NBER WORKING PAPER SERIES

INTERNATIONAL CAPITAL FLOW PRESSURES

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Working Paper 24286
http://www.nber.org/papers/w24286

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
February 2018

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, the IMF, its Executive Management, its Board or the National Bureau of Economic Research. The authors would like to thank Gustavo Adler, Joshua Aizenman, Mahir Binici, Stijn Claessens, Giovanni Dell'Ariccia, Joseph Gagnon, Olivier Jeanne, Martin Kaufmann, Robin Koepke, Maury Obstfeld, Jonathan Ostry, Sunil Sharma, Cédric Tille, Ted Truman, Jeromin Zettelmeyer and participants at research seminars at the IMF Research Department, the ECB, Danmarks Nationalbank, the Peterson Institute and the Graduate Institute in Geneva for insightful comments and suggestions. Jacob Conway, Wenjie Li, Susannah Scanlan, Akhtar Shah, and Elaine Yao provided research assistance.

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NBER Working Paper No. 24286
February 2018
JEL No. F32,G11,G20

ABSTRACT

This paper presents a new measure of capital flow pressures in the form of a recast Exchange Market Pressure index. The measure captures pressures that materialize in actual international capital flows as well as pressures that result in exchange rate adjustments. The formulation is theory-based, relying on balance of payments equilibrium conditions and international asset portfolio considerations. Based on the modified exchange market pressure index, the paper also proposes the Global Risk Response Index, which reflects the country-specific sensitivity of capital flow pressures to measures of global risk aversion. For a large sample of countries over time, we demonstrate time variation in the effects of global risk on exchange market pressures, the evolving importance of the global factor across types of countries, and the changing risk-on or risk-off status of currencies.

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1 Introduction

International capital flows are demonstrated as consistently important for economic outcomes and driven by global factors (Milesi-Ferretti and Tille [2011], Forbes and Warnock [2012], Fratzscher [2012], Rey [2015a], Avdjiev, Gambacorta, Goldberg, and Schiaffi [2017]). Global risk aversion tends to drive capital flows into emerging market countries when global risk perceptions are low, and out again when global risk perceptions increase. Advanced economy monetary policies matter too, as illustrated by the sharp swing in emerging market capital flows following the Federal Reserve's tapering talk in 2013 (Shaghil, Coulibaly, and Zlate [2015], Ghosh, Qureshi, Kim, and Zalduendo [2014], Aizenman, Binici, and Hutchison [2014a], Eichengreen and Gupta [2014] and Mishra, Moriyama, N'Diaye, and Nguyen [2014]). In advanced economies, global risk aversion is linked to capital flows and appreciation pressures on so-called safe haven countries (Ranaldo and Soederlind [2010], Botman, Filho, and Lam [2013], de Carvalho Filho [2013] and Bundesbank [2014]). The approach of the literature on international capital flows characterizes global risk sensitivity based on the relationship between data on capital flows and measures of global risk aversion. These two phenomena, safe haven flows to advanced economies and risk-on risk-off capital flows to emerging markets, are intimately connected. While generalizations often are made with respect to the particular status of specific countries or groups of countries, we will argue that these are not necessarily valid, and certainly are not intrinsic country features. We will also argue that neither capital flow data nor exchange rate data, as commonly used in these types of analyses, can adequately represent market pressures or capture the strength of the global factor in a cross-country setting.

Capital flows respond differently to global risk factors depending on whether a country's monetary authorities intervene in foreign exchange markets to influence the local currency exchange rate, or whether capital flow pressures result in changes in the exchange rate or interest rate sufficient to discourage capital flow pressures from being realized in actual flows. In fully floating exchange rate regimes, capital flow pressures would materialize in exchange rate adjustments while in fixed exchange rate regimes, the price adjustment is prevented, and a capital flow is fully realized in response to the same pressure. Recent event studies of international monetary spillovers underscore the importance of this point, with full international capital flow pressures reflected in actual flows, as well as in exchange rate or interest rate changes (Chari, Stedman, and Lundblad [2017]). These shortcomings make realized international flow quantities an imprecise measure of the capital flow pressures that arise in response to risk and other factors. In addition to this shortcoming, realized capital flow data are often imprecisely measured, incomplete, and often only available consistently across countries in quarterly frequency. As risk-off episodes are often shorter, they may not be observable in quarterly data. Moreover, data on capital flows based on balance of payments statistics are often only available with a lag.

Some of the shortcomings of capital flow data also have an analogue in asset price data, which are used in the typical approach in the safe haven literature for measuring sensitivity to global risk factors. Studies typically assess the degree to which a currency experiences appreciation pressure or exhibits excess returns when global risk sentiment increases (Ranaldo and Soederlind [2010], Habib and Stracca [2012], Fatum and Yamamoto [2014] and Bundesbank [2014]).[1] Measures based purely on observed currency movements, however, also do not take into account that some countries may respond to currency pressures by intervening in the foreign exchange market or changing the policy rate, thereby moderating or preventing the signal value of exchange rate movements.

In this paper, we propose a metric that combines price and quantity information, within an updated exchange market pressure index (EMP) building on early contributions (Girton and Roper [1977], Eichengreen, Rose, and Wyplosz [1994] and Kaminsky and Reinhart [1999]). The EMP we propose is an alternative gauge of net capital flow pressures, which takes into account outright capital flows through foreign exchange reserves as well as exchange rate and interest rate changes for use in time series and cross-country analyses. It relies on data which is available in monthly frequency and is more up-to-date than outright capital flows. We depart from the earlier literature on exchange market pressure indices, which has operated with a number of ad hoc assumptions about how the components of the index should be weighted against each other. Instead, our construct is grounded in international asset market equilibrium conditions, investor gross international asset and liability positions, and alternative exchange rate regimes that shift the balance of price and quantity reaction to international capital flow pressures. The resulting EMP is less likely to be biased, is available at monthly frequency, and with conceptual underpinnings constructed specifically to capture capital flow pressures. We provide a simple theoretical construct which maps pressures arising from a range of domestic and foreign drivers, directly linking our measure to the active literature on the importance of the global financial cycle and the role of exchange rate regimes in policy autonomy (Miranda-Agrippino and Rey [2015]; Cerutti, Claessens, and Rose [2017]). We also show conceptually the effects on this index of valuation changes due to the (externally unobservable) multi-currency portfolio composition of central bank foreign exchange reserve holdings.

The EMP measures capital flow pressures in units of exchange rate depreciation equivalents, with an increase denoting a capital outflow pressure. For analytical purposes, it is like a "super-exchange rate" index that directly accounts for central bank interventions in the foreign exchange market by converting the intervention to a hypothetical exchange rate response calibrated to

[1] 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.

country-specific asset market conditions.

We demonstrate the index's usefulness in characterizing patterns in capital flow pressures with specific applications, first for the debate over global financial cycles, and second for assessing country specific responses to global risk conditions over time. We construct a baseline EMP measure for 1995 through 2017, creating monthly series for 44 countries.

Cerutti, Claessens, and Rose [2017] argue that the "global financial cycle" in international net capital flows is quantitatively less important than argued in, for example, Rey [2015a]. Yet, exchange rate flexibility mitigates some observed capital flows, reinforcing the importance of also capturing exchange rate changes. Using the EMP, we show the period by period global factor over time, also testing for differences between so-called safe haven currencies and emerging markets. We demonstrate that the importance of the common global factor changes significantly over time, consistent with recent evidence in Avdjiev, Gambacorta, Goldberg, and Schiaffi [2017]. The findings underline the importance of separating extreme events from normal times, reinforcing the message of Forbes and Warnock [2012] of looking carefully at the players which serve as sources of pressures, and whether stress episodes are stops, flights, surges, or retrenchments. In general, idiosyncratic country factors drive international capital flow pressures with a common global financial factor appearing to be quite variable in importance across time.

Using the EMP, we propose a new measure, the Global Risk response (GRR) index, to empirically categorize the link between global risk factors and changes in international capital flow pressures by country. The index is constructed as the correlation between monthly observations of a measure of global risk sentiment and monthly observations of the EMP. Using the VIX as a sample measure of global risk appetite, we demonstrate that the GRR is useful for sorting countries according to whether their exchange market pressures exhibit risk-on behavior (i.e. inflows pressures when risk appetite is high), or risk-off behavior (so-called safe haven type inflows when risk appetite is low). The GRR shows that the status of currencies evolves over time. While currency status has some persistence, the label of "safe haven" for currencies and for countries clearly is not stagnant. We show that emerging market currencies occasionally behave as risk-off currencies, while advanced country currencies occasionally or persistently have risk-on status.

The paper is structured as follows. In Section 2, we discuss the exchange market pressure indices used in the previous literature and detail a number of concerns with such measures. Section 3 presents our theoretical framework for deriving an alternative exchange market pressure index that is closely tied to capital flow pressures, and which addresses some concerns around the construction of previous measures. In Section 4, we discuss the empirical implementation of the EMP, including the consequences of various weighting and scaling choices. Section 5 compares the EMP relative to realized net capital flows in a sample of 44 countries, providing perspective on the strengths and limitations of alternative metrics for empirical analyses. Evidence is presented on the size and importance of the global factor for so-called safe haven currencies, other advanced economy currencies, and emerging market currencies. The Global Risk Response index is presented in Section 6, which also discusses the stability and persistence of currency risk-on and risk-off status. The final section discusses the implications of our findings and concludes. The appendix contains additional analysis, information and charts.

2 Previous Exchange Market Pressure Indices

The variants of the exchange market pressure index used in prior literature take the form of a weighted index of changes in the exchange rate, changes in official foreign exchange reserves and changes in policy interest rates along the following lines:

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

where the index pertains to a particular country (country subscripts not included here), $\left(\frac{\Delta e_t}{e_t}\right)$ is the relative change in an exchange rate defined as domestic currency per unit of foreign currency at t over a Δt interval, ΔR_t is the change in the central bank's foreign exchange reserves, and S_t is a scaling variable for the reserve changes. Monetary policy actions of a country are captured by Δi_t representing the change in policy interest rate. w_k are the weights at which components $k = (e, R, i)$ enter the index. The literature uses the weighting choices to filter out noisy signals from exchange rates and official reserve changes. Scaling factor choices reflect views of the relative magnitude or importance of official foreign exchange purchases or sales. The weights, scaling factors, and the specific definition of the exchange rate (e.g. bilateral against the dollar, or multilateral) used for producing the EMP vary across studies (Table 1). This variation reflects the desire to have a practical basic measure, but also reflects the weak theoretical underpinning and lack of consensus on the logic of the construction.

