1000 is the dependent variable, winsorized at the 1st and 99th percentile. Safe haven countries include Denmark, Hong Kong, Japan, Switzerland, and the United States. 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
$dVIX$	0.722	0.335	3.371	1.217*	2.267	-2.101***	-3.169***	-2.028***	-1.808*	-1.544
	(0.315)	(0.482)	(2.051)	(0.410)	(1.957)	(0.262)	(0.556)	(0.512)	(0.692)	(0.791)
$dVIX * NFA/GDP_{t-1}$		-0.069			0.107		-0.305			-0.544
		(0.122)			(0.830)		(0.271)			(0.303)
$dVIX * Infl_{t-1}$		1.998			3.302		-2.754			-6.516
		(11.387)			(19.717)		(4.860)			(4.482)
$dVIX * PubDebt/GDP_{t-1}$		0.005			0.006*		0.021*			0.012
		(0.002)			(0.002)		(0.009)			(0.010)
$dVIX * ShareofWorldGDP_{t-1}$			5.150*		4.595*			-4.053		-6.274
			(1.271)		(1.595)			(8.537)		(8.495)
$dVIX * StockmarketCap/GDP_{t-1}$			-0.000		-0.002			-0.008		-0.010*
			(0.000)		(0.003)			(0.004)		(0.004)
$dVIX * Dom.Credit/GDP_{t-1}$			-0.017		-0.017			0.006		-0.001
			(0.011)		(0.010)			(0.008)		(0.006)
$dVIX * (GFA + GFL)/GDP_{t-1}$				-0.082	0.168				0.131	0.299**
				(0.034)	(0.087)				(0.074)	(0.088)
$dVIX * ChinnIto_{t-1}$				0.000	0.000				-0.886	-1.125
				(.)	(.)				(0.849)	(0.670)
Constant	-0.528**	-5.604	4.300	6.919**	-33.493	33.403***	22.179**	52.628***	79.283***	57.034***
	(0.089)	(3.430)	(13.005)	(1.330)	(21.350)	(0.079)	(6.589)	(7.992)	(15.637)	(14.974)
Adj. R2	0.011	0.030	0.023	0.022	0.038	0.029	0.114	0.038	0.059	0.136
No.Obs	1109	1095	1109	1109	1095	7777	6919	6964	6996	6790

Table 5: **Panel Regressions with Risk Sensitivity– Excluding High Stress**

Results from monthly panel regressions of equations 25 and 26 from 2000m1 - 2020m12 excluding 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, Switzerland, and the United States. 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
$dVIX$	0.373	0.388	1.883	0.593	-0.609	-1.216***	-1.260*	-1.507***	-1.105**	-1.059
	(0.243)	(0.506)	(1.753)	(0.356)	(1.679)	(0.147)	(0.497)	(0.354)	(0.315)	(0.939)
$dVIX * NFA/GDP_{t-1}$		-0.167			1.477		-0.023			-0.095
		(0.161)			(0.880)		(0.144)			(0.203)
$dVIX * Infl_{t-1}$		13.921			30.853		-6.134			-7.683
		(13.433)			(26.188)		(4.744)			(6.506)
$dVIX * PubDebt/GDP_{t-1}$		-0.000			0.000		0.004			0.004
		(0.003)			(0.001)		(0.006)			(0.007)
$dVIX * ShareofWorldGDP_{t-1}$			3.176		9.447*			4.382		5.713
			(1.191)		(2.460)			(4.136)		(4.748)
$dVIX * StockmarketCap/GDP_{t-1}$			-0.000		-0.007			0.001		0.001
			(0.000)		(0.004)			(0.002)		(0.002)
$dVIX * Dom.Credit/GDP_{t-1}$			-0.010		-0.003			0.001		-0.003
			(0.010)		(0.012)			(0.004)		(0.005)
$dVIX * (GFA + GFL)/GDP_{t-1}$				-0.037	0.258*				0.059	0.032
				(0.029)	(0.092)				(0.039)	(0.070)
$dVIX * ChinnIto_{t-1}$				0.000	0.000				-0.401	-0.144
				(.)	(.)				(0.534)	(0.528)
Constant	1.818	1.346	1.483	1.696	0.715	40.042***	42.956***	43.795***	42.985***	44.015***
	(0.679)	(1.081)	(0.549)	(0.714)	(0.958)	(0.267)	(0.315)	(0.303)	(0.285)	(0.321)
Adj. R2	0.032	0.032	0.043	0.032	0.066	0.092	0.095	0.092	0.093	0.091
No.Obs	121	121	121	121	121	823	736	726	737	711

Table 6: **Panel Regressions with Risk Sensitivity– 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. z^{EMP}*1000 is the dependent variable, winsorized at the 1st and 99th percentile. Safe haven countries include Denmark, Hong Kong, Japan, Switzerland, and the United States. 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.

Columns II and VII also indicate that the variables group under the macroeconomic heading together have the largest explanatory power for realized excess returns. Economic size (as a share of world GDP), gross foreign assets and high public debt ratios also tend to work against the average $dVIX$ effects, and can be associated with safe havenness in both country samples. While Habib and Stracca 2012 provided a macroeconomic interpretation to our columns II and VII, the combination of variables with significance across the columns of the table also could be interpreted as associated with large and deep international asset markets.

Table 4 unpacks these results across the so-called safe havens (left panel, already selected based on the opposite sign of EMP correlation with VIX) and all other countries (right panel). As a group, the average $dVIX$ effect on realized excess returns is positive and insignificant for the safe havens. Already within the safe haven category, for these countries the incremental explanatory power of the groups of variables is relatively small. By contrast, the right panel countries demonstrate the negative and significant effect of $dVIX$ on realized excess returns. The macroeconomic drivers of column VII significantly contribute to the explanatory power of the specifications, mainly in levels of realized returns over time more than in differentiating countries by risk sensitivity. The average risk sensitivity as reflected in the first row of $dVIX$ is much larger for some countries, once differences in macroeconomic conditions and size are accounted for.

The next tables of results provide an interesting distinction between high stress months and the more normal risk periods, again separating the so-called safe havens and all other countries. Outside of the high stress dates, the average sensitivity to risk is quantitatively higher than previously observed, with the same sign patterns. Among the safe havens, country size reinforces the safe haven status. Within non-safe havens, there is again significant differentiation in excess return sensitivity - with greater differentiation when accounting for public debt share relative to GDP, which is associated with weaker excess return response to risk changes. The causality in this case might be questioned: it may be the countries that are stronger that can actually finance greater debt levels relative to GDP, but this is outside of the scope of our specifications.

Using in specifications on the more limited observations of high stress months, Table 6 demonstrates the lower incremental explanatory powers of the right hand side regression variations. Outside of the safe havens and in periods of high stress, but groupings of explanatory variables contribute little to explaining differences in effects of $dVIX$ on realized excess returns. This broad latter group of countries, containing advanced economies and emerging markets, have statistically significant and more common reflections of international capital outflow pressures in high stress times.

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 only some of the determinants found in the literature, with country size and public sector debt share positive contributors. Financial market development and financial openness changes over time, with country fixed effects in specifications, do not differentiate risk behavior of realized excess returns.

4.5 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 (which we extended through 2022, relative to the April 2020 end date in Chari et al. 2022). This set of robustness checks entails generating different GRR values, high stress dates, and analytics on differentiation in risk sensitivity. 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. The $RORO$-based results are more dissimilar (and are still being studied).

The next set of robustness checks are around the relevant monetary policy rates to use in the analytics. While we have used actual policy rates, some countries hit up against the zero lower pound during the latter part of the post GFC period and additionally forward guidance at times was applied to influence the yield curve. We test for the sensitivity of all results to replacing actual policy rates with Krippner 2016 values. This replacement applies to Australia, New Zealand, Canada, United States, Japan, the UK, the Euro Area, and Switzerland. These countries then enter computations as demonstrating stronger interest rate reductions than otherwise captured at the zero lower bound, which will reduce the EMP in periods of declining Krippner rates. The safe haven GRR values tended to be substantially larger with this adjustment, with the post GFC period also having even larger sensitivities during more normal times.

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 *alpha* 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 will explore alternative approaches to measuring in particular the foreign investor behavior and the potential to magnify the response of foreign portfolio flows and deliver 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 foreign exchange interventions, as well as incipient flows that are instead manifested in exchange rate changes or monetary policy rate changes. The proposed 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 with different exchange rate and monetary policy regimes in place.

We have computed the proposed EMP for a broad panel of countries and over time, offering an empirical measure of monthly variation in international capital flow pressures, with at most a few months of lag. The implementation approach closely follows and extends recent empirical advances in international finance. The empirical applications across 41 countries and over 20 years of monthly data have demonstrated that the EMP is a useful 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.

Using the EMP formulation, we have characterized cross country differences in the different components' contributions to the EMP, and illustrated how capital flow pressures are highly responsive to global risk conditions across countries. Countries typically viewed as exhibiting safe haven characteristics are more affected by capital inflows during high stress periods than during more normal times, when correlations are weaker. We have also shown that the characterization as a safe haven is not a permanent feature of currencies, as we observe large differences across countries and over time in the international capital flow pressures that occur when risk sentiment changes. Finally, we have also shown that the country characteristics associated with safe haven currency status include country size, net foreign asset positions, and financial openness. Overall, our measure recognizes the richness of important differences in exchange rate and monetary regimes across countries and time, and advances our understanding of international capital flow pressures.

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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

[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.