First, the choice of scaling of changes in reserves is not neutral, as it affects the amplitude of the variation in reserves changes. Girton and Roper [1977] and Weymark [1995] present monetary models and suggest that changes in reserves should be scaled by the monetary base. However, those derivations are based on unsupported assumptions about international financial markets, including perfect capital mobility and perfect substitutability across assets of different countries.[2] Other researchers have used the level of reserves for scaling (Kaminsky and Reinhart [1999]) or a narrow monetary aggregate (Eichengreen et al. [1994]) in order to provide perspective on the relative magnitude of reserve losses in a crisis event. These choices are also problematic. Scaling

[2]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 USD
Eichengreen, Rose, Wyplosz [1994][c]	$w_e \frac{de}{e} + w_i d(i - i^*) - w_R \frac{(dR - dR^*)}{M1}$	Precision	Nominal bilateral against DM / USD
Weymark [1995]	$\frac{de}{e} + w_R \frac{dR}{M}$	Model based price and interest elasticities	Nominal bilateral against USD
Sachs, Tornell, Velasco [1996]	$w_e \frac{de}{e} - w_R \frac{(dR - dR^*)}{R}$	Precision	Nominal bilateral against USD
Kaminsky and Reinhart [1999]	$w_e \frac{de}{e} + w_R \frac{dR}{R}$	Precision	Real effective
Aizenman, Lee, 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 USD
Aizenman, Chinn, Ito [2015]	$w_e \frac{de}{e} + w_i d(i - i^*) - w_R \frac{(dR - dR^*)}{R}$	Precision	Nominal bilateral against base currency
Patnaik, Felman, Shah [2017]	$\frac{de}{e} - w_R \frac{dR}{M0}$	Empirical estimates of exchange rate elasticity to interventions	Not disclosed
Goldberg and Krogstrup [2017][e]	$\frac{de}{e} - \frac{1}{\Pi_{e,t}} dR_t + \frac{\Pi_{i,t}}{\Pi_{e,t}} di$	Model based weight	Nominal bilateral against base currency

[a] e is the exchange rate, R is central bank foreign currency reserves measured in USD, 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 et al. [1996] apply bilateral rate against USD.

[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. Base currency as in Klein and Shambaugh [2008].

Table 1: **Exchange Market Pressure Indices**

by the initial level of reserves (effectively using relative changes in 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. Neither approach to scaling provides a meaningful or relevant concept of equivalence between the currency depreciation and reserve losses components to justify an adding up of prices and quantities within the EMP.

Second, approaches to weighting the different components of the index likewise vary in relevance and conceptual underpinnings. Girton and Roper [1977] and Weymark [1998] do not take into account the size and structure of foreign exchange markets and external balance positions. The derivation based on the monetary approach in Weymark [1995] has stronger underpinnings and suggests that the change in reserves should be weighted by the elasticities of money demand to interest rates and prices to exchange rate, as these are the main channels of balance of payments adjustment in such models. While Weymark [1995] applies such weights empirically, most other studies remain "agnostic" as to whether such elasticities can be appropriately estimated or make sense, and instead employ precision weights.

Precision weights are constructed by weighting the components of the index by the inverse of their sample variance. This approach ensures that the variation in all the elements of the EMP contribute equally, and hence, that none of the components dominate the index.[3] However, these weighting schemes do not account for the information inherent in the central bank's exchange rate policy regime about the relative role of the components, as noted in 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 under such regimes. Tanner [2002] and Brooks and Cahill [2016] apply equal weights to exchange rate and official reserves, weighting movements in official reserves substantially even for countries with fully floating exchange rates. In this latter case, observed official reserve movements are unlikely to reflect interventions and are more likely due to portfolio valuation effects. Patnaik et al. [2017] propose weights based on the sensitivity of the exchange rate to changes in reserves, but without a firm conceptual underpinning.

Third, the prior constructions ignore exchange rate-induced valuation changes in central bank reserve portfolios that can bias the index. In practice, central bank reserve portfolios are comprised of a basket of currencies, instead of exclusively being invested in one currency with US dollars, on average, representing 60 to 65 percent of total foreign reserve portfolios (Goldberg, Hull, and Stein [2013], Eichengreen, Chiandtcedilu, and Mehl [2016]).[4] The value of reserves reported in USD equivalents fluctuates with the exchange rate vis-à-vis the currencies in which the reserves are held, without reflecting foreign exchange interventions or international capital flow pressures. Such valuation effects can impart a bias or imprecision in the exchange market pressures associated with capital flows.[5] The potential for bias and imprecision of the EMP due to valuation effects is increased by precision weights, which raise the relative weight of reserve

[3]Eichengreen, Rose, and Wyplosz [1994] offers a thorough discussion of the advantages and drawbacks of using this weighting scheme.

[4]Data on the full currency breakdown of central bank foreign currency reserves is not readily available in cross country comparable data sources. The IMF's COFER database keeps data for individual countries strictly confidential, providing a breakdown across advanced economies and emerging and developing countries.

[5]For example, when reserves are measured in local currency equivalents, increases in the value of the local currency against the foreign currency result in a fall in the domestic currency value of reserves, all else equal. In the absence of adjusting for valuation effects, this fall will incorrectly be interpreted as an indication of capital outflows.

changes exactly in flexible rate countries.[6]

Fourth, as is clear from Table (1), the literature has used different definitions of the exchange rate. The choice of currency is important because the exchange rate component of the EMP index is not an absolute measure of pressure, but rather is relative to the currency against which the exchange rate is defined. Suppose the exchange rate of a country is defined as the bilateral rate against the USD, and suppose that the USD is appreciating against both the local currency and against the euro during a specific risk-off episode. Even if that country is also experiencing increased net capital inflows and local currency appreciation against the euro, the EMP construction registers a currency depreciation and increased exchange market pressure in dollar terms. No exchange rate definition perfectly solves this problem, given the relative nature of exchange rates. Our preferred approach is to choose an exchange rate definition that most closely matches the main monetary base currency of a country. The main monetary base currency is defined as the foreign currency against which a country manages its exchange rate, or if a country's currency is floating, the main foreign currency that matters for monetary and financial conditions of a country, as defined in Klein and Shambaugh [2008]. The currency denomination of official reserves changes used in the EMP needs to be matched to the selection of base currency.

Finally, previous EMPs differ in the components included. Most include the change in the exchange rate and the change in reserves, excluding policy rate changes.[7] The exclusion of interest rate changes can be a practical consideration associated with a lack of consistent data over time or across countries on the relevant policy rate. Indeed, the problem of identifying the right policy rate is compounded since the global financial crisis, when some countries arrived at the zero lower bound and many countries changed the tools used for monetary policy, such as shifting to quantitative easing and forward guidance. Conceptually, the broader issue is about where the metric draws the line on which policy interventions to directly embed as capital controls and macroprudential instruments might likewise be considered.

In the next section, we provide a conceptual framework that directly links international capital flow pressures to exchange market pressures. We show that the appropriate scaling of reserves relies on the sensitivities of gross foreign asset positions and interest on foreign liabilities to expected rates of return and risk preference shocks. Logically, there is an equivalence between

[6] A broader conceptual issue concerns how well the change in foreign exchange reserves captures foreign exchange market pressures at any given time (Neely [2000]). Around the global financial crisis, some countries hoarded foreign exchange reserves to secure perceived insurance against future potential disruptions in access to international capital markets (Aizenman, Cheung, and Ito [2014b]). Reserve management strategies might likewise be used to absorb commodity terms of trade shocks (Aizenman, Edwards, and Riera-Crichton [2012]) or be held for mercantilistic motives (Dooley, Folkerts-Landau, and Garber [2004], Bonatti and Fracasso [2013]). If reserves are persistently accumulated over time, a level shift in the reserve accumulations should not necessarily lead to a higher variance of these changes.

[7] Recent analyses focusing only on exchange rates as in the safe haven literature can be viewed as a special case of the EMP for freely floating currencies.

the amount of exchange rate depreciation and the amount of official reserve sales that are needed for offsetting exogenous quantities of private capital flow pressures. A balance of payments equilibrium condition along with foreign asset and foreign liability demand equations underpin this equivalence.

3 Modelling Exchange Market Pressures

The theoretical foundation takes an international financial flow perspective and is based on an international portfolio balance approach, following the long tradition of Girton and Henderson [1976], Henderson and Rogoff [1982], Branson and Henderson [1985], Kouri [1981], Blanchard et al. [2005] and Caballero, Farhi, and Gourinchas [2016]. Any given excess supply or demand for a currency can be offset by an equivalent amount of foreign exchange intervention quantity, by an endogenous exchange rate movement, or by a change in the domestic policy rate sufficient to generate a private balance of payments flow. The equivalence factors across these components derive from the balance of payments identity and international asset demand functions with imperfect asset substitutability. The equivalencies depend on elasticities of response of foreign assets and foreign liabilities to exchange and interest rate changes, stocks of outstanding foreign asset and liability positions, and ex ante initial terms of financing on such positions. The combination of exchange rate changes and reserves (or other measures) in response to observed pressures depend on the exchange rate regime in place.

In this section, we set out the main building blocks of the model, which describes the external financial position of an open economy.[8] For any country, Home, the balance of payments identity captures flows of financing vis-à-vis the rest of the world, Foreign, over a unit measure of time t, which we consider as short, e.g. one month. The balance of payments, denominated in foreign currency equivalents, is given by

$$(EX_t - IM_t) + \left(i_t^* FA_{t-1} - i_t \frac{FL_{t-1}}{e_t} \right) + \left(\frac{dFL_t}{e_t} - dFA_t \right) = dR_t \tag{2}$$

where the first term in parentheses is the trade balance comprised of foreign currency denominated nominal value of exports EX_t less imports IM_t. The second term in parentheses contains the net foreign investment income received by Home residents on their gross nominal holdings of foreign assets denominated in foreign currency ($i_t^* FA_{t-1}$), less the returns paid out to Foreign residents on nominal holdings of Home assets denominated in domestic currency, ($i_t FL_{t-1}$), converted to

[8] We derive the EMP in the case where reserves are denominated only in one foreign currency and measured in equivalents of this foreign currency (in which case, there are no valuation fluctuations in reserves). Since observed changes in central bank reserves will often include fluctuations due to valuation as well as due to outright interventions, and because outright valuation adjustment of reserves is not possible when the currency composition of reserves is not observed, we suggest proximate adjustments in Appendix C.

foreign currency equivalents. The exchange rate e between the Home and Foreign currencies is defined in units of Home currency per one unit of Foreign currency. The third term in parentheses is net capital inflow denominated in foreign currency equivalents, represented by the difference between the valuation adjusted change in residents' gross foreign liabilities (foreigners' claims on domestic residents) and the change in residents' holdings of gross foreign assets. The balance of payments flows on the left hand side are zero under a fully flexible exchange rate regime, or are offset by changes in official foreign exchange reserve balances dR_t in international monetary regimes wherein some official foreign exchange market intervention activity occurs.

Gross foreign assets and liabilities positions are functions of domestic and foreign nominal financial wealth, W_t and W_t^*, with the portfolio-equilibrium conditions respectively:

$$FA_t = \frac{W_t}{e_t} \cdot \left[1 - \alpha(i_t - i_t^* - \frac{E(e) - e_t}{e_t}, s_t)\right] \tag{3}$$

$$FL_t = e_t \cdot W_t^* \cdot \left[1 - \alpha^*(-i_t + i_t^* + \frac{E(e) - e_t}{e_t}, s_t^*)\right] \tag{4}$$

where for the purpose of the derivation, W_t and W_t^* are both denominated in their respective local currencies and $i_t - i_t^* - \frac{E(e)-e_t}{e_t} \equiv uip_t$ is the deviation from uncovered interest rate parity from the point of view of Home.[9] The α and α^* functions capture the shares of residents' portfolios that are invested in domestic assets (also referred to as the degree of home bias) and depend, first, on the expected relative risk-adjusted return on foreign versus domestic assets as captured by deviations from uip, and, second, on a risk or investment sentiment measure pertinent to each country's investment decisions. s_t and s_t^* capture factors that are independent of relative expected returns, such as local and foreign risk sentiment, and can differ both in size and sign. Respective asset demand functions α and α^* are positive, with signs of the first derivatives $\alpha'_{uip}, \alpha^{*'}_{uip^*}, \alpha'_s, \alpha^{*'}_{s^*} > 0$.[10]

[9] In practice, foreign assets need not be denominated entirely in foreign currency, nor foreign liabilities in domestic. Moreover, resident wealth is not the same as national wealth. The important assumption is that due to portfolio effects, a deterioration in a country's net international investment position is associated with currency depreciation pressure.

[10] From the perspective of Home balance of payments, $1 - \alpha^*$ is the share of Foreign wealth investment in Home assets. α^* is more appropriately described as the share of Foreign wealth in rest of world investments. The difference in level between α and α^* conditional on the arguments reflects the differences in size of domestic and foreign financial asset markets.

Totally differentiating (3) and (4), substituting (2), and rearranging terms yields:

$$\frac{de_t}{e_t}\Pi_{e,t} - dR_t - di_t\Pi_{i,t} \tag{5}$$

$$= -\Pi_{i^*,t}di_t^* - \frac{FL'_{s^*}}{e_t}ds_t^* + FA'_s ds_t - \frac{FL'_w}{e_t}dW_t^* + FA'_w dW_t$$

where

$$\begin{aligned}
\Pi_{e,t} &= \frac{FL_{t-1}}{e_t}i_t + \epsilon_e^{FL}\frac{FL_t}{e_t} - \epsilon_e^{FA}FA_t \\
\Pi_{i^*,t} &= \frac{1}{i_t^*}\left[FA_{t-1}(i_t^* - \epsilon_{i^*}^{FL}) + \epsilon_{i^*}^{FA}\frac{FL_t}{e_t}\right] \\
\Pi_{i,t} &= \frac{1}{i_t}\left[\frac{FL_t}{e_t}[i_t - \epsilon_i^{FL}] + \epsilon_i^{FA}FA_t\right]
\end{aligned} \tag{6}$$

The terms on the right hand side of equation (5) reflect exogenous drivers of international financial flows vis-à-vis the Home country, while the left hand side terms are Home policy measures that might offset pressure from imbalances in the demand and supply for Home currency.[11] The parameters in front of the exogenous drivers reflect the channels through which capital flow pressures are realized and adjusted. For example, when there is a shift in home risk sentiment, the degree of foreign asset sensitivity FA'_s (which maps to $\alpha'_s > 0$) is the key parameter of interest capturing wealth retrenchment back Home. An exogenous increase in Home wealth is an adverse shock to the Home balance of payments, while increased Foreign wealth raises foreigners' demand for Home assets as captured by foreign liability growth in Home. Higher foreign interest rates make Home assets relatively less attractive, while raising Home demand for foreign assets. The magnitude of the resulting net effect is the collection of effects in $\Pi_{i^*,t}$ where we define elasticities of foreign asset demand and foreign liability supply with respect to exchange rates as $\epsilon_e^{FL},\ -\epsilon_e^{FA} > 0$, and with respect to foreign rates $\epsilon_{i^*}^{FL}, -\epsilon_{i^*}^{FL} < 0$, with details in Appendix B.

Further arranging terms, we express the combination of policy adjustments on the left hand side in units of currency depreciation, thus deriving our EMP metric (7) and its drivers (7):

[11] For analytical convenience, and because our interest is in short term capital account pressures on the balance of payments, we assume that net exports are stable in the short term with international prices and aggregate demand conditions exogenously determined. This assumption can be easily relaxed, and our derivations of exchange rate channels for a short term balance of payments adjustment modified accordingly to reflect short term trade balance elasticities and invoice currency use that relates to rates of exchange rate pass through into traded goods prices.

$$EMP_t = \frac{de_t}{e_t} - \frac{1}{\Pi_{e,t}} dR_t - \frac{\Pi_{i,t}}{\Pi_{e,t}} di_t \tag{7}$$

$$= -di_t^* \frac{\Pi_{i^*,t}}{\Pi_{e,t}} - \frac{\frac{1}{e_t} FL'_{s^*}}{\Pi_{e,t}} ds_t^* + \frac{FA'_s}{\Pi_{e,t}} ds_t - \frac{\frac{1}{e_t} FL'_W}{\Pi_{e,t}} dW^* + \frac{FA'_W}{\Pi_{e,t}} dW$$

This measure of exchange market pressures, with its derived weighting structure across quantities of reserves and prices of currency and assets, is both highly intuitive and directly maps to the broader literature on global financial cycles. For any quantity of international capital flows, the equivalency of Home currency depreciation and changes in central bank foreign reserves depends on the full set of mechanisms through which exchange rate changes influence international capital cycles. As shown within $\Pi_{e,t}$, given an expected future exchange rate, a depreciation of the Home currency lowers its expected future rate of depreciation and thereby lowers the relative return expected on foreign currency investments. A smaller Home exchange rate depreciation is needed to offset capital outflows if investments by home and foreign investors are highly sensitive to uncovered interest parity conditions. An exchange rate depreciation also operates on the balance of payments by reducing the value of payments on foreign liabilities made by Home (assumed for this derivation that the liabilities are denominated in Home currency). Overall, the larger is $\Pi_{e,t}$, the smaller is the exchange rate equivalent of any foreign exchange market pressure that otherwise would need to be reflected in a loss of official foreign reserves or tightening in domestic policy rates.

Excluded from this main EMP formulation are adjustments for the changes in official reserves from exchange rate movements. In practice, central banks hold official foreign exchange reserve portfolios comprised of multiple currencies. As data on reserves is available only in USD or domestic currency equivalents, this value of foreign exchange reserves changes due to valuation changes of third country currencies j vis-à-vis the foreign main anchor currency or domestic currency, without arising from official intervention activity dR_t by Home. As we observe $\hat{R}_t$, the value of the total stock of central bank reserves in US dollar equivalents:

$$\hat{R}_t = R_t + \frac{R_t^j}{e_t^j} \tag{8}$$

where R_t^j are reserves held in assets denominated in third country currency, for example, euros, for a country with the dollar playing the role of main anchor currency. We refer to the main foreign currency of a country as the base currency in the following, to allow for a broader concept that also includes main foreign currencies of floating exchange rates. The base currency is hence distinct from, put can include, outright monetary anchor currencies for pegs.

Observed changes in reserves, $d\hat{R}_t$, can be due to official acquisitions of reserves, dR_t, or to changes in the exchange rate vis-à-vis third currencies, $-\frac{R_t^j}{e_t^j}\frac{de_t^j}{e_t^j}$. As valuation changes would not reflect capital flow pressures and would hence cause erroneous signals in the EMP, we would ideally want to valuation adjust the EMP to reduce the associated bias. Suppose the general portfolio composition guidance of the central bank is for ρ_t share of the portfolio to be held in non-base currencies. Setting

$$\frac{R_t^j}{e_t^j} = \rho_t \hat{R}_t + \nu_t \tag{9}$$

We derive the EMP component of interest, dR_t, as $dR_t = d\hat{R}_t + \rho_{t-1}\hat{R}_{t-1} \cdot \frac{de_t^j}{e_t^j}$, assuming $dR_t^j = 0$ and $\nu_t \frac{de_t^j}{e_t^j} = 0$.

$$EMP_t = \frac{de_t}{e_t} - \frac{1}{\Pi_{e,t}} d\hat{R}_t - \frac{1}{\Pi_{e,t}} \rho_{t-1}\hat{R}_{t-1} \cdot \frac{de_t^j}{e_t^j} - \frac{\Pi_{i,t}}{\Pi_{e,t}} di_t \tag{10}$$

where the valuation effect from third party exchange rate movements is included and then converted into units of base currency change equivalents. In practice, ρ is not known to researchers as very few central banks provide full information on the composition of their portfolios. According to COFER data, available at a quarterly frequency, the dollar asset share of portfolios is 67.7 percent for developed economies (64.4 for advanced), with the euro share at 18.3 percent (21.6). For every billion dollars of reserves, a 1 percent euro-dollar appreciation inflates $d\hat{R}_t$ by \$2 million, using an EMP measured against the dollar as base currency.

4 Empirical Implementation

Constructing the EMP empirically requires a number of choices regarding the data and size of parameters. Key decision points include which components to include in the index; the type of exchange rate to use as a baseline; and the exchange rate elasticities of foreign assets and liabilities needed for interaction with gross foreign investments positions in the construction of the scaling factor $\Pi_{e,t}$. Our baseline choices are intensionally simplifying with the purpose of illustrating the EMP empirically for a broad set of countries over time. This set of choices produces what we refer to as the baseline EMP, which we compare with alternative EMP construction assumptions in Section 4.4 and the appendix. We compute the EMP for 44 advanced and emerging market countries for years 1995–2017 using monthly data. Our approach is intended to illustrate the performance of this measure of international capital flow pressures, while also identifying key areas where further improvements might be fruitful.

The EMP of equation (10) consists of three components: the rate of exchange rate depreciation over the time interval, the change in official foreign reserves, and the change in the short-term or policy interest rate. The literature is divided on whether policy interventions (beyond official reserves changes) are a pressure measure or a driver of international capital flows. To facilitate computing the the EMP for a broad sample of countries, our baseline EMP takes the latter approach as a simplification, moving the interest rate term to the right side, treating it as a capital flow driver.[12]

4.1 Exchange Rate Measure

The baseline EMP is constructed using the bilateral exchange rate vis-à-vis the main monetary base currency of the country.[13] We use the Klein and Shambaugh [2008] (henceforth KS) classification, which is available quarterly until the first quarter of 2014 with values extrapolated to 2017. For the US and the euro area, which do not have KS base currencies, we use the euro and the USD respectively. In practice, most countries in the sample have the USD as base currency, with the exceptions of a number of European non-euro countries, which have the euro as main base currency (and the Deutsche mark before the euro), Singapore, which has the Malaysian baht as base currency, and New Zealand which has the Australian dollar as base currency.[14]

4.2 Scaling of Reserves

Empirical measures of the scaling factor $\Pi_{e,t}$ require estimates of the elasticities ϵ_e^{FA} and ϵ_e^{FL} and information on gross assets and liabilities. Because of the difficulty identifying causality from exchange rate movements to portfolio shares, the existing literature tends to use data on specific types of flows, typically portfolio equity flows at a fund level, which allows for more granularity and higher frequency and thus an assessment of the relative timing of exchange rate and capital flow changes. This literature generally finds that foreign shares in investors' portfolios respond significantly negatively to an appreciation shock to the exchange rate of the foreign currency (e.g. Hau and Rey [2004], Hau and Rey [2006], Curcuru, Thomas, Warnock, and Wongswan [2014])).

[12] The policy rate clearly responds to and serves as a measure of pressures in some countries, notably small open economies with fixed exchange rate regimes. Future refinements of the empirical EMP could consider how to include the interest rate differential, see also Klaassen and Jager [2011]. It is not straightforward to identify the right policy interest rate for a broad set of countries, however, particularly for the period during which a number of advanced countries were at the zero lower bound and implementing unconventional monetary policy measures. Moreover, additional elasticities are needed for computing time-varying $\Pi_{i,t}$ and $\Pi_{i^*,t}$.

[13] An alternative would be to use the effective exchange rate. An effective exchange rate would not allow us to convert reserves to effective exchange rate units, however.

[14] As an alternative to the baseline using the KS base currency, we compute an EMP based on the USD for all countries for comparison, see Figure (2). Results are sensitive to this choice for non-USD monetary base currencies.