[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 A Model with Foreign Liabilities Issued in Foreign Currency

B.1 Gross Foreign Liabilities Flows In Foreign Currency

Foreign's holdings of initial foreign liabilities in period t, including valuation effects from changes in Home's asset prices but no longer reflecting exchange rate valuation effects, before portfolio adjustments take place, are described as

$$\bar{L}_t^{fx} = L_{t-1}^{fx} \left(1 + \dot{p}_t\right) \tag{29}$$

Foreign's wealth now evolves according to

$$W_t^* = \left(1 + \dot{p}_t^* + \dot{g}_t^*\right) w_{t-1}^* + L_{t-1}^{fx} \left(1 + \dot{p}_t + i_{t-1}^*\right) - A_{t-1} \left(1 + \dot{p}_t^* + i_{t-1}^*\right) \tag{30}$$

Foreign's demand for new Home liabilities in Foreign's currency is now:

$$\begin{aligned} IL_t^{fx} = & \left(1 - \alpha^* \left(uip_t, l_t, s_t\right)\right) \left[w_{t-1}^* \left(1 + \dot{p_t^*} + \dot{g}_t^*\right) + L_{t-1}^{fx} \left(1 + \dot{p}_t + i_{t-1}^*\right) - A_{t-1} \left(1 + \dot{p}_t^* + i_{t-1}^*\right)\right] \\ & - L_{t-1}^{fx} \left(1 + \dot{p}_t\right) \end{aligned} \tag{31}$$

Linearizing equation (31) with respect to portfolio demand determinants, asset prices and the exchange rate yields:

$$\begin{aligned} dIL_t^{fx} = & \frac{de_t}{e_{t-1}} \left[-\alpha_{uip}^{*'} W_t^* \frac{e_{t-1}}{e_t} \frac{E(e_{t+1})}{e_t}\right] \\ & + \left[di_t - di_t^*\right] \left[W_t^* \alpha_{uip}^{*'}\right] \\ & - \frac{dp_t}{p_{t-1}} \left[\alpha^* L_{t-1}^{fx}\right] + \frac{dp_t^*}{p_{t-1}^*} \left[\left(1 - \alpha^*\right) \left(w_{t-1}^* - A_{t-1}\right)\right] \\ & + \frac{dg_t^*}{g_{t-1}^*} \left[\left(1 - \alpha^*\right) w_{t-1}^*\right] \\ & - dl_t \left[W_t^* \alpha_l^{*'}\right] - ds_t \left[W_t^* \alpha_s^{*'}\right] \end{aligned} \tag{32}$$

Note that if $\alpha_{uip}^{*'} = 0$, then only Foreign growth and Home and Foreign asset prices and risk factors would drive the demand for Home's foreign liabilities. Divide by L_t^{fx} and make use of

$w^*_{t-1} - A_{t-1} = W^*_{t-1} - L^{fx}_{t-1}$ to get

$$\begin{aligned}\frac{dIL^{fx}_t}{L^{fx}_t} =& \frac{de_t}{e_{t-1}}\left[-\alpha^{*'}_{uip}\frac{W^*_t}{L^{fx}_t}\frac{e_{t-1}}{e_t}\frac{E(e_{t+1})}{e_t}\right] \\ & - [di_t - di^*_t]\left[\frac{W^*_t}{L^{fx}_t}\alpha^{*'}_{uip}\right] \\ & - \frac{dp_t}{p_{t-1}}\left[\alpha^*\frac{L^{fx}_{t-1}}{L_t}\right] + \frac{dp^*_t}{p^*_{t-1}}\left[(1-\alpha^*)\left(\frac{W^*_{t-1}}{L^{fx}_{t-1}} - 1\right)\frac{L^{fx}_{t-1}}{L^{fx}_t}\right] \\ & + \frac{dg^*_t}{g^*_{t-1}}\left[(1-\alpha^*)\frac{w^*_{t-1}}{L^{fx}_t}\right] \\ & - dl_t\left[\frac{W^*_t}{L^{fx}_t}\alpha^{*'}_l\right] - ds_t\left[\frac{W^*_t}{L^{fx}_t}\alpha^{*'}_s\right]\end{aligned} \tag{33}$$

Making use of $\frac{W^*}{L^{fx}} = \frac{1}{1-\alpha^*}$ and rewriting with elasticities, we get

$$\begin{aligned}\frac{dIL^{fx}_t}{L^{fx}_t} =& \frac{de_t}{e_{t-1}}\epsilon^{L,fx}_e + [di_t - di^*_t]\,\epsilon^L_i \\ & - \left[\frac{dp_t}{p_{t-1}} - \frac{dp^*_t}{p^*_{t-1}}\right]\left[\alpha^*\frac{L^{fx}_{t-1}}{L^{fx}_t}\right] \\ & + \frac{dg^*_t}{g^*_{t-1}}\left[(1-\alpha^*)\frac{w^*_{t-1}}{L^{fx}_t}\right] \\ & - dl_t\left[\frac{\alpha^{*'}_l}{1-\alpha^*}\right] - ds_t\left[\frac{\alpha^{*'}_s}{1-\alpha^*}\right]\end{aligned} \tag{34}$$

where

$$\epsilon^L_i = \frac{dIL^{fx}_t}{L^{fx}_t}\frac{1}{de_t} = -\frac{\alpha^{*'}_{uip}}{1-\alpha^*} \leq 0 \tag{35}$$

$$\epsilon^{L,fx}_e = \frac{dIL^{fx}_t}{L^{fx}_t}\frac{e_{t-1}}{de_t} = -\left[\frac{\alpha^{*'}_{uip}}{1-\alpha^*}\frac{e_{t-1}}{e_t}\frac{E(e_{t+1})}{e_t}\right] \approx -\left[\frac{\alpha^{*'}_{uip}}{1-\alpha^*}\right] \leq 0 \tag{36}$$

Under the approximation that the future exchange rate is expected to move the same way as the current exchange rate, i.e. $\frac{e_{t-1}}{e_t}\frac{E(e_{t+1})}{e_t} \approx 1$.

In contrast to when foreign liabilities are issued in domestic currency, this elasticity is unambiguously negative. There are two reasons for this. First, the effect of an exchange rate change on the future expected rate of appreciation now leads to a higher demand for Home's liabilities, while the opposite is the case when liabilities are issued in Home currency. Second, the valuation effect on Foreign's wealth of an exchange rate change is no longer active. If the *uip* is assumed to be irrelevant for the Foreign investor's decision to invest in foreign assets that are denominated Foreign's own currency, then the two elasticities are zero.

B.2 Foreign Asset Flows When Foreign Liabilities Are In Foreign Currency

The response of foreign assets to exchange rate changes will also change when foreign liabilities are issued in foreign currency, because the effect of the exchange rate on Home's wealth changes. Equations (13) and (14) thus remain unchanged but the expression for wealth becomes

$$W_t = (1 + \dot{p}_t + \dot{g}_t)\, w_{t-1} + e_{t-1}A_{t-1}\left(1 + \dot{p}_t{}^* + \dot{e}_t + i^*_{t-1}\right) - e_{t-1}L^{fx}_{t-1}\left(1 + \dot{p}_t + \dot{e}_t + i^*_{t-1}\right) \tag{37}$$

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

$$\begin{aligned} IA^{fx}_t e_t =& \left(1 - \alpha\left(uip_t, l^*_t, s_t\right)\right)\Big[w_{t-1}\left(1 + p_t + \dot{g}_t\right) + A_{t-1}e_{t-1}\left(1 + \dot{p}_t{}^* + \dot{e}_t + i^*_{t-1}\right) - L^{fx}_{t-1}e_{t-1}\left(1 + \dot{p}_t + \dot{e}_t + i^*_{t-1}\right)\Big] \\ &- A_{t-1}e_{t-1}\left(1 + \dot{p}_t{}^* + \dot{e}_t\right) \end{aligned} \tag{38}$$

Linearizing with respect to all arguments and drivers yields:

$$\begin{aligned} d\left(IA^{fx}_t\right)e_t =& \frac{de_t}{e_{t-1}}\left[-\alpha'_{uip}W_t\frac{1}{e_t}\frac{E(e_{t-1})}{e_t} - \alpha e_{t-1}\left(A_{t-1} - L^{fx}_{t-1}\right)\right] \\ &- \left[di_t - di^*_t\right]\left[\alpha'_{uip}W_t\right] \\ &+ \frac{dp_t}{p_{t-1}}\left[(1-\alpha)\left(w_{t-1} - e_{t-1}L^{fx}_{t-1}\right)\right] - \frac{dp^*_t}{p^*_{t-1}}\left[\alpha e_{t-1}A_{t-1}\right] \\ &+ \frac{dg_t}{g_{t-1}}\left[(1-\alpha)\, w_{t-1}\right] \\ &- dl\left[W_t\alpha'_l\right] - ds\left[W_t\alpha'_s\right] \end{aligned} \tag{39}$$

Divide equation (39) by $A_t e_t$ and make use of equation (**??**) to replace $w_{t-1} - e_{t-1}L^{fx}_{t-1}$ by $W_{t-1} - A_{t-1}e_{t-1}$. Additionally, make use of equation (2) and the fact that $A_t = \tilde{A}_t$ in equilibrium such that $\frac{W_t}{e_t A_t} = \frac{1}{1-\alpha}$. Rearrange terms and simplify and rewrite in terms of elasticities to get

$$\begin{aligned}\frac{d\left(IA_t^{fx}\right)}{A_t} &= \frac{de_t}{e_{t-1}}\epsilon_e^{A,fx} - [di_t - di_t^*]\,\epsilon_i^A \\ &+ \left[\frac{dp_t}{p_{t-1}} - \frac{dp_t^*}{p_{t-1}^*}\right]\left[\alpha\frac{A_{t-1}}{A_t}\frac{e_{t-1}}{e_t}\right] \\ &+ \frac{dg_t}{g_{t-1}}\left[(1-\alpha)\frac{w_{t-1}}{A_t e_t}\right] \\ &- dl\left[\frac{\alpha_l'}{1-\alpha}\right] - ds\left[\frac{\alpha_s'}{1-\alpha}\right]\end{aligned} \tag{40}$$

where we define the elasticity of gross foreign asset flows with respect to the exchange rate:

$$\epsilon_e^{A,fx} = -\left[\frac{\alpha_{uip}'}{1-\alpha}\frac{e_{t-1}}{e_t}\frac{E(e_{t-1})}{e_t} + \alpha\frac{A_{t-1} - L_{t-1}^{fx}}{A_{t-1}}\frac{e_{t-1}A_{t-1}}{e_t A_t}\right] \approx -\left[\frac{\alpha_{uip}'}{1-\alpha} + \alpha\frac{A_{t-1} - L_{t-1}^{fx}}{A_{t-1}}\right] \tag{41}$$

Under similar approximations as used above, the expression for the exchange rate elasticity of foreign asset flows. The sign of the exchange rate elasticity of gross foreign asset flows is now ambiguous. The effect of changes in *uip* remain the same, but now the effect of the exchange rate on Home's wealth depends on Home's net exposure to foreign currency in its total portfolio. If the value of foreign assets outstrip the value of foreign liabilities, the wealth effect of an appreciation of foreign currency is positive, while the opposite is the case if the value of foreign liabilities outstrip the value of foreign assets.