To our knowledge, estimates of the responsiveness of countries' aggregate gross foreign asset and liabilities positions to changes in returns, including exchange rates, are not available.[15]

Lacking empirical guidance on the size of the portfolio rebalancing responses of international investment positions to exchange rate changes, we construct our baseline EMP based on elasticities ϵ_e^{FA} and ϵ_e^{FL} of 0.05 that we estimate from simple panel regressions of foreign investment positions for the sample countries that we explore (details provided in Appendix D). We make this choice in order to illustrate the functioning of our EMP for a broad set of countries. Even though the elasticities are assumed constant, the resulting scaling factor $\Pi_{i,e}$ varies over time and countries with the size of gross investment positions, consistently with theory. However, the approach to assessing the elasticities warrants more research and refinement in future applications. For application to specific countries, the elasticity estimates could be refined based on country specific data. Appendix (D) illustrates some examples of consequences of alternative choices for the elasticities.

4.3 Data

Data on exchange rates, interest rates, central bank foreign reserves, gross foreign assets, and gross foreign liabilities denominated in foreign currency are drawn from national central banks, the IMF's International Financial Statistics, International Investment Positions and The Financial Flows Analytics Databases and the Lane and Milesi-Ferretti "External Wealth of Nations Dataset". To extend the coverage of the data back in time, we supplement quarterly data with earlier annual values of gross foreign assets and liabilities, for constructing the $\Pi_{e,t}$ scaling factor.[16] All data sources and definitions are provided in Appendix (A) Table 4, with descriptive statistics provided in Appendix (A) Table 5 for the unbalanced sample period extending from January 1990 to October 2017. In analyses that sort countries into Advanced Economies versus Emerging and Developing economies, we utilize the IMF's country classifications. Because the EMP relies on exchange rate variation, we exclude countries that do not have their own currency. This excludes individual euro area countries, while the euro area as a whole is included. We further include Estonia and Latvia up until their dates of entry into the euro area in January

[15] 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, notably to be used in an alternative exchange market pressure index (Patnaik, Felman, and Shah [2017], or to assess the effectiveness of foreign exchange interventions in affecting the exchange rate (e.g. Menkhoff [2013], 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 et al. [2017] illustrate 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.

[16] The level of gross foreign positions, not their month-to-month variation, is what matters in the scaling factor.

of 2011 and 2014 respectively, but do not include countries that joined the euro earlier.[17] For consistency across all 44 countries, we focus on and present the monthly baseline EMP starting in 2000m1.

4.4 The Baseline EMP

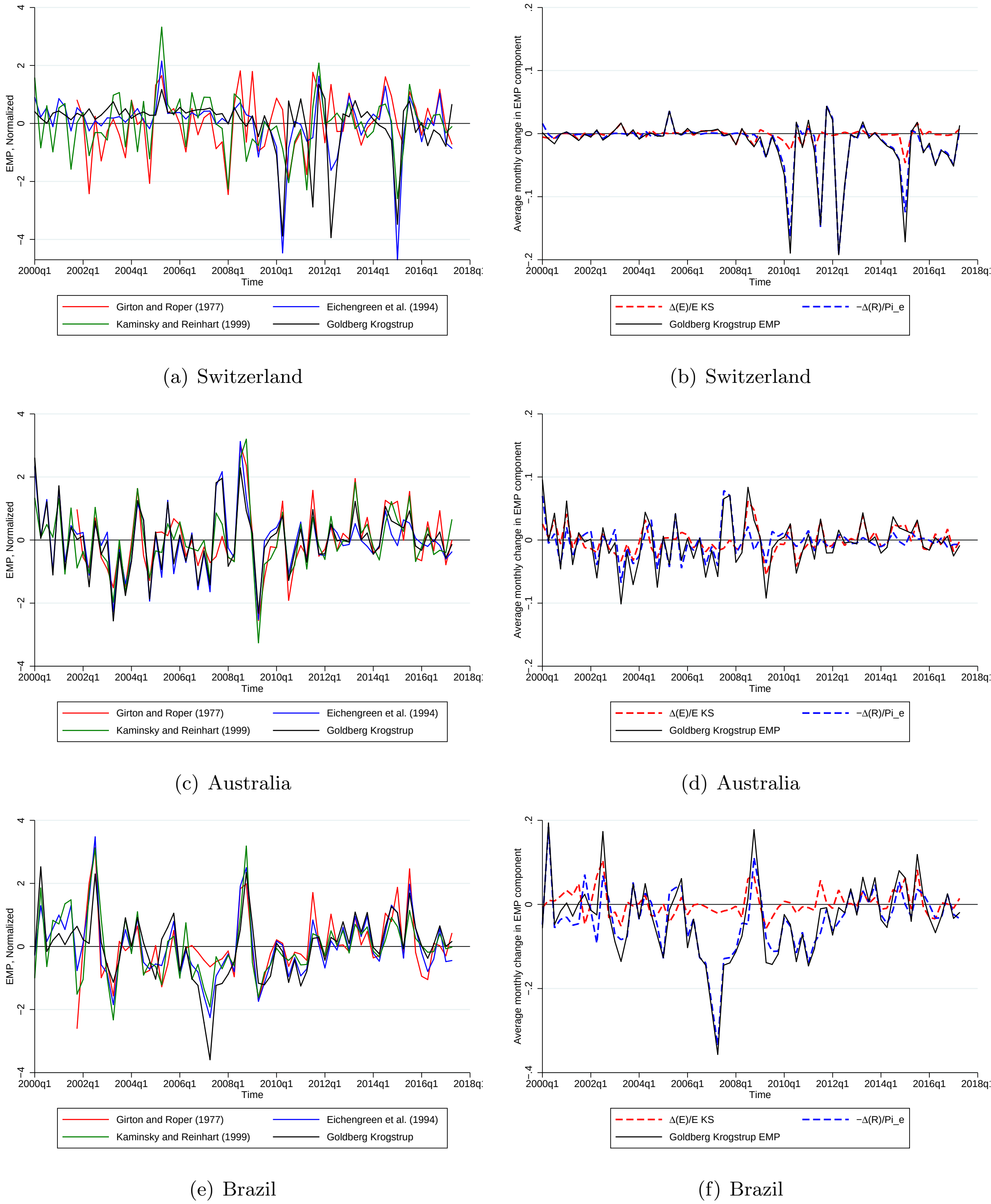
This section provides insights into the performance of the baseline EMP through a series of lenses. We begin by comparing performance against constructions of the earlier literature. We illustrate the role of base currency selections for countries that are not anchored to the US dollar, and turn to a comparison between the EMP and capital flow measures. In all statistical analyses and correlations, we use the monthly frequency of the EMP series. However, when we illustrate the EMPs graphically, we use quarterly averages to average out some of the monthly volatility and make trends more visible.

Figure (1) compares the EMP measures proposed in Girton and Roper [1977], Eichengreen et al. [1994], and Kaminsky and Reinhart [1999], with our measure (Goldberg Krogstrup) for Australia, Brazil, and Switzerland. For better comparability across the types of constructs, we depict standardized versions of these measures.[18] In all of the left panels of this figure, a positive EMP denotes an international capital outflow pressure (local currency depreciation pressure), and a negative EMP denotes a capital inflow pressure (local currency appreciation pressure). The baseline EMP series departs significantly from the metrics of the prior literature in both the scaling of foreign exchange reserve changes and the weighting of components. Scaling with reserves, as done for example in Kaminsky and Reinhart [1999], tends to overstate fluctuations in reserves when the level of reserves is very small, while this mismeasurement is reduced at larger levels of reserves. Applying precision weights to mismeasured changes in reserves amplifies the problem. The measures differ, at times strongly, in both direction and sign. These differences reflect in part the signal to noise ratio of the measurement of reserves changes related to valuation effects, and in part the occasional overweighing of reserves through precision weights, and the interaction of these two factors. Across the broader sample of countries, differences are particularly strong for countries with floating exchange rates, where foreign exchange reserves held at the central bank are minimal, and even small fluctuations in reserves can be large in relative terms. In contrast to previous measures, our scaling scheme results in largely zero scaled fluctuations in foreign currency reserves. The contributions of currency depreciation and scaled reserves within our baseline EMP are provided in the right panels of this figure.

In the case of Switzerland, where the absolute value of foreign currency reserves grew strongly

[17] For example, we do not include Slovenia and Slovakia, which joined in 2007 and 2009 respectively.

[18] Differences in amplitude are partly due to the choice of weighting scheme. Our EMP places a weight of one on exchange rate changes, and a weight on reserves changes between zero and one, while precision weights sum to one. Differences are also due to the scaling of reserves changes.



(a) Switzerland

(b) Switzerland

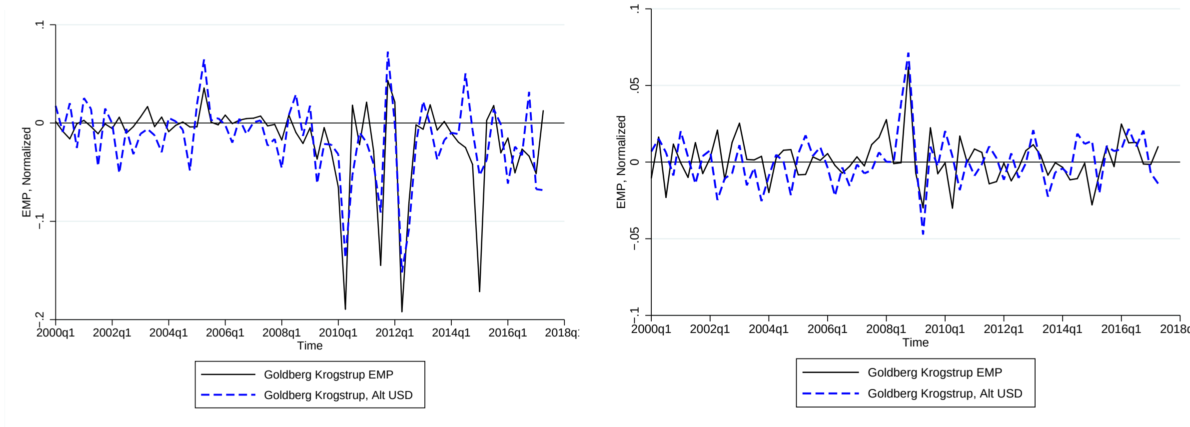
(c) Australia

(d) Australia

(e) Brazil

(f) Brazil

Figure 1: **Goldberg Krogstrup EMP: Alternative Constructs and Decomposition**
Left hand panels display standardized quarterly averages of monthly EMPs constructed as the baseline Goldberg Krogstrup EMP, Girton and Roper [1977], Eichengreen et al. [1994], and Kaminsky and Reinhart [1999] respectively. The right hand panels display the baseline Goldberg Krogstrup EMP (not standardized) as well as exchange rate changes against the base currency, and changes in reserves scaled by Π_e separately.



(a) Switzerland (b) United Kingdom

Figure 2: **Baseline EMP and Alternative Based On The USD**
The baseline EMPs for Switzerland and the United Kingdom use the euro as a base currency. The alternative EMP uses the USD. The EMPs are displayed in quarterly averages of monthly values.

in the aftermath of the Global Financial Crisis (GFC), our measure does not amplify the changes in reserves in the early part of the sample period, when reserve levels were still low, but allows for fully capturing the large changes in reserves that took place, at increasingly high levels, in the latter part of the sample. The measure for Australia, often described as a commodity currency, shows large period-by-period directional swings mainly driven by sharp exchange rate moves vis-à-vis the USD. The EMP for Brazil is driven by both exchange rate and reserve movements. For example, large reserve accumulations occurred before the GFC, and both reserve sales and currency depreciation occurred post crisis.