B.3 EMP with foreign liabilities in foreign currency

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

$$dFXI_t = NX_{e,t}' + \left(L_t^{fx}\frac{dIL_t^{fx}}{L_t^{fx}} - A_t\frac{dIA_t^{fx}}{A_t}\right) \tag{42}$$

Insert equations (34) and (40), and define π_i and π_e as follows:

$$\pi_e = \left[NX_{e,t}' + L_t^{fx}\epsilon_e^{L,fx} - A_t\epsilon_e^{A,fx}\right] \tag{43}$$

$$\pi_i = \left[L_t^{fx}\epsilon_i^L + A_t\epsilon_i^A\right] \tag{44}$$

Define the exchange market pressure index as follows:

$$
\begin{aligned}
EMP_t^{fx} \equiv & \frac{de_t}{e_{t-1}} + di_t \frac{\pi_i}{\pi_e} \frac{dFXI_t}{\pi_e} \\
= & \left[\frac{dp_t}{p_{t-1}} - \frac{dp_t^*}{p_{t-1}^*} \right] \frac{1}{\pi_e} \left[L_{t-1}^{fx} \alpha^* + \frac{e_{t-1}}{e_t} A_{t-1} \alpha \right] \\
& + \frac{dg_t}{g_{t-1}} \frac{1}{\pi_e} \left[(1-\alpha) \frac{w_{t-1}}{A_t e_t} \right] - \frac{dg_t^*}{g_{t-1}^*} \frac{1}{\pi_e} \left[(1-\alpha^*) \frac{w_{t-1}^*}{L_t^{fx}} \right] \\
& + dl \frac{1}{\pi_e} \left[L_t^{fx} \frac{\alpha_l^{*'}}{1-\alpha^*} \right] - dl^* \frac{1}{\pi_e} \left[A_t \frac{\alpha_l'}{1-\alpha} \right] \\
& + ds \frac{1}{\pi_e} \left[L_t^{fx} \frac{\alpha_s^{*'}}{1-\alpha^*} - A_t \frac{\alpha_s'}{1-\alpha} \right] + di_t^* \frac{\pi_i}{\pi_e}
\end{aligned}
\tag{45}
$$

C Data Sources, Definitions and Descriptive Statistics

16 Advanced economies	25 Emerging Markets
United States, Japan, Switzerland, United Kingdom, Denmark, Norway, Sweden, Canada, Euro area, Czech Republic, Israel, South Korea, Singapore, Hong Kong, Australia, New Zealand	South Africa, Benin, Bolivia, Botswana, Brazil, Chile, Colombia, Mexico, Peru, Uruguay Jordan, India, Malaysia, Thailand, Morocco, Tunisia, Armenia, Senegal, Russia, China, Ukraine, Hungary, Croatia, Poland, Romania

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 earliest, or until 2017m1 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 Armenia, Brazil and Ukraine, observations prior to 2001m1 for Hong Kong and India, and 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 Appendix **??**.	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 the US, euro area, Japan and UK	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 Bias 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.	Daily data from 2003 to 2020. Sourced from Chari and Lundblad (2020) and updated using Haver Analytics	
BEX	Time variation in risk appetite and uncertainty.	Monthly data from 1986 to 2021, sourced from Geert Bekaert and Xu (2021) and updated using Bloomberg.	
VSTOXX	Euro Stoxx Volatility Index	Daily data from 1999 to 2020, sourced from Chari and Lundblad (2020) and updated using Bloomberg.	

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

(a) Global Factors

	Mean	Max	Min	Std. Dev	Obs
di^*	-0.000	0.005	-0.015	0.002	262
di^*_{ssr}	-0.000	0.005	-0.015	0.002	262
$dlog(VIX)$	-0.001	1.079	-0.373	0.179	262
vshock	0.002	5.987	-3.716	0.996	228
di^*_{US}	-0.021	0.500	-1.500	0.211	262
$di^*_{ssr,US}$	-0.021	0.500	-1.500	0.211	262
di^*_{EU}	-0.022	0.500	-2.330	0.194	262
$di^*_{ssr,EU}$	-0.022	0.500	-2.330	0.194	262

(b) Safe Havens

	Mean	Max	Min	Std. Dev	Obs
EMP_{base}	-0.000	0.089	-0.079	0.018	1244
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	-0.003	0.035	-0.049	0.015	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

(c) Non-Safe Havens

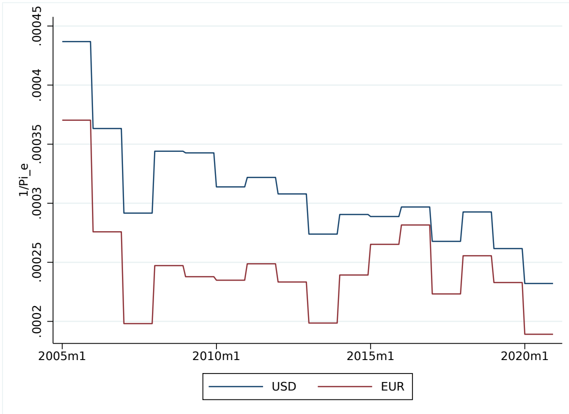
	Mean	Max	Min	Std. Dev	Obs
EMP_{base}	-0.001	0.100	-0.080	0.025	8588
de/e	0.001	0.541	-0.169	0.027	9070
FXI_{USD}	0.437	83.865	-129.204	5.215	8950
di	-0.000	0.340	-0.389	0.013	8933
A, billions USD	0.911	22.615	0.000	2.962	9048
L/e, billions USD	1.097	26.498	0.001	3.487	9072
α	0.861	1.000	0.371	0.147	9072
α^*	0.994	1.000	0.878	0.017	9072
Interest Diff	0.037	1.177	-0.050	0.058	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**

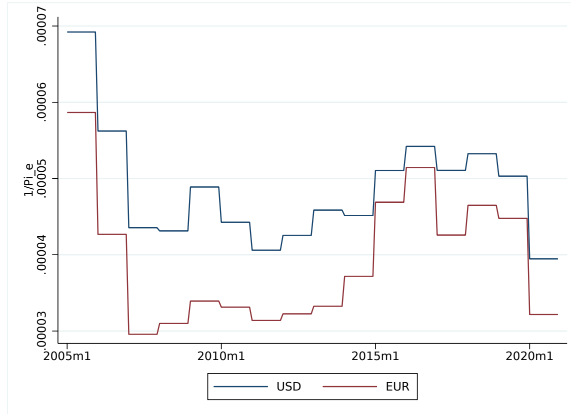
The data are in monthly frequency and span 2000m1 to 2020m12. Gross foreign positions are interpolated from quarterly and yearly frequency. GDP is interpolated from quarterly frequency.

C.1 Home α Computations

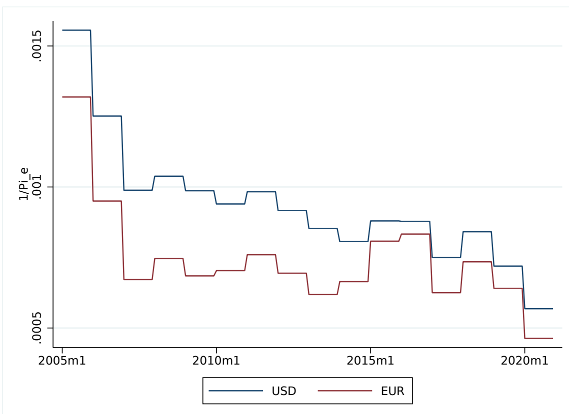
Home bias is calculated as each country's domestic assets a share of total (domestic+foreign) assets at time t. Following Coeurdacier and Rey (2012), we consider three asset categories: equity, debt, and bank loans. Domestic equity is calculated as the difference between domestic equity market capitalization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



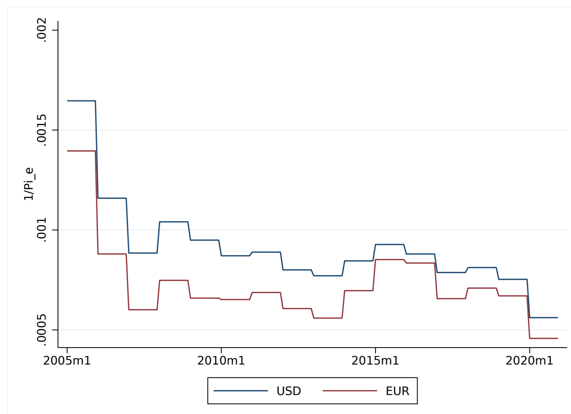
(a) Switzerland



(b) United Kingdom



(c) Denmark



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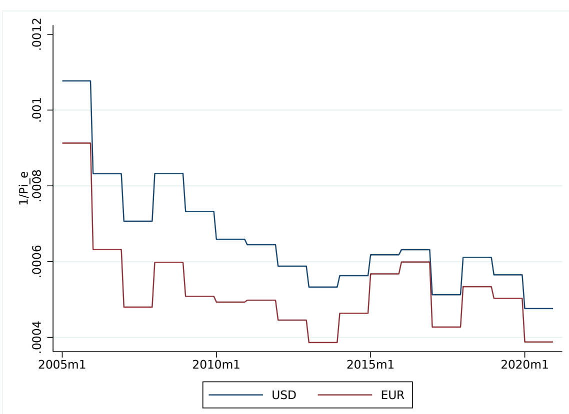
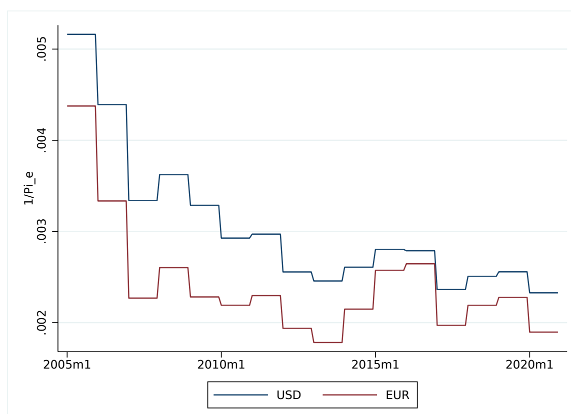


(e) Sweden



(f) Poland

Figure A1: $\frac{1}{Pi_e}$ **Comparison of Baselines 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.

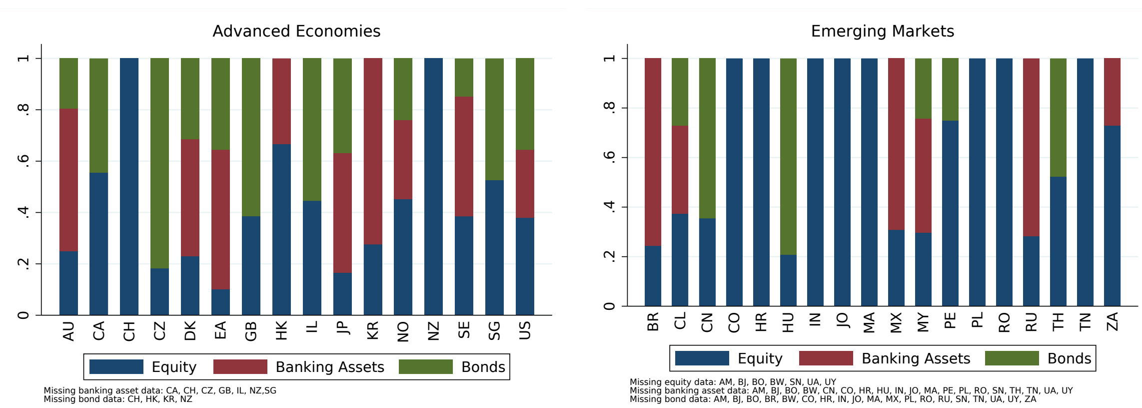


Figure A2: **Total Assets by Asset Category, 2019**

(a) Available Data on α and α^* Values by Country

Country	IFS	Alpha Values				Alpha Star Values			
		Bonds		Equity		Bonds		Equity	
		2007	2019	2007	2019	2007	2019	2007	2019
Armenia	911	.	.	.	.	.	.	.	.
Australia	193	0.841	0.781	0.784	0.620	0.991	0.990	0.994	0.994
Benin	638	.	.	.	.	.	.	.	.
Bolivia	218	.	.	.	.	.	.	.	.
Botswana	616	.	.	.	.	.	.	.	.
Brazil	223	0.986	.	0.993	0.955	0.998	.	0.993	0.995
Canada	156	0.872	0.823	0.744	0.541	0.993	0.988	0.992	0.992
Chile	228	0.785	0.831	0.744	0.556	0.999	0.999	0.999	0.999
China, People's Republic	924	0.864	0.981	0.995	0.951	0.999	0.994	0.992	0.987
Colombia	233	0.754	.	0.989	0.840	0.999	.	1.000	0.999
Croatia	960	.	.	0.965	0.925	.	.	1.000	1.000
Czech Republic	935	0.779	0.912	0.792	0.488	0.999	0.999	0.999	0.999
Denmark	128	0.791	0.708	0.538	0.370	0.996	0.997	0.998	0.997
Euro area	163	0.768	0.687	0.641	0.180	0.905	0.932	0.902	0.886
Hong Kong, PRC	532	.	.	0.811	0.791	.	.	0.992	0.993
Hungary	944	0.963	0.943	0.764	0.586	0.999	0.999	0.999	0.999
India	534	0.999	.	0.999	0.998	0.999	.	0.998	0.998
Israel	436	0.821	0.777	0.912	0.613	0.999	0.999	0.999	0.999
Japan	158	0.824	0.808	0.843	0.691	0.988	0.981	0.977	0.974
Jordan	439	.	.	0.997	0.991	.	.	0.999	1.000
Korea	542	.	.	0.884	0.739	.	.	0.994	0.993
Malaysia	548	0.983	0.932	0.953	0.805	0.999	0.999	0.998	0.999
Mexico	273	0.851	.	0.985	0.861	0.998	.	0.997	0.998
Morocco	686	.	.	.	0.982	.	.	.	1.000
New Zealand	196	.	.	0.489	0.450	.	.	0.999	0.999
Norway	142	0.285	0.267	0.472	0.158	0.997	0.997	0.997	0.998
Peru	293	0.929	0.997	0.824	0.661	0.999	0.999	0.999	0.999
Poland	964	.	.	0.936	0.821	.	.	0.999	0.999
Romania	968	.	.	0.968	0.918	.	.	1.000	1.000
Russia Federation	922	.	.	.	0.985	.	.	.	0.997
Senegal	722	.	.	.	.	.	.	.	.
Singapore	576	0.378	0.376	0.591	0.394	0.999	0.999	0.997	0.997
South Africa	199	0.941	.	0.904	0.841	0.999	.	0.998	0.998
Sweden	144	0.618	0.645	0.570	0.475	0.995	0.995	0.996	0.996
Switzerland	146	0.221	.	0.517	0.396	0.998	.	0.987	0.983
Thailand	578	0.939	0.928	0.977	0.923	0.999	0.999	0.999	0.998
Tunisia	744	.	.	.	0.992	.	.	.	1.000
Ukraine	926	.	.	.	.	.	.	.	.
United Kingdom	112	0.544	0.701	0.543	0.313	0.962	0.970	0.969	0.975
United States	111	0.904	0.878	0.760	0.722	0.832	0.805	0.909	0.805
Uruguay	298	.	.	.	.	.	.	.	.

Table A6: **Country α and α^* Values**

Country	IFS	α		α^*	
		2007	2019	2007	2019
Armenia$^\diamond$	911	0.957	0.950	0.998	0.998
Australia*	193	0.842	0.787	0.994	0.994
Benin$^\diamond$	638	0.957	0.950	0.998	0.998
Bolivia$^\diamond$	218	0.957	0.950	0.998	0.998
Botswana$^\diamond$	616	0.957	0.950	0.998	0.998
Brazil§	223	0.973	0.963	0.994	0.995
Canada†	156	0.789	0.666	0.992	0.992
Chile*	228	0.813	0.764	1.000	1.000
China	924	0.953	0.971	0.993	0.987
Colombia*	233	0.893	0.840	1.000	1.000
Croatia†	960	0.966	0.925	1.000	1.000
Czech Republic†	935	0.785	0.835	1.000	1.000
Denmark*	128	0.746	0.648	0.999	0.997
Euro area*	163	0.672	0.641	0.902	0.887
Hong Kong, PRC*	532	0.812	0.670	0.992	0.994
Hungary†	944	0.897	0.870	1.000	1.000
India*	534	1.000	0.999	0.998	0.998
Israel†	436	0.874	0.704	0.999	0.999
Japan*	158	0.814	0.774	0.977	0.974
Jordan‡	439	0.998	0.992	1.000	1.000
Korea§	542	0.935	0.881	0.994	0.994
Malaysia*	548	0.933	0.882	0.999	0.999
Mexico*	273	0.931	0.937	0.997	0.998
Morocco$^\diamond$	686	0.957	0.950	0.998	1.000
New Zealand‡	196	0.489	0.451	1.000	0.999
Norway*	142	0.574	0.376	0.998	0.999
Peru‡	293	0.824	0.662	1.000	1.000
Poland†	964	0.937	0.821	0.999	0.999
Romania‡	968	0.969	0.919	1.000	1.000
Russia Federation$^\diamond$	922	0.957	0.950	0.998	0.997
Senegal$^\diamond$	722	0.957	0.950	0.998	0.998
Singapore*	576	0.509	0.386	0.997	0.997
South Africa§	199	0.930	0.854	0.998	0.998
Sweden*	144	0.624	0.616	0.996	0.996
Switzerland‡	146	0.518	0.397	0.987	0.984
Thailand†	578	0.955	0.926	0.999	0.999
Tunisia$^\diamond$	744	0.957	0.950	0.998	1.000
Ukraine$^\diamond$	926	0.957	0.950	0.998	0.998
United Kingdom†	112	0.544	0.552	0.969	0.976
United States*	111	0.828	0.816	0.909	0.805
Uruguay$^\diamond$	298	0.957	0.950	0.998	0.998

Table A7: α **and** α^* **Used in Empirical Implementation, by Country, 2007 and 2019 values**

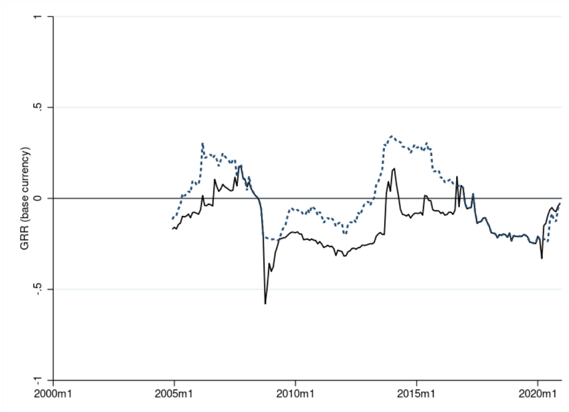
$\star$: α constructed across bonds, equities, and banking assets. $\dagger$: α constructed across bonds and equities. $\ddagger$: α constructed across equities only. $\S$: α constructed across equities and banking assets. $\diamond$: α and α^* constructed using the average across market type and time.

(a)

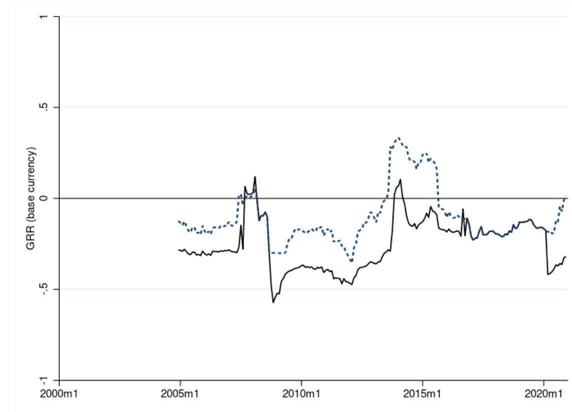
IFS	Country Name	GRR – All Periods	GRR – Excluding Extreme Risk-Off	Difference
111	United States	0.090***	–0.006	0.096***
112	United Kingdom	–0.157***	–0.147***	–0.010
128	Denmark	0.180***	0.079***	0.102***
142	Norway	–0.134***	–0.073***	–0.061***
144	Sweden	–0.097***	0.009	–0.105***
146	Switzerland	0.111***	0.164***	–0.053***
156	Canada	–0.179***	–0.092***	–0.087***
158	Japan	0.228***	0.310***	–0.082***
163	Euro area	–0.087***	0.009	–0.096***
193	Australia	–0.128***	–0.001	–0.126***
196	New Zealand	–0.114***	0.015	–0.129***
199	South Africa	–0.106***	–0.021*	–0.085***
218	Bolivia	–0.086***	0.006	–0.092***
223	Brazil	–0.253***	–0.105***	–0.148***
228	Chile	–0.088***	0.036***	–0.124***
233	Colombia	–0.102***	–0.045***	–0.057***
273	Mexico	–0.296***	–0.121***	–0.175***
293	Peru	–0.082***	0.080***	–0.162***
298	Uruguay	–0.195***	–0.086***	–0.109***
436	Israel	–0.195***	0.002	–0.197***
439	Jordan	0.009	–0.041	0.050***
532	Hong Kong, PRC	0.134***	0.209***	–0.074***
534	India	–0.183***	–0.105***	–0.077***
542	Korea	–0.238***	–0.136	–0.102***
548	Malaysia	–0.260***	–0.158***	–0.102***
576	Singapore	–0.168***	–0.016*	–0.152***
578	Thailand	–0.079***	0.060***	–0.139***
616	Botswana	–0.229***	–0.122***	–0.107***
638	Benin	–0.050***	–0.000	–0.050***
686	Morocco	–0.128***	–0.096***	–0.032*
722	Senegal	0.000	0.031	–0.031***
744	Tunisia	0.124***	0.138	–0.013
911	Armenia	–0.209***	–0.080	–0.129***
922	Russia Federation	–0.294***	–0.172	–0.122***
924	China, People's Republic	–0.241***	–0.125	–0.116***
926	Ukraine	–0.194***	0.062	–0.256***
935	Czech Republic	–0.121***	0.044*	–0.165***
944	Hungary	–0.148***	0.016***	–0.164***
960	Croatia	0.003	–0.025**	0.028*
964	Poland	–0.258***	–0.011	–0.248***
968	Romania	–0.079***	–0.113***	0.034*