The importance of the choice of base currency used for the EMP is shown in Figure (2) for Switzerland and the United Kingdom, which have the euro as foreign base currency according to Klein and Shambaugh [2008]. The alternative EMP construction is based on bilateral exchange rates vis-á-vis the US dollar and US dollar denominated changes in official foreign reserves. While the base currency is important during episodes when exchange rate changes dominate the index, they become less so when reserves changes clearly dominate, as in the latter part of the sample for Switzerland. The way in which the two versions of the EMP capture capital flow pressures during the height of the financial crisis, moreover, illustrates the relative nature of the EMP as a measure of capital flow pressures. In the last quarter of 2008, the onset of the GFC triggered important capital inflow pressures in Switzerland, causing the exchange rate against the euro to appreciate. However, capital inflow pressures into the US dollar were stronger, leading to a net depreciation of the Swiss franc against the US dollar in that quarter. The EMP based on the bilateral rate against the US dollar captures this as a capital outflow pressures, however mild.

When the baseline euro exchange rate is used, however, the resulting EMP suggests a capital inflow pressures during this episode. A similar phenomenon took place in 2015 with divergence between the US dollar and the euro value of the Swiss franc. In the United Kingdom, where exchange market pressures against the euro versus against the dollar can persistently differ in direction, and there exchange rate movements are the main driver of the EMP, the two measures differ even more.

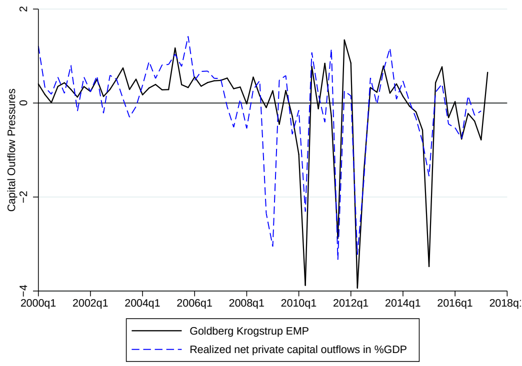
Figure (3) compares the baseline EMP with quarterly net private capital outflows in percent of GDP for Australia, Brazil, and Switzerland, representing different degrees of exchange rate management across both time and countries. The sign and the direction of change in the EMP and realized net private capital flows are constructed to be directly comparable under the assumptions of the model.[19] The level and amplitude of these two series are not, and they are hence both standardized by country.

As expected, the degree to which the EMP correlates with actual capital flows depends on the currency regime in place. In countries and periods where the exchange rate is freely floating, capital flow pressures will result in more exchange rate adjustment, which in turn moderates realized private capital flows. Switzerland before 2008, when the exchange rate was freely floating, is an example of this. In contrast, when the exchange rate is highly managed, capital flow pressures materialize in a private net capital flow which is instead fully accommodated by changes in central bank foreign reserves that stunt any exchange rate response. This has for example been the case in the post-GFC period for Switzerland, when the lower bound on interest rates resulted in a shift in monetary policy tools toward more active exchange rate management.[20]

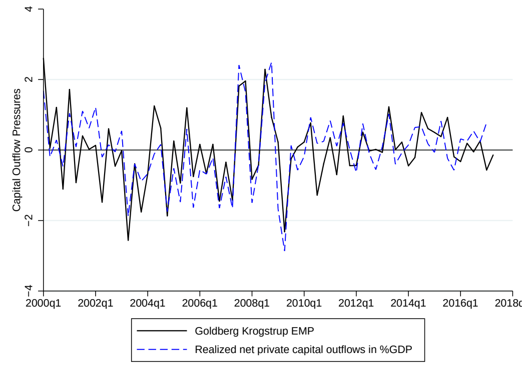
Figure (4) illustrates this point more generally with a scatter plot of a de facto index of exchange rate management by country (see Appendix C), against the country specific correlation of the EMP and actual net private capital flows. Realized private capital flows and the EMP tend to be highly correlated in countries with a high average degree of exchange rate management. The few countries with little exchange rate management (such as the US, EU, and UK) invariably

[19] An important assumption is that the current account is constant and not responsive to exchange movements. If the current account moves a lot across the sample, this would reduce direct comparability of levels. For example, if the current account deviated persistently from zero, this would lead to an average net capital flow reflecting the current account which would not constitute a capital flow pressure.

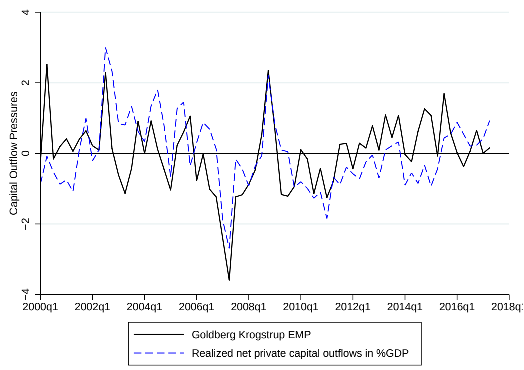
[20] The large realized capital inflow in late 2008 and early 2009 in Switzerland not reflected in the EMP is related to the large scale foreign exchange swap operations carried out by the Swiss National Bank during this period. When the swaps are added to reserves for Switzerland, the EMP indeed suggests a large capital inflow pressure during the time when realized inflows were large. We have not corrected for central bank foreign exchange swap operations because data do not allow us to do so consistently for all countries that have been counterparties to such swap operations. For example, the foreign exchange proceeds from central bank swap operations carried out in 2008-2009 by the Swiss National Bank and the US Federal Reserve are not included in the statistics on foreign exchange reserves, but instead feature as separate items on the central bank balance sheets that could be corrected for. However, the counterparty positions to these swaps are not disclosed by the counterparty central banks. We also do not correct for country-specific use of non-deliverable forwards or repo arrangements that might otherwise appear as foreign exchange intervention activity.



(a) Switzerland



(b) Australia



(c) Brazil

Figure 3: ***EMP* and Realized Net Private Capital Outflows.**
Quarterly averages of monthly values of the Goldberg Krogstrup baseline EMP and net capital outflows in percent of GDP. Both series are standardized for comparability. Positive values are reflective of net capital outflows and depreciation pressures against the base currency, while negative values reflect net inflows and appreciation pressures.

exhibit low correlation between the EMP and realized net capital flows. That capital flow pressures, as captured by the EMP, and actual capital flows are more correlated in countries with managed exchange rates, and less so in countries with floating rates, underscores an advantage of using the EMP to measure capital flow pressures in a way that is comparable across exchange rate regimes, and highlights the risk of missing important aspects of capital flow pressures when these pressures are exclusively measured by realized capital flows.

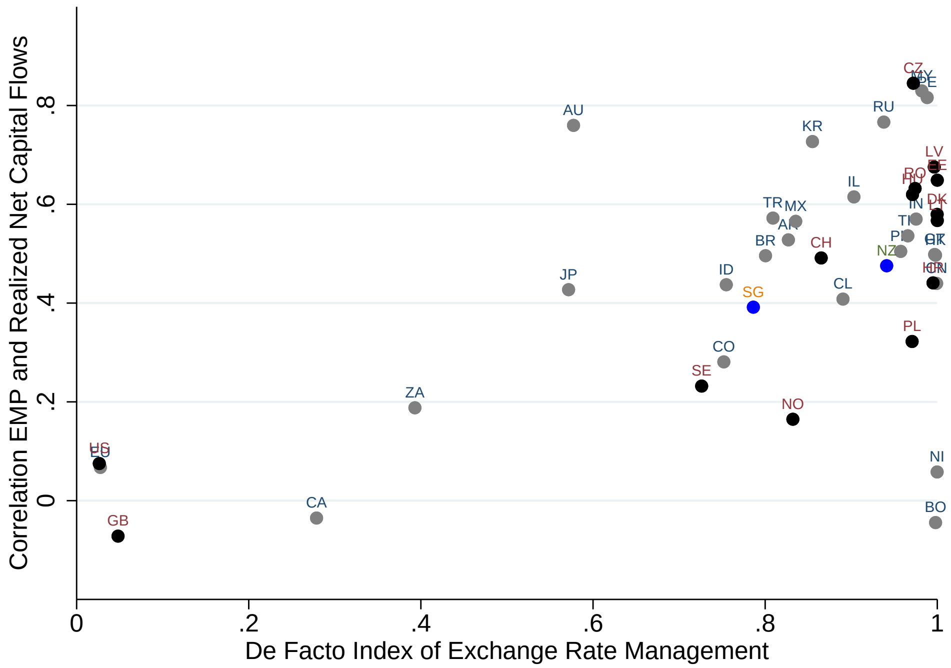


Figure 4: **Effective Exchange Rate Regime Versus Correlations Of The EMP And Realized Flows**

The vertical axis depicts the unconditional correlation of the Goldberg-Krogstrup baseline EMP with realized net capital flows by country in quarterly frequency. The horizontal axis depicts an index of effective exchange rate management by country for the sample period as described in Appendix (C). Black dots are USD base currency countries, gray dots are countries with the euro as base currency, and blue dots are countries with third base currencies (the Malaysian baht and the Australian dollar). The sample period is 2000Q1 to 2017Q3. The sample includes countries for which data on realized net capital flows and the EMP span a minimum of 10 years.

5 Recent Patterns in Capital Flow Pressures

The advantages of the EMP as a measure of balance of payments pressures include its comprehensiveness (i.e. covers all net non-reserve flows), monthly frequency, as well as its comparability across different countries, currency regimes, and over time. Hence, it allows for an assessment of the link between capital flow pressures and global factors at a higher frequency and more consistently across countries than accomplished using realized capital flow data based on Balance of Payments Statistics and global liquidity series. In this section, we illustrate how the EMP performs in regression specifications typically applied to study international capital flows and global factors, and implications for the assessment of the role of global factors. The results are directly relevant for the debate over the importance of the global factor over the cycle, at crisis points, and over time.

5.1 The EMP and Global Liquidity Drivers

As the literature on global factors and international capital flows uses flow data, we test the insights from that literature using the EMP as an alternative metric. The expected link between the EMP and global financial factors is captured in the balance of payments based derivation of equation (7), with global factors comprising changes in the foreign interest rate (di^*), changes in global financial risk sentiment as captured by ds^*, and changes in global financial wealth. Our panel estimating equation is

$$EMP_{t,c} = \beta_i di_{t,c} + \beta_{i*} di^*_t + \beta_s ds^*_t + \kappa_c + \varepsilon_{t,c} \tag{11}$$

where c-subscripts denote the country, κ_c is a country specific fixed effect, and the focus is on the role of global financial risk sentiment and global interest rates as global factors, which can be measured in monthly frequency.[21] Based on equation (7), we expect a negative sign for β_i and a positive sign for β_{i^*}, i.e. a lower domestic or a higher foreign interest rate should induce capital outflows and thus increase $EMP_{t,c}$, all else equal. The sign for the βs depends on the strength of the elasticities of gross foreign assets and liabilities to increases in risk perception. The literature traditionally has found it to be positive for emerging markets, in that risk-off sentiment has been related to outflows, and negative for so-called safe haven countries (Habib and Stracca [2012], Ranaldo and Soederlind [2010]). The size and sign of the parameter estimate as captured by the panel specification (11) will reflect the unweighted average of the countries included in the panel and specific time period. Since it is unweighted, the parameter estimate for

[21] To arrive at specification (11) from equation (7), we make the simplifying assumptions that the terms $\frac{FA'_s}{\Pi_{e,t}} ds_t - \frac{\frac{1}{e_t} FL'_W}{\Pi_{e,t}} dW^* + \frac{FA'_W}{\Pi_{e,t}} dW$ are uncorrelated with the regressors and picked up in country fixed effects and the error term.

the full sample can reflect a net positive association if more countries in the sample experience capital outflow pressures during global risk-off episodes, even though on net, global capital flow pressures appropriately weighted should sum to zero. Section 6 explores possible country and time variation in βs.

We run a set of panel regressions based on specification (11) for three separate country sub-samples, namely emerging markets, so-called safe haven countries and other advanced countries. The literature usually points to at least three currencies with safe haven characteristics, namely the US dollar, the Swiss franc and the Japanese yen. Other currencies have occasionally been associated with safe haven status, but not consistently so, and we hence restrict our safe haven sample to these three countries, purely for illustrative purposes. For each country sub-sample, we run the regressions for the entire period from 2000m1 to 2017m10, and for three sub-periods, namely the pre-financial crisis period ending with June 2007, the GFC period lasting from July 2007 to June 2009, and the post crisis period beginning in July 2009. The descriptive statistics for the baseline EMP are shown in Table 2.

The foreign interest rate is the rate associated with the base currency. These short term policy rates do not fully reflect monetary policy measures in the post crisis period because most advanced economies were near the zero lower bound (ZLB). We follow Avdjiev, Gambacorta, Goldberg, and Schiaffi [2017] and use a shadow policy rate generated by Krippner [2016]. These cover the US, UK, Japan, and euro area in the ZLB periods, but results are largely robust to using observed policy rates for the countries instead (not shown). Global financial risk sentiment is measured by fluctuations in the VIX, following prior studies (e.g. Forbes and Warnock [2012], Rey [2015a]). Recent research on global financial factors and capital flows brings into question the ability of the VIX to consistently capture global financial risk sentiment over time (Cerutti, Claessens, and Rose [2017], Avdjiev, Gambacorta, Goldberg, and Schiaffi [2017], Krogstrup and Tille [2017], Shin [2016]). As an alternative metric, we also consider time fixed effects for the global factor, as discussed further below.

The panel regression results are displayed in columns 1 to 4 in panels (a)-(c) of Table (3) for the three country group panels and the different time periods and specifications captured by the columns. The variation explained by the changes in the VIX and interest rates is low, but less so for safe haven countries and in the crisis and post-crisis samples. The effect of the VIX varies across specifications. It is significant and positive for emerging markets, and positive although insignificant for advanced non-safe haven countries since the crisis, suggesting that increases in risk aversion as captured by the VIX was associated, on average, with capital outflow pressures in these country groupings during those time periods. The change in the VIX is negatively related to capital flow pressures in safe haven countries, and significantly so in the pre-crisis period. The parameter estimates for interest rates are mostly insignificant, which may reflect the

(a) U.S., Japan and Switzerland

	Mean	Max	Min	Std. Dev	Obs
Total	-0.010	0.181	-0.416	0.053	644
Pre-crisis	-0.007	0.115	-0.272	0.043	269
Crisis Period	-0.010	0.090	-0.116	0.044	72
Post-crisis	-0.012	0.181	-0.416	0.062	303

(b) Advanced Economies excl. U.S., Japan and Switzerland

	Mean	Max	Min	Std. Dev	Obs
Total	-0.007	0.568	-0.552	0.073	2232
Pre-crisis	-0.009	0.568	-0.440	0.076	988
Crisis Period	-0.004	0.436	-0.450	0.099	264
Post-crisis	-0.005	0.344	-0.552	0.062	980

(c) Emerging Markets

	Mean	Max	Min	Std. Dev	Obs
Total	-0.032	8.722	-5.427	0.205	6319
Pre-crisis	-0.044	8.722	-5.427	0.266	2665
Crisis Period	-0.034	1.140	-0.799	0.193	720
Post-crisis	-0.021	0.794	-1.275	0.131	2934

(d) Full Sample of Countries

	Mean	Max	Min	Std. Dev	Obs
Total	-0.025	8.722	-5.427	0.175	9195
Pre-crisis	-0.033	8.722	-5.427	0.223	3922
Crisis Period	-0.025	1.140	-0.799	0.168	1056
Post-crisis	-0.017	0.794	-1.275	0.115	4217

Table 2: **Descriptive Statistics for the *EMP* for Country Samples and Subperiods**
The full sample is from 2000m1 to 2017m10, the pre-crisis sample stops in 2007m6, the crisis sample runs from 2007m7 to 2009m6 and the post crisis sample runs from 2009m7 to 2017m10. 44 countries are included in the sample, of which 11 are non-"safe haven" advanced economies (Australia, Canada, Denmark, Estonia, Israel, Latvia, New Zealand, Norway, Sweden, United Kingdom, and the euro area), 3 are considered "safe havens" (U.S., Japan and Switzerland) and 30 are emerging markets and developing countries (Argentina, Bangladesh, Bolivia, Brazil, Chile, China, Colombia, Croatia, Czech Republic, Guatemala, Hong Kong, Hungary, India, Indonesia, Republic of Korea, Lithuania, Malaysia, Mexico, Nicaragua, Panama, Peru, Philippines, Poland, Romania, Russian Federation, Singapore, South Africa, Sri Lanka, Thailand and Turkey).

poor measurement of funding costs since the crisis and the during ZLB period.[22]

As it is notoriously difficult to accurately assess global financial factors as drivers of capital flow pressures empirically, we follow Cerutti, Claessens, and Rose [2017] and capture global common factors indirectly by including time fixed effects in these EMP specifications, in lieu of changes in the foreign interest rate and the VIX. Time fixed effects indiscriminately capture all global factors that affect capital flow pressures in the same way across the panel countries, including the part of the impact of the VIX, the foreign interest rate, foreign financial wealth changes and other possible global factors that similarly impact the sample countries. This time fixed effect allows us to assess how much of the variation in capital flow pressures can be accounted for by common responses to global factors, but does not allow us to assign this global factor to individual types of drivers. Moreover, country specific variation not captured by time fixed effects can still be a response to global factors, if this response differs from the response of the average country of the sample. A panel regression restricts the responses of the panel countries to be the same, while Equation (7) makes clear that there is no reason to expect countries to respond in the same way to global factors. Indeed, the fact that safe haven countries have a very different response, as we have shown, is an extreme manifestation of this more general point. We turn to an assessment of individual countries' capital flow sensitivity to global factors in Section (6).

The fifth column in the panels of Table (3) presents the results in the full sample including period fixed effects and excluding the VIX and i^*. Time fixed effects substantially increase the share of the variation in the EMP accounted for by the regressors. The share is highest, about 35%, in the safe haven countries. The common global factors tend to explain a somewhat larger share of the variation in our measure of capital flow pressures than similarly estimated global factors in regressions on standard capital flow measures for pooled groups of countries in Cerutti et al. [2017]. This is illustrated in columns 6 and 7, depicting the regressions in quarterly frequency using the EMP and net capital outflows in percent of GDP respectively as dependent variable. Based on the explained share of variation, the EMP as a gauge of capital flow pressures thus points to a slightly stronger role for a global financial cycle than when realized capital flows are analyzed. This could be related to the fact that the EMP accounts for different types of manifestations of pressures (in flows or prices) instead of exclusively in outright flows, especially for countries with more de facto flexibility in exchange rates.

The results suggest that global factors for emerging markets and advanced economies are significantly positively correlated, while safe haven global factors are significantly negatively correlated with those of emerging market countries. The left hand panel in Figure (5) presents a

[22] Including interaction terms with either capital controls as measured by the Chinn-Ito index, or currency regime using the Klein and Shambaugh [2008] measure of pegs, does not change the share of variation explained in these regressions, and the interaction terms are rarely significant.

(a) U.S., Japan and Switzerland

	1.EMP	2.EMP	3.EMP	4.EMP	5.EMP	6.EMP	7.NCAP
$dlog(VIX)$	-0.032**	-0.008	-0.089	-0.058			
	(0.002)	(0.023)	(0.051)	(0.022)			
di	-1.407	-3.975	0.885	-0.925	-2.436	-4.048	-61.945
	(0.887)	(1.058)	(2.510)	(1.115)	(2.098)	(1.832)	(739.236)
di^*	1.926	7.959*	3.941*	3.910			
	(2.897)	(1.406)	(0.566)	(0.932)			
R2	0.021	0.338	0.125	0.092	0.352	0.358	0.293
No.Obs	269	72	294	635	638	210	207
Sample	pre	fc	post	full	full	full	full
FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PE	No	No	No	No	Yes	Yes	Yes
Freq	M	M	M	M	M	Q	Q

(b) Advanced Economies excl. U.S., Japan and Switzerland

	1.EMP	2.EMP	3.EMP	4.EMP	5.EMP	6.EMP	7.NCAP
$dlog(VIX)$	-0.003	0.085	0.038	0.036			
	(0.020)	(0.038)	(0.025)	(0.022)			
di	-0.940	-1.191	-0.230	-0.851	-0.911	-1.293	-231.759
	(0.679)	(1.517)	(0.743)	(0.685)	(0.991)	(0.703)	(171.738)
di^*	1.684	1.114	0.495	0.744			
	(1.066)	(2.183)	(0.414)	(0.458)			
R2	0.006	0.059	0.013	0.012	0.137	0.176	0.115
No.Obs	810	216	876	1902	1911	630	623
Sample	pre	fc	post	full	full	full	full
FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PE	No	No	No	No	Yes	Yes	Yes
Freq	M	M	M	M	M	Q	Q

(c) Emerging Markets

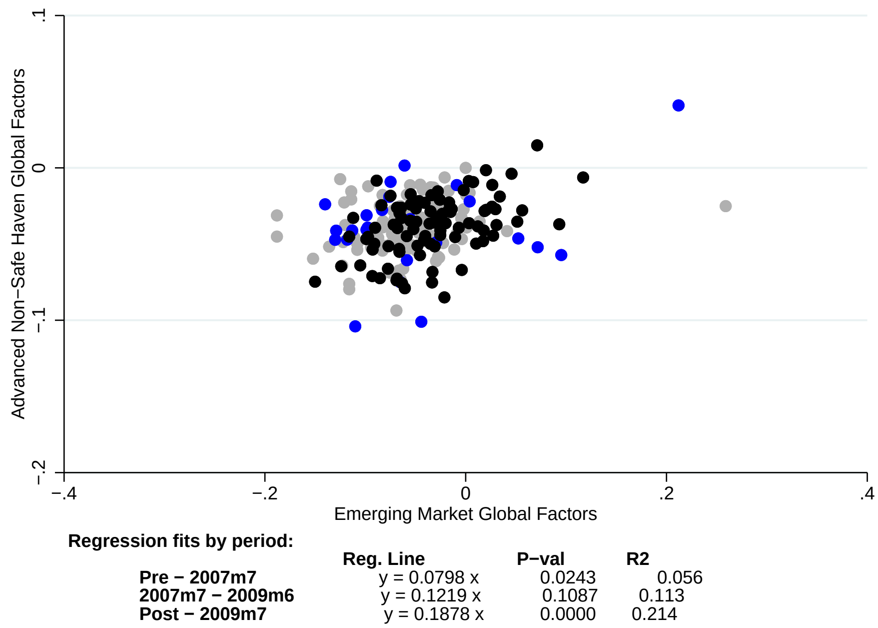
	1.EMP	2.EMP	3.EMP	4.EMP	5.EMP	6.EMP	7.NCAP
$dlog(VIX)$	0.024	0.204**	0.090***	0.098***			
	(0.017)	(0.058)	(0.024)	(0.022)			
di	0.037**	0.359	-0.008	0.041*	0.046*	0.156	-1.156
	(0.012)	(0.649)	(0.748)	(0.015)	(0.018)	(0.192)	(5.578)
di^*	-3.808*	3.779	3.179**	1.468			
	(1.429)	(3.189)	(0.984)	(0.888)			
R2	0.002	0.051	0.017	0.006	0.078	0.145	0.065
No.Obs	2842	768	2931	6541	6605	2165	2020
Sample	pre	fc	post	full	full	full	full
FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PE	No	No	No	No	Yes	Yes	Yes
Freq	M	M	M	M	M	Q	Q