Table A8: **Country-Specific Difference-in-Means Tests for GRR against each country's base currency.**

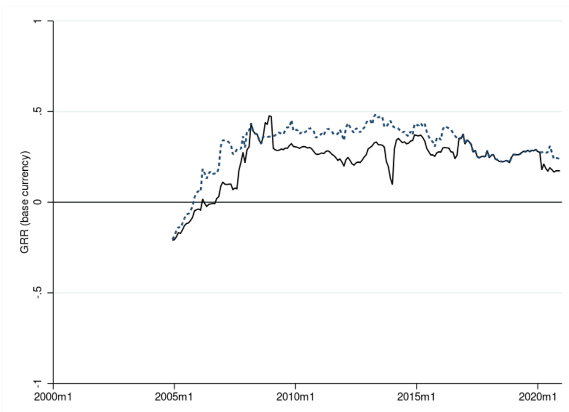
GRR is computed as -1 times the rolling correlation over 5 years between EMP against base currency and the VIX. In the excluding P90 analysis, the rolling correlation is calculated excluding months at or above the 90th percentile value of the VIX from 01/2000 to 12/2020. Significance tests whether the average is different from 0. Asterisks *, ** and *** indicate significance at the 10, 5 percent and 1 percent levels.



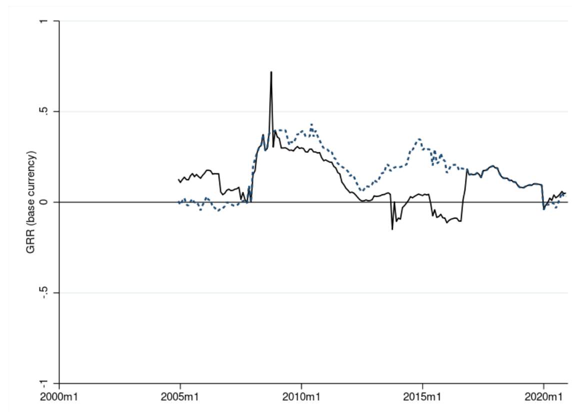
(a) Australia



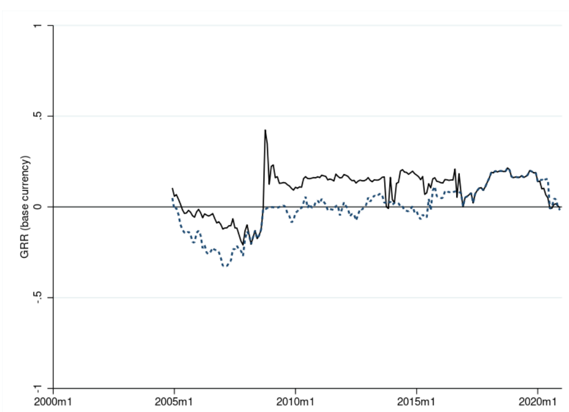
(b) Brazil



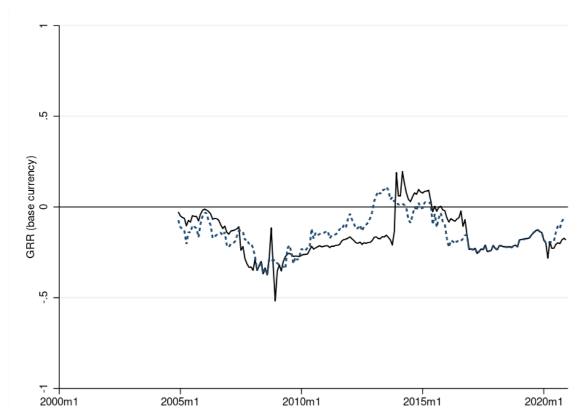
(c) Japan



(d) Switzerland



(e) United States



(f) United Kingdom

Figure A3: **Global Risk Response (*GRR*) Comparison**
GRR based on the *EMP* against the US dollar in panels (a) through (c) and against the Euro in panels (d) 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
$dVIX$	0.721*	0.174	2.898	1.185**	1.710	-2.100***	-3.170***	-2.026***	-1.807**	-1.529
	(0.316)	(0.473)	(2.130)	(0.420)	(1.516)	(0.262)	(0.555)	(0.512)	(0.692)	(0.794)
$dVIX * NFA/GDP_{t-1}$		-0.080			-0.238		-0.307			-0.544
		(0.123)			(0.791)		(0.271)			(0.304)
$dVIX * Infl_{t-1}$		7.349			2.883		-2.950			-6.652
		(11.340)			(21.827)		(4.931)			(4.571)
$dVIX * PubDebt/GDP_{t-1}$		0.006*			0.007***		0.021*			0.012
		(0.002)			(0.002)		(0.009)			(0.010)
$dVIX * ShareofWorldGDP_{t-1}$			5.507***		4.684***			-4.122		-6.492
			(1.049)		(1.396)			(8.571)		(8.544)
$dVIX * StockmarketCap/GDP_{t-1}$			-0.000		-0.000			-0.008		-0.010*
			(0.000)		(0.003)			(0.004)		(0.004)
$dVIX * Dom.Credit/GDP_{t-1}$			-0.015		-0.016			0.006		-0.001
			(0.012)		(0.009)			(0.008)		(0.006)
$dVIX * (GFA + GFL)/GDP_{t-1}$				-0.086*	0.187				0.131	0.300***
				(0.035)	(0.096)				(0.074)	(0.087)
$dVIX * ChinnIto_{t-1}$				0.000	0.000				-0.893	-1.149
				(.)	(.)				(0.850)	(0.674)
Constant	-0.452	-1.212	4.826	0.000	0.000	33.835***	22.696***	53.968***	76.101***	55.000***
	(3.033)	(3.747)	(19.915)	(.)	(.)	(4.657)	(6.205)	(10.742)	(15.011)	(13.487)
R2	0.013	0.004	0.007	0.009	0.005	0.029	0.115	0.039	0.059	0.137
No.Obs	1109	1095	1109	1109	1095	7777	6919	6964	6996	6790

Table A9: **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 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, Switzerland, and the United States. 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.

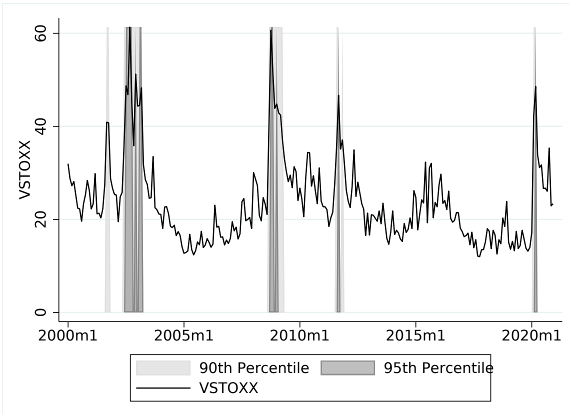
	$z^{EMP} * 1000$ – Safe Havens					$z^{EMP} * 1000$ – Non-Safe Havens				
	I	II	III	IV	V	VI	VII	VIII	IX	X
$dVIX$	0.374	0.300	1.659	0.594	-0.573	-1.226***	-1.294**	-1.406***	-1.112***	-0.940
	(0.244)	(0.460)	(1.513)	(0.357)	(1.726)	(0.148)	(0.495)	(0.350)	(0.311)	(0.893)
$dVIX * NFA/GDP_{t-1}$		-0.132			1.767*		-0.020			-0.067
		(0.146)			(0.723)		(0.142)			(0.198)
$dVIX * Infl_{t-1}$		15.043			29.742		-5.261			-7.047
		(14.266)			(23.547)		(4.654)			(6.254)
$dVIX * PubDebt/GDP_{t-1}$		0.000			-0.000		0.004			0.003
		(0.002)			(0.000)		(0.006)			(0.007)
$dVIX * ShareofWorldGDP_{t-1}$			3.429***		9.419***			5.537		7.079
			(0.871)		(1.932)			(3.792)		(4.363)
$dVIX * StockmarketCap/GDP_{t-1}$			0.000		-0.008*			0.001		0.000
			(0.000)		(0.003)			(0.002)		(0.002)
$dVIX * Dom.Credit/GDP_{t-1}$			-0.009		-0.001			0.000		-0.004
			(0.008)		(0.011)			(0.004)		(0.005)
$dVIX * (GFA + GFL)/GDP_{t-1}$				-0.037	0.171**				0.053	0.036
				(0.028)	(0.066)				(0.038)	(0.067)
$dVIX * ChinnIto_{t-1}$				0.000	0.000				-0.391	-0.149
				(.)	(.)				(0.528)	(0.511)
Constant	1.881	1.347	1.504	1.757	0.624	40.701***	43.425***	44.211***	43.488***	44.297***
	(4.083)	(4.550)	(4.320)	(4.047)	(4.762)	(5.002)	(5.219)	(5.320)	(5.223)	(5.317)
R2	0.040	0.063	0.074	0.048	0.125	0.093	0.100	0.096	0.097	0.102
No.Obs	121	121	121	121	121	823	736	726	737	711

Table A10: **Panel Regressions with Risk Sensitivity– Only High Stress and Excluding Fixed Effects**

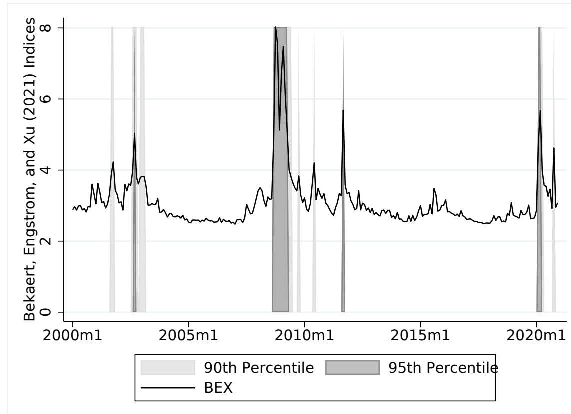
Results from monthly panel regressions of equations 25 and 26 from 2000m1 - 2020m12 for only months where the VIX is at or above its 90th percentile value of the period. z^{EMP}*1000 is the dependent variable, winsorized at the 1st and 99th percentile. Safe haven countries include Denmark, Hong Kong,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

D Robustness

D.1 Robustness to Alternative Risk Measures



(a) VSTOXX



(b) BEX

Figure A4: **High Risk Periods As Defined By Alternative Risk Measures**

The Euro Stoxx 50 Volatility Index (VSTOXX), sourced from Chari and Lundblad (2020), is in daily frequency and spans from 1999 to present day. End of period values were chosen to aggregate to the monthly level. BEX, a risk aversion index from Geert Bekaert and Xu (2021), is in monthly frequency and spans from 1986 to 2021. Highlighted periods represent intervals where the risk measure at or above the 90th percentile.