Table 3: EMP **Panel Regression Results**

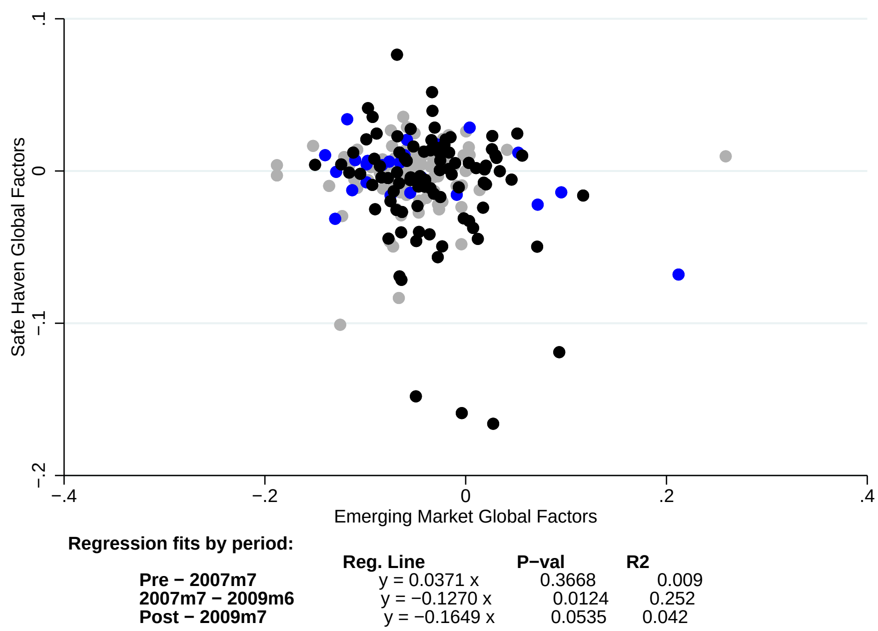
Results from monthly panel regressions of equation (11). i^* is the euro area rate for countries with the euro as base currency, and the US interest rate otherwise. Shadow policy rates from Krippner [2016] are used for the US, the euro area, Japan and the UK. No.Obs gives the number of regression observations. Dep indicates the dependent variable, Sample indices the time sample used (”full” is from 2000m1 to 2017m10, ”pre” indicates the pre-crisis sample which stops in 2007m6, ”fc” indices the GFC from 2007m7 to 2009m6, and ”post” indices the post crisis sample from 2009m7 to 2017m10). FE indicates country fixed effects and PE indicates period fixed effects. ”Freq” indices the frequency, with ”M” indicating monthly end-of-month data and ”Q” indicating quarterly averages. Clustered standard errors are shown in parentheses. Asterisks *, ** and *** indicate significance at the 10, 5 percent and 1 percent levels.

scatter plot of the time fixed effects for emerging markets and non-safe haven advanced economy groupings.[23] Panel (b) shows the global factor for emerging markets against that of safe havens (a similar pattern emerges with safe haven global factors plotted against non-safe haven advanced economies, not shown). The size range of global factors for emerging markets is widest, and the advanced non-safe haven global factors are smaller during the crisis period. The global effects push more toward capital outflow pressures post crisis than pre crisis. As the regression lines below these charts show, the size of the global factor for emerging markets is generally about 5 times larger than for other countries.

[23]The global factors are derived from the regressions presented in columns 5 in Table (3).



(a) EMs vs Non-safe haven AEs



(b) EMs vs. Safe Haven AEs

Figure 5: **Global Factors Proxied By Panel Time Effects**

Global factors for non-safe haven countries, emerging markets, and safe haven AEs, as measured by the time fixed effects from panel regressions of the EMP on time and country fixed effects and first differences of domestic interest rate (Columns 5, Table (3).) Grey dots are for pre-2007m7 observations, blue dots are for observations from 2007m7 to 2009m6, and black dots are for 2009m7 to 2017m10.

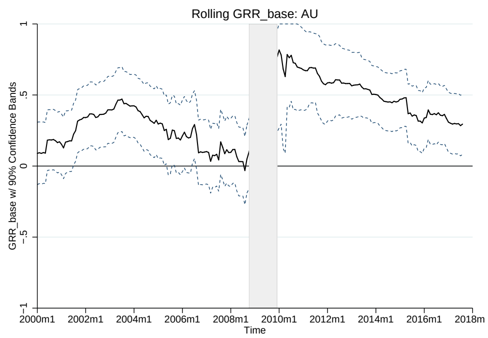
6 The GRR: Country Specific Global Factor Sensitivities

The role played by global factors in driving the capital flow pressures estimated above represents unweighted average effects across countries. The restriction of joint parameter estimates across countries inherent in the panel approach neglects the information in the data about differences in the sensitivities of capital flow pressures to global factors across countries. Country specific sensitivities are relevant for assessing the nature of a country's exposure to shifts in global factors, as in the evidence for global monetary policy spillovers and policy trade-offs for emerging markets (Rey [2015b], Obstfeld et al. [2017]) and the challenges of capital flow pressures for safe asset providers and safe havens (Gourinchas and Rey [2016], Habib and Stracca [2012], Ranaldo and Soederlind [2010]). Indeed, we expect that the size and sign of the correlation between capital flow pressures (captured by the EMP) and global factors (captured by i^*, s^* or W^* in equation (7)) will be country specific.

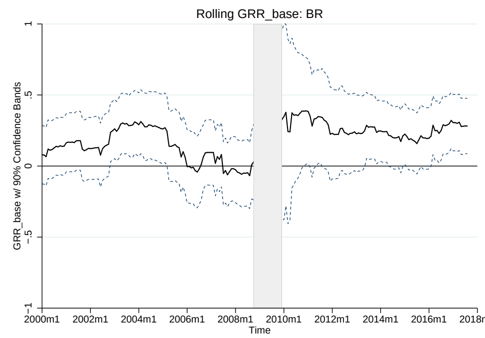
The EMP can be used to assess the country specific sensitivities empirically by honing in on the global financial sentiment factors as captured by s^* in equation (7). We propose and compute a new measure, which we call the empirical Global Risk Response index (the GRR) as the time varying empirical correlation of monthly changes in the global factor s^* with the monthly country and time specific baseline EMP. Specifically, the $GRR_{t,c}$ is the country specific partial correlation coefficient between the $EMP_{t,c}$ and the global factor based on country specific regressions of equation (11), in which we have standardized all variables using their sample mean and standard deviation, so as to make the regression coefficients directly comparable across countries. Notationally, below we refer to GRR with time and country subscripts implied but not shown.

The GRR reflects the degree to which exchange market pressures measured against a base currency are driven by global risk sentiment rather than other shocks during a specified period (the regression sample period) before time t. It takes values between -1 and 1. The closer the GRR is to 1 in absolute terms, the stronger is global risk sentiment as the main driver of exchange market pressures relative to other drivers (such as interest rates that we directly control for, and other factors that enter the error term), relative to the base currency. The sign of the GRR contains information on the direction of the correlation. If the GRR is positive, capital outflow pressures increase relative to the base currency when global risk sentiment increases. If the GRR is negative, a risk-off event tends to be associated with relative capital inflow pressures.

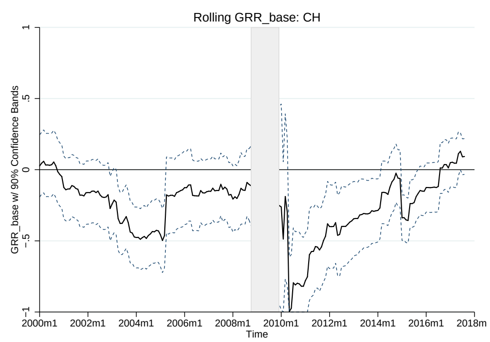
The GRR has a specific bilateral interpretation. Given that the baseline EMP is a measure of capital flow pressures relative to the base currency, and hence the base currency country, the GRR is interpreted as capital flow pressure sensitivity relative to that of the anchor country. A positive sign thus does not necessarily mean that higher risk aversion is associated with absolute capital outflow pressures, but rather that it is associated with more outflow pressures than what the anchor country is experiencing. The significance of the GRR indicates a deviation in the pattern from that of the anchor country, rather than the absolute sensitivity of capital flow pressures to global risk factors.



(a) Australia



(b) Brazil

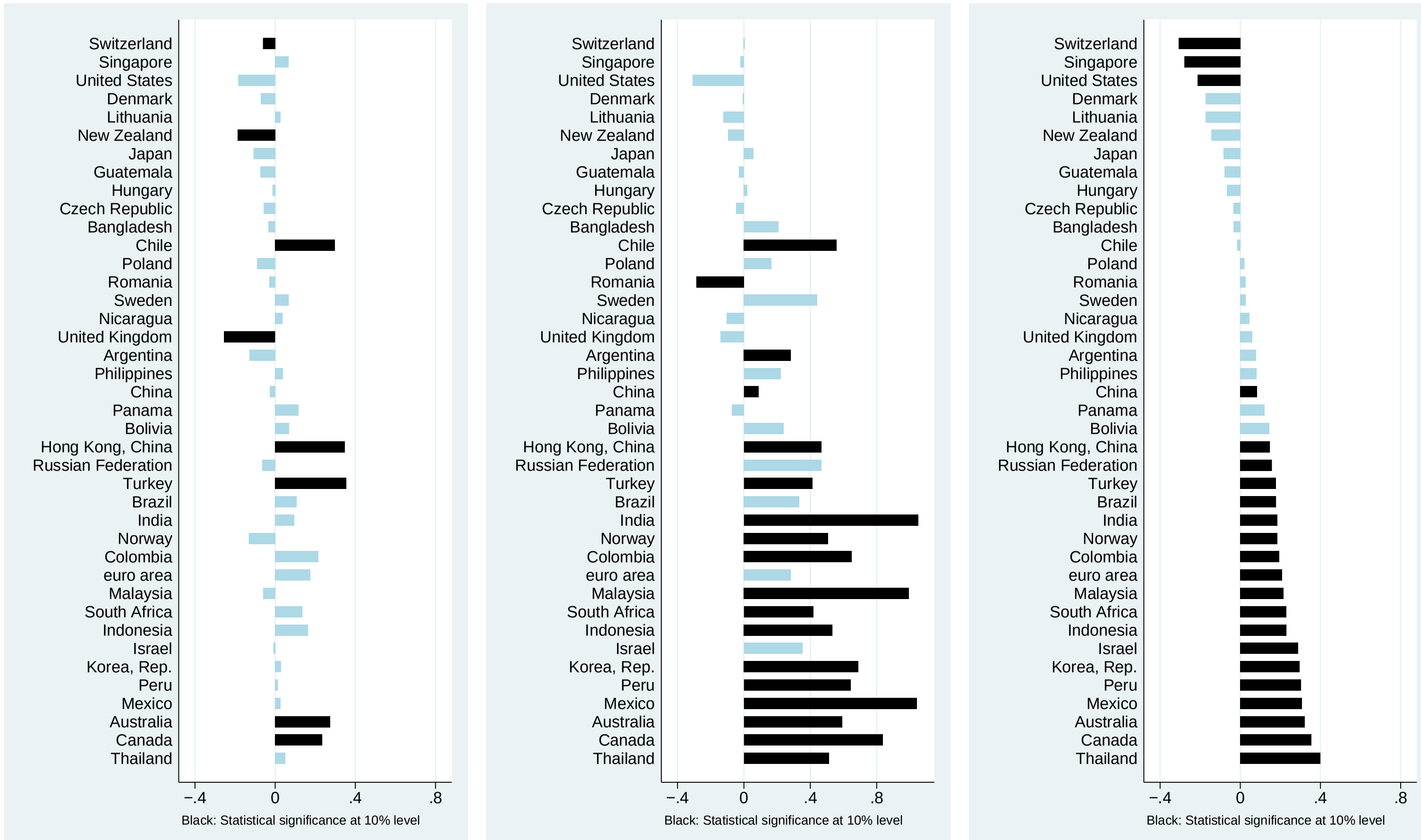


(c) Switzerland

Figure 6: **Time-varying GRR for Australia, Brazil, and Switzerland**
The Global Risk Response (GRR) index for Australia, Brazil, and Switzerland. Computation uses the Goldberg Krogstrup baseline EMP and the VIX as a measure of global risk sentiment. Global financial crisis period structural break assumed. Solid lines depict mean GRR estimates by date, and dashed lines indicate the associated one standard error band.