(a)

		90th Percentile	95th Percentile
Event Time	Event Name	BEX	
2002–2003		8/2002-12/2002 ; 1/2003-2/2003	9/2002
2020–2021	COVID-19	2/2020-4/2020 ; 10/2020	2/2020-3/2020
2008–2009	Great Financial Crisis	9/2008-5/2009 ; 10/2009	9/2008- 4/2009
2011	US Debt Ceiling & European Crisis	9/2011	9/2011
2001	9/11 Attacks	9/2001-10/2001	
2008–2009	Euro Area Crisis	6/2009	
2010	Euro Area Crisis	6/2010	

(b)

		90th Percentile	95th Percentile
Event Time	Event Name	VSTOXX	
2002–2003		7/2002-3/2003	7/2002-10/2002 ; 12/2002 ; 2/2003-3/2003
2020–2021	COVID-19	2/2020-3/2020	3/2020
2008–2009	Great Financial Crisis	9/200-4/2009	10/2008-11/2008 ; 1/2009
2011	US Debt Ceiling & European Crisis	8/2011-9/2011 ; 11/2011	9/2011
2001	9/11 Attacks	9/2001-10/2001	
2002–2003	Euro Area Crisis	6/2002	

Table A11: **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***

(b) VSTOXX: 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***

(c) VSTOXX: 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) RA 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***

(e) RA BEX: Pre-GFC

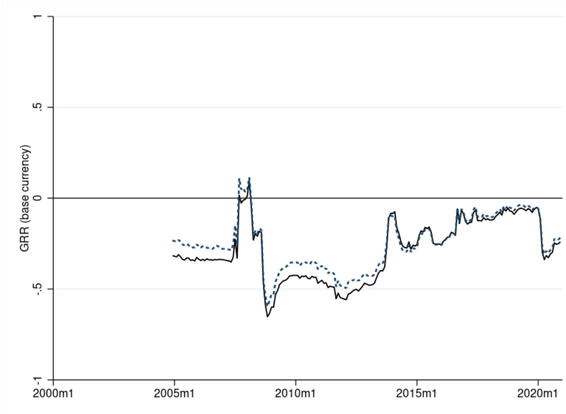
	All	Safe Haven	Excl. Safe Haven
GRR- AllPeriods	-0.087***	0.008	-0.097***
GRR- Excluding P90	-0.019***	-0.022	-0.018***
Difference	-0.068***	0.029	-0.079***

(f) RA BEX: Post-GFC

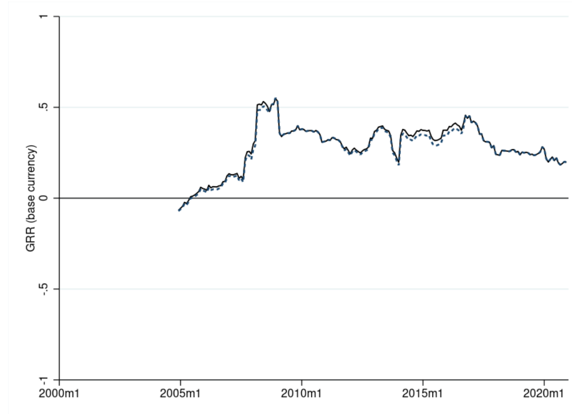
	All	Safe Haven	Excl. Safe Haven
GRR- AllPeriods	-0.122***	0.139***	-0.142***
GRR- Excluding P90	-0.061***	0.153***	-0.078***
Difference	-0.061***	-0.014	-0.065***

Table A12: **GRR Difference in Means Tests for GRR with Alternative Risk Indices**

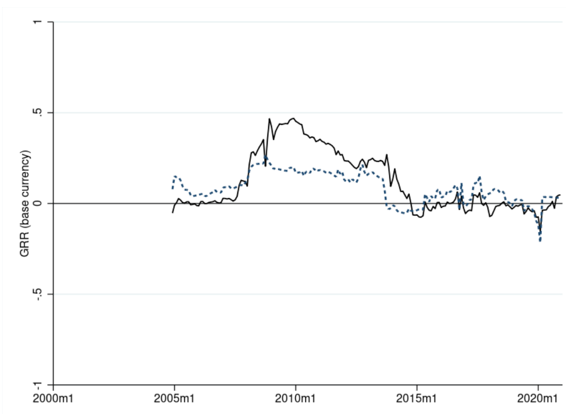
GRR is computed as -1 times the rolling correlation over 5 years between EMP against base currency and the alternative risk measure. In the excluding P90 analysis, the rolling correlation is calculated excluding months, between 01/2000 to 12/2020, that are at or above the 90th percentile value of the 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.



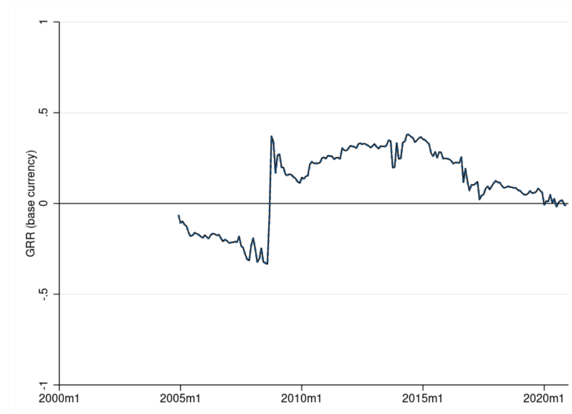
(a) Brazil



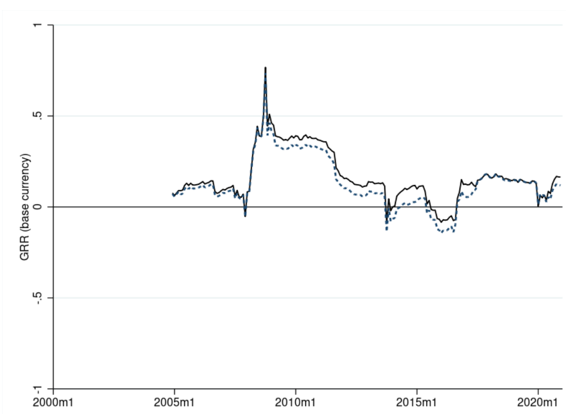
(b) Japan



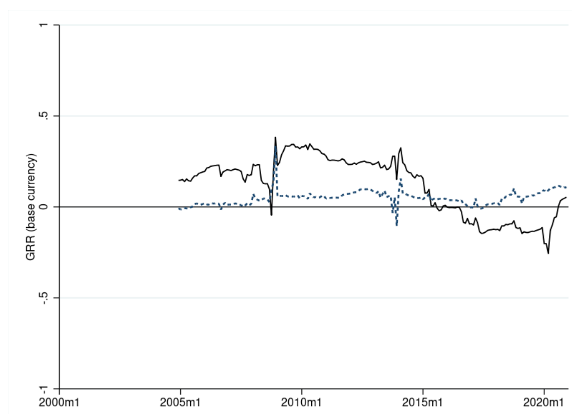
(c) Hong Kong



(d) United States

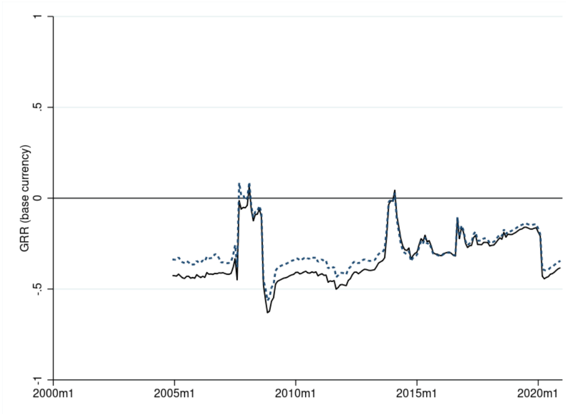


(e) Switzerland

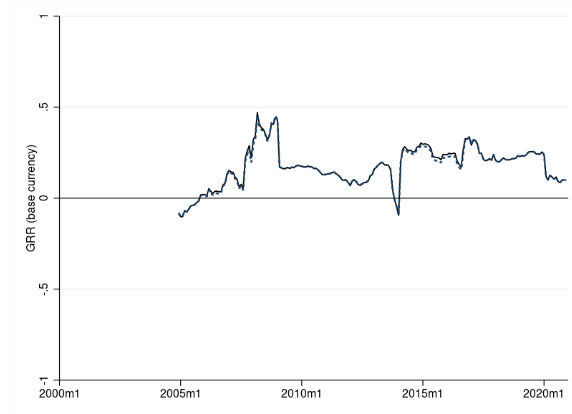


(f) Denmark

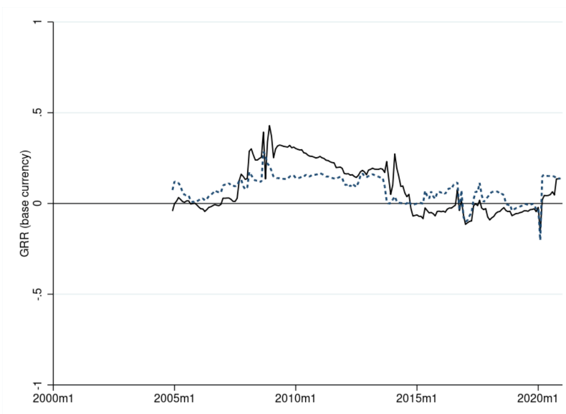
Figure A5: **GRR Time Series with VSTOXX Index**
GRR using the $VSTOXX$ as the risk sentiment proxy and based on the EMP against the US dollar in panels (a) through (c) and against the euro in panels (d) through (f). The solid line displays GRR computed the EMP. The dashed line displays the GRR computed using realized depreciation rate.



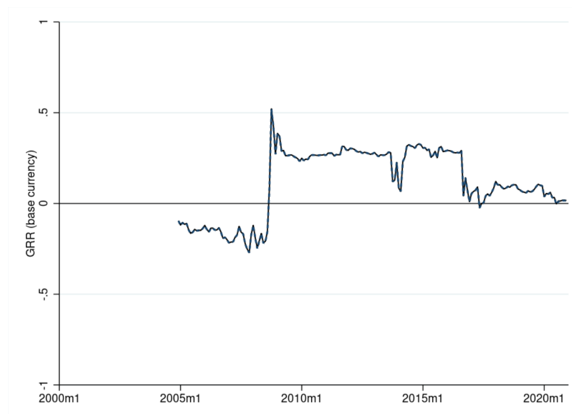
(a) Brazil



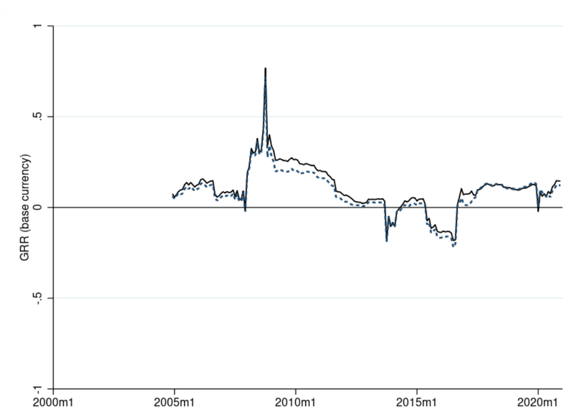
(b) Japan



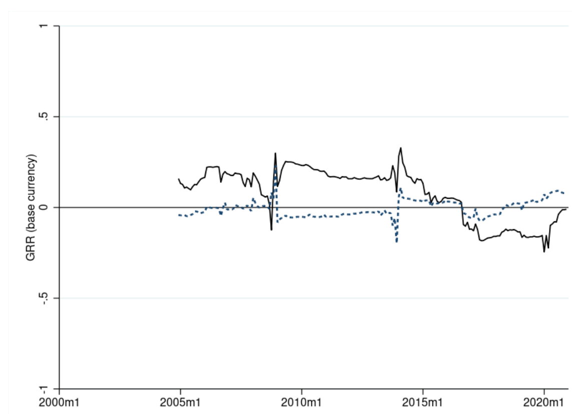
(c) Hong Kong



(d) United States

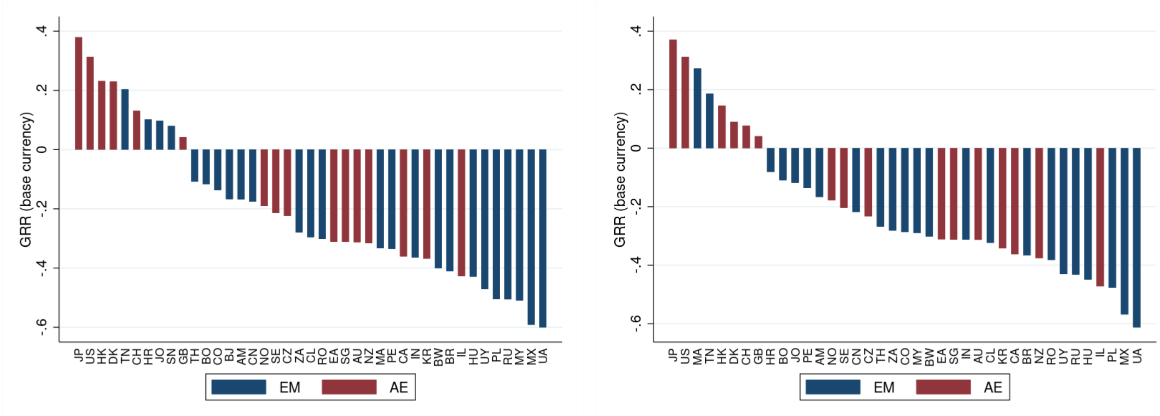


(e) Switzerland



(f) Denmark

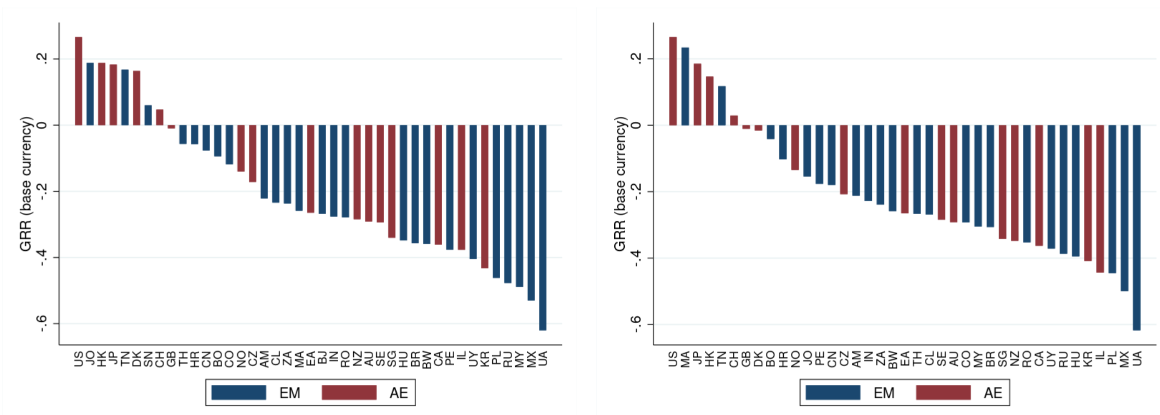
Figure A6: **GRR Time Series with BEX**
GRR using the BEX as the risk sentiment proxy and based on the EMP against the US dollar in panels (a) through (c) and against the euro in panels (d) through (f). The solid line displays GRR computed the EMP. The dashed line displays the GRR computed using realized depreciation rate.



(a) EMP

(b) de/e

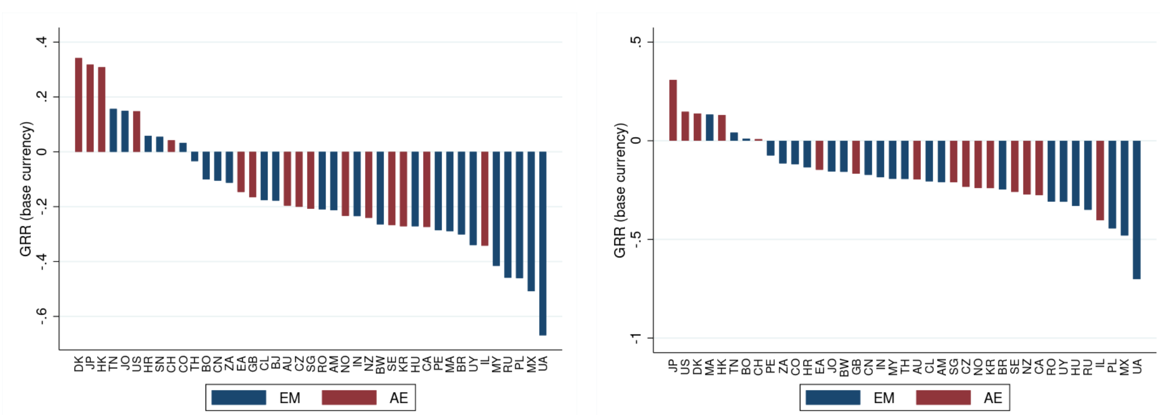
Figure A7: **GRR calculated with the VSTOXX Index, June 2013**



(a) EMP

(b) de/e

Figure A8: **GRR calculated with the BEX, June 2013**



(a) EMP

(b) de/e

Figure A9: **GRR calculated with the VIX Index and Shadow Rates, June 2013**

	$z^e * 1000$					$z^{EMP} * 1000$				
	I	II	III	IV	V	VI	VII	VIII	IX	X
$dVSTOXX$	-0.879***	-1.411***	-1.352***	-1.282*	-1.623**	-1.095***	-1.730***	-2.018**	-1.352*	-2.078***
	(0.187)	(0.338)	(0.374)	(0.527)	(0.468)	(0.253)	(0.360)	(0.725)	(0.544)	(0.483)
$dVSTOXX * NFA/GDP_{t-1}$		0.171			-0.270		0.148			-0.457
		(0.201)			(0.291)		(0.238)			(0.394)
$dVSTOXX * Infl_{t-1}$		-1.399			-0.120		1.626			3.715
		(5.334)			(4.731)		(6.472)			(5.655)
$dVSTOXX * PubDebt/GDP_{t-1}$		0.009*			0.005		0.010*			0.006
		(0.004)			(0.004)		(0.004)			(0.005)
$dVSTOXX * ShareofWorldGDP_{t-1}$			4.481		5.706*			4.058		5.725*
			(2.605)		(2.314)			(2.572)		(2.328)
$dVSTOXX * StockmarketCap/GDP_{t-1}$			-0.000		-0.001			-0.000		-0.001
			(0.001)		(0.002)			(0.001)		(0.002)
$dVSTOXX * Dom.Credit/GDP_{t-1}$			0.005		-0.001			0.010		0.001
			(0.004)		(0.005)			(0.007)		(0.005)
$dVSTOXX * (GFA + GFL)/GDP_{t-1}$				0.113*	0.216*				0.149*	0.256*
				(0.054)	(0.087)				(0.066)	(0.101)
$dVSTOXX * ChinnIto_{t-1}$				0.191	0.065				-0.154	-0.097
				(0.658)	(0.543)				(0.737)	(0.634)
Adj. R2	0.010	0.170	0.013	0.063	0.202	0.001	0.124	0.001	0.004	0.153
No.Obs	10116	8797	9186	9217	8640	9966	8726	9054	9105	8571

Table A13: **Panel Regressions with VSTOXX Sensitivity**

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 $dVSTOXX$ 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
$dVSTOXX$	0.526	0.310	0.951	0.744*	-0.396	-1.327***	-2.057***	-1.684*	-1.149*	-1.208*
	(0.243)	(0.384)	(1.492)	(0.260)	(1.239)	(0.264)	(0.524)	(0.812)	(0.528)	(0.585)
$dVSTOXX * NFA/GDP_{t-1}$		-0.102			0.395		-0.196			-0.565
		(0.122)			(0.640)		(0.300)			(0.333)
$dVSTOXX * Infl_{t-1}$		5.994			14.562		4.228			3.458
		(5.161)			(14.675)		(5.912)			(5.293)
$dVSTOXX * PubDebt/GDP_{t-1}$		0.003			0.006		0.011			0.004
		(0.003)			(0.003)		(0.009)			(0.009)
$dVSTOXX * ShareofWorldGDP_{t-1}$			1.746		5.105*			-1.500		-3.770
			(1.958)		(1.818)			(7.112)		(8.862)
$dVSTOXX * StockmarketCap/GDP_{t-1}$			-0.000		-0.004			-0.007		-0.009*
			(0.001)		(0.002)			(0.004)		(0.004)
$dVSTOXX * Dom.Credit/GDP_{t-1}$			-0.003		-0.005			0.010		0.001
			(0.010)		(0.007)			(0.009)		(0.006)
$dVSTOXX * (GFA + GFL)/GDP_{t-1}$				-0.041	0.296				0.137	0.302***
				(0.028)	(0.122)				(0.077)	(0.068)
$dVSTOXX * ChinnIto_{t-1}$				0.000	0.000				-0.735	-0.684
				(.)	(.)				(0.743)	(0.554)
Adj. R2	0.015	0.038	0.026	0.020	0.048	0.001	0.136	0.001	0.004	0.165
No.Obs	1240	1195	1240	1240	1195	8726	7531	7814	7865	7376

Table A14: **Panel Regressions with VSTOXX Sensitivity– 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 $dVSTOXX$ 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.

	$z^e * 1000$					$z^{EMP} * 1000$				
	I	II	III	IV	V	VI	VII	VIII	IX	X
$dBEX$	-11.387***	-14.704**	-17.423***	-15.695**	-16.008*	-14.098***	-17.789***	-25.855**	-18.003**	-21.758**
	(2.285)	(4.536)	(4.107)	(5.732)	(5.958)	(2.856)	(4.664)	(7.244)	(5.908)	(6.317)
$dBEX * NFA/GDP_{t-1}$		1.277			-3.403		1.537			-3.544
		(2.562)			(3.106)		(2.760)			(3.596)
$dBEX * Infl_{t-1}$		-72.279			-56.365		-63.861			-32.476
		(57.341)			(57.668)		(63.086)			(59.815)
$dBEX * PubDebt/GDP_{t-1}$		0.093			0.046		0.108*			0.054
		(0.048)			(0.042)		(0.051)			(0.042)
$dBEX * ShareofWorldGDP_{t-1}$			99.648**		108.771**			93.924**		107.739**
			(35.752)		(33.881)			(32.309)		(31.955)
$dBEX * StockmarketCap/GDP_{t-1}$			0.001		-0.004			-0.001		-0.004
			(0.010)		(0.017)			(0.009)		(0.017)
$dBEX * Dom.Credit/GDP_{t-1}$			0.047		-0.029			0.111		0.004
			(0.052)		(0.057)			(0.072)		(0.056)
$dBEX * (GFA + GFL)/GDP_{t-1}$				1.265	2.236*				1.608	2.255*
				(0.709)	(0.928)				(0.799)	(0.965)
$dBEX * ChinnIto_{t-1}$				2.012	0.306				0.070	-0.443
				(7.426)	(6.422)				(8.194)	(7.091)
Adj. R2	0.014	0.182	0.018	0.067	0.215	0.001	0.134	0.001	0.004	0.164
No.Obs	10116	8797	9186	9217	8640	9966	8726	9054	9105	8571

Table A15: **Panel Regressions with BEX Sensitivity**

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 $dBEX$ 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
$dBEX$	5.704	7.898	6.540	9.499	-8.357	-16.909***	-24.537***	-22.224*	-15.892**	-18.811*
	(4.469)	(7.905)	(15.487)	(7.594)	(16.108)	(2.903)	(6.134)	(8.453)	(5.741)	(9.135)
$dBEX * NFA/GDP_{t-1}$		-2.957			1.296		-1.790			-2.732
		(2.768)			(4.198)		(3.029)			(3.636)
$dBEX * Infl_{t-1}$		66.362			52.043		-20.642			-18.128
		(71.913)			(113.124)		(57.432)			(55.652)
$dBEX * PubDebt/GDP_{t-1}$		-0.007			-0.002		0.167			0.142
		(0.040)			(0.013)		(0.092)			(0.098)
$dBEX * ShareofWorldGDP_{t-1}$			79.192**		117.607***			30.274		10.340
			(11.963)		(11.581)			(77.058)		(86.738)
$dBEX * StockmarketCap/GDP_{t-1}$			-0.000		-0.031			-0.076		-0.100*
			(0.003)		(0.019)			(0.047)		(0.045)
$dBEX * Dom.Credit/GDP_{t-1}$			-0.035		-0.013			0.124		0.026
			(0.088)		(0.087)			(0.099)		(0.069)
$dBEX * (GFA + GFL)/GDP_{t-1}$				-0.691	2.852*				1.497	1.931
				(0.652)	(0.876)				(1.079)	(1.089)
$dBEX * ChinnIto_{t-1}$				0.000	0.000				-6.326	-4.942
				(.)	(.)				(8.069)	(7.030)
Adj. R2	0.016	0.042	0.050	0.023	0.072	0.002	0.147	0.001	0.004	0.176
No.Obs	1240	1195	1240	1240	1195	8726	7531	7814	7865	7376

Table A16: **Panel Regressions with BEX Sensitivity– 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 $dBEX$ 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.

D.2 Robustness to Using Krippner Shadow Rates

(a) Krippner Shadow Rates: Full Sample

	All	Safe Haven	Excl. Safe Haven
GRR- AllPeriods	-0.105***	0.112***	-0.124***
GRR- Excluding P90	-0.015***	0.122***	-0.027***
Difference	-0.090***	-0.011	-0.097***

(b) Krippner Shadow Rates: Pre-GFC

	All	Safe Haven	Excl. Safe Haven
GRR- AllPeriods	-0.087***	0.020	-0.098***
GRR- Excluding P90	-0.031***	-0.012	-0.032***
Difference	-0.056***	0.033	-0.066***

(c) Krippner Shadow Rates: Post-GFC

	All	Safe Haven	Excl. Safe Haven
GRR- AllPeriods	-0.080***	0.155***	-0.099***
GRR- Excluding P90	-0.031***	0.187***	-0.048***
Difference	-0.049***	-0.031***	-0.051***

Table A17: **Difference in Means Tests for GRR with VIX and Shadow Rates**
GRR is computed as -1 times the 5 year rolling correlation between the EMP against base currency and the VIX where the Krippner shadow rates impact the *di* term in the EMP. In the excluding P90 analysis, the rolling correlation is calculated excluding months, within 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.

	$z^e * 1000$					$z^{EMP} * 1000$				
	I	II	III	IV	V	VI	VII	VIII	IX	X
$dVIX$	-1.600***	-2.100***	-2.332***	-2.158***	-2.651***	-2.076***	-2.999***	-3.850**	-2.351**	-4.656**
	(0.232)	(0.411)	(0.431)	(0.545)	(0.631)	(0.458)	(0.718)	(1.394)	(0.734)	(1.474)
$dVIX * NFA/GDP_{t-1}$		0.189			-0.289		-0.271			-1.933
		(0.238)			(0.289)		(0.697)			(1.541)
$dVIX * Infl_{t-1}$		-5.220			-2.735		-7.773			-0.199
		(4.816)			(5.026)		(12.661)			(9.355)
$dVIX * PubDebt/GDP_{t-1}$		0.011*			0.007		0.021			0.020
		(0.004)			(0.004)		(0.011)			(0.012)
$dVIX * ShareofWorldGDP_{t-1}$			8.720**		7.958*			6.866		0.765
			(3.109)		(3.031)			(3.590)		(7.321)
$dVIX * StockmarketCap/GDP_{t-1}$			0.000		0.000			-0.000		0.004
			(0.001)		(0.001)			(0.001)		(0.004)
$dVIX * Dom.Credit/GDP_{t-1}$			0.005		-0.001			0.018		0.008
			(0.005)		(0.005)			(0.012)		(0.008)
$dVIX * (GFA + GFL)/GDP_{t-1}$				0.117*	0.161				0.178*	0.320
				(0.049)	(0.085)				(0.071)	(0.218)
$dVIX * ChinnIto_{t-1}$				0.410	0.402				-0.216	-0.205
				(0.690)	(0.603)				(0.928)	(0.936)
Adj. R2	0.019	0.215	0.023	0.072	0.240	0.002	0.010	0.002	0.005	0.011
No.Obs	10192	9144	9254	9273	8987	10030	9039	9114	9155	8884

Table A18: **Panel Regressions with Risk Sensitivity Using Krippner Shadow Rates**

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 $dVIX$ 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
$dVIX$	0.227	-0.203	1.240	0.679	-0.111	-2.422***	-4.842**	-3.571*	-2.093**	-5.994
	(0.348)	(0.581)	(1.366)	(0.523)	(0.941)	(0.497)	(1.701)	(1.604)	(0.710)	(3.072)
$dVIX * NFA/GDP_{t-1}$		-0.195			0.647		-1.464			-1.745
		(0.190)			(0.685)		(1.302)			(1.366)
$dVIX * Infl_{t-1}$		24.232			27.840		-1.237			3.500
		(14.675)			(22.307)		(10.148)			(7.881)
$dVIX * PubDebt/GDP_{t-1}$		0.003			0.003		0.048			0.046
		(0.003)			(0.002)		(0.031)			(0.031)
$dVIX * ShareofWorldGDP_{t-1}$			6.218**		8.453*			2.183		-1.560
			(1.030)		(2.290)			(7.176)		(10.983)
$dVIX * StockmarketCap/GDP_{t-1}$			-0.000		-0.004			-0.004		-0.002
			(0.000)		(0.003)			(0.005)		(0.007)
$dVIX * Dom.Credit/GDP_{t-1}$			-0.008		-0.008			0.017		0.013
			(0.008)		(0.008)			(0.015)		(0.013)
$dVIX * (GFA + GFL)/GDP_{t-1}$				-0.078	0.194				0.150	0.099
				(0.040)	(0.116)				(0.077)	(0.176)
$dVIX * ChinnIto_{t-1}$				0.000	0.000				-0.971	0.154
				(.)	(.)				(0.939)	(1.097)
Adj. R2	0.010	0.047	0.031	0.025	0.093	0.002	0.011	0.002	0.005	0.011
No.Obs	1248	1234	1248	1248	1234	8782	7805	7866	7907	7650

Table A19: **Panel Regressions with Risk Sensitivity Using Krippner Shadow Rates– 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 $dVIX$ 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.