We first compute the GRR based on five year rolling windows for each sample country, and illustrate the results for Australia, Brazil and Switzerland in Figure (6). While we illustrate the GRR using the VIX as a measure of s^*, the VIX can be substituted with any global risk measure of choice available in monthly frequency.[24] For countries with data available for construction of the EMP starting in 1995m1, the GRR can be produced starting in 2000m1 given a rolling window of five years. For most countries, however, the GRR will start later.[25]

[24] In robustness tests not shown, we computed the GRR using alternative regional implicit stock volatility measures, with very similar results.
[25] The $GRR_{t,c}$ is presented by country in appendix Figure (10).



(a) Pre-Crisis Period (b) Crisis Period (c) Post-Crisis Period

Figure 7: GRR**s for Selected Sample Periods**

The $GRR_{t,c}$ is computed as the partial correlation coefficient from regressions of monthly standardized values of the baseline EMP and the $dlog(VIX)$, controlling for changes in domestic and foreign interest rates, over the specified sample period. The pre-crisis sample runs from 2000m1 to 2007m6, the crisis sample runs from 2007m7 to 2009m6, and the post-crisis sample runs from 2009m7 to 2017m10. Countries are ordered according to the size of observed correlations in the post-crisis period, and countries with less than 5 years of data on the EMP in the pre- and post periods are excluded. Correlations significantly different from zero at a 90% confidence level are marked by black bars.

Figure (7) compares the GRR computed for the pre-crisis, crisis, and post-crisis periods. All three figures are sorted according to the size of the GRR during the post-crisis period. These exhibits show substantial difference between the sensitivities as well as the relative rankings of countries implied by the pre and post crisis samples. Bars shaded in black are those with statistically significant correlation. The size of the positive GRRs increased strongly from the pre-crisis period to the crisis period, and positive GRR are more frequent in the crisis and post-crisis samples, suggestive of a greater sensitivity of many countries to global factors after the crisis.

Switzerland, the US and Japan feature at the top of the post-crisis ranking, taking so-called safe-haven status. Some surprising countries also appear in the top part of the list with negative $GRR_{t,c}$ values, including Guatemala and Lithuania, raising questions as to the drivers of these sensitivities relative to the base currency. Other countries exhibit rather muted GRRs, suggesting a role for capital controls in stunting relative sensitivities. Whether these findings are specific to the VIX as a measure of global risk is left for future research.

The rankings do not reflect any clear dichotomy between advanced and emerging markets in terms of their capital flow sensitivities to global factors. Both types of countries are present in both ends of the rankings in all periods. Moreover, the country specific sensitivities have changed across the three sample periods, with the pre-crisis ranking very different to the post-crisis ranking. Time variation is evident from the country charts of rolling $GRR_{t,c}$ presented in the appendix. India, Mexico and Malaysia stand out as having particularly elevated sensitivity to global factors during the (short) crisis period.

7 Conclusions

This paper has proposed a new measure of capital flow pressures in the form of an exchange market pressure index. While exchange market indices have a long tradition, our approach provides a solid grounding in international financial theory and balance of payments conditions. The metric takes seriously the form of exchange rate regime in place at each point in time, the level and composition of the foreign exchange reserve portfolio, and the drivers of gross foreign asset and liability positions at the country level. The advantages of this index over the use of data on actual flows are that it can be computed for a broad panel of countries and over time, that it offers monthly variation in capital flow pressures, that it can be computed with only a few months of lag, and that it takes into account actual flows as well as incipient capital flow pressures that result in exchange rate changes rather than actual flows. Disadvantages are that the index must be constructed and relies on some baseline parameters, with associated scope for mismeasurement. The baseline country examples demonstrate the value of the EMP for countries spanning a range of exchange rate regimes.

This paper has also proposed the Global Risk Response index, capturing the country specific correlation of the Goldberg-Krogstrup EMP with a global risk proxy. Empirical exploration using the $GRR_{t,c}$ demonstrates that countries' capital flow response to global risk vary across time as well as across currencies. The sensitivity of capital flow pressures to global risk aversion has increased over the past decades, and in particular, since the global financial crisis. Some countries now have stronger capital inflow pressures as risk aversion increases, while other countries have stronger capital outflow pressures during risk-off episodes. This general finding coexists with substantial variation, both over time and across countries, in both the size and sign of the response of capital flows to global risk aversion. Clearly, the so called "safe-haven" status of any country or currency is by no means immutable. Important questions remain about what drives the response of global capital flows to risk aversion across both time and countries. The new metrics presented in this paper should facilitate further explorations.

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A Data Sources and Definitions

Variable	Definition	Source and Description
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.
$reer$	Real effective exchange rate	Monthly frequency. Defined such that an increase denotes a depreciation of the domestic currency. IMF International Financial Statistics.
R	Official foreign exchange reserves (total reserves minus gold)	In billions of base currency units, end of period, monthly. Dollar value from IMF International Financial Statistics. Observations from 2004m5 to 2004m8 for Sri Lanka are excluded due to huge outlier values.
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 Nicaragua, Panama, 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.
i_{SSR}, i^*_{SSR}	Shadow policy rate in the US, EU, Japan and UK	In percentage points, end of period, monthly. Krippner [2016].
GDP	Gross domestic product	In USD, quarterly. IMF International Financial Statistics.
$M1$	Narrow monetary aggregate	In billions of USD, end of period, monthly. IMF International Financial Statistics.
$M0$	Monetary base	In billions of USD, end of period, monthly. IMF International Financial Statistics.
VIX	CBOE Volatility Index	End of period, monthly. Extended backwards in time by the VXO from 1986m1 to 1989m12. Chicago Board Options Exchange.
FA	Total Foreign Assets less FDI	In billions of base currency units. End of period, yearly, interpolated to monthly frequency. Own calculations based on IMF International Investment Positions.
FL	Total Foreign Liabilities less FDI	In billions of base currency units. End of period, yearly, interpolated to monthly frequency. Own calculations based on IMF International Investment Positions.
$NCAP$	Net private capital outflows in percent of GDP	In percent, quarterly. IMF Financial Flows Analytics (FFA) database. Bangladesh and Panama do not have capital flows data.

Table 4: **Data Sources and Definitions**
Base currency references the country's main base currency by Klein and Shambaugh [2008]; data is available yearly until 2014Q1, interpolated to monthly frequency and extrapolated to 2017.

	Mean	Max	Min	Std. Dev	Obs
Advanced					
$\frac{de}{e}$	0.000	0.180	-0.160	0.024	3946
$\frac{de\_USD}{e\_USD}$	0.000	0.180	-0.160	0.029	3909
$\frac{dreer}{reer}$	0.000	0.144	-0.107	0.016	3372
dR	0.538	95.687	-32.520	4.751	3851
dR_USD	0.595	95.687	-28.569	4.852	3851
di	-0.033	68.480	-69.680	1.601	3897
di^*	-0.022	1.000	-0.960	0.174	3960
di_ssr	-0.036	68.480	-69.680	1.608	3897
di_ssr^*	-0.023	1.562	-1.327	0.295	3960
GDP	2016.961	19250.000	40.972	3616.384	3628
$M1$	952.662	8580.783	0.000	1652.858	3699
FA	2593.064	17063.699	-67.361	3925.570	3960
FL	2902.632	23346.709	32.693	4800.272	3960
FA_USD	2781.491	17643.199	-51.731	4464.772	3960
FL_USD	3120.352	25443.301	32.693	5473.529	3960
Emerging					
$\frac{de}{e}$	0.006	1.975	-0.349	0.051	10042
$\frac{de\_USD}{e\_USD}$	0.006	1.975	-0.455	0.052	10139
$\frac{dreer}{reer}$	-0.000	0.692	-0.209	0.027	7186
dR	0.706	112.596	-107.922	6.470	10084
dR_USD	0.627	112.596	-107.922	6.058	10084
di	-4.395	83311.359	-128154.094	1572.617	9660
di^*	-0.022	0.530	-0.960	0.174	10560
di_ssr	-4.395	83311.359	-128154.094	1572.617	9660
di_ssr^*	-0.022	1.562	-1.327	0.299	10560
GDP	453.957	11882.560	3.248	1073.752	8517
$M1$	132.259	7411.401	0.191	579.235	8090
FA	247.696	10744.289	-3353.793	1000.266	10404
FL	196.367	6037.523	-1828.495	581.510	10404
FA_USD	166.629	5555.663	-3353.793	621.574	10560
FL_USD	151.666	2236.450	-616.117	284.073	10560

Table 5: **Data Sample and Descriptive Statistics**

The data are in monthly frequency and span January 1990 to October 2017. Gross foreign positions are interpolated from yearly frequency. GDP is interpolated from quarterly frequency. 44 countries are included in the sample, of which 14 are advanced economies (Australia, Canada, Denmark, Estonia, Israel, Japan, Latvia, New Zealand, Norway, Sweden, Switzerland, United Kingdom, United States and the euro area), and 31 are emerging markets and developing countries (Argentina, Bangladesh, Bolivia, Brazil, Chile, China, Colombia, Croatia, Czech Republic, Guatemala, Hong Kong, Hungary, India, Indonesia, Republic of Korea, Lithuania, Malaysia, Mexico, Nicaragua, Panama, Peru, Philippines, Poland, Romania, Russian Federation, Singapore, South Africa, Sri Lanka, Thailand and Turkey).

B Exchange Rate Elasticities Definitions

The elasticities of foreign assets and foreign liabilities to the exchange and interest rates can be derived from equations 3 and 4:

$$
\begin{aligned}
\epsilon_e^{FA} &= \frac{\partial FA}{\partial e}\frac{e_t}{FA_t} = \left[\frac{W_t}{e_t}(-\alpha'_{uip}\frac{E(e)}{e_t^2}) - (1-\alpha)\frac{W_t}{e_t^2}\right]\frac{e_t}{(1-\alpha)\frac{w_t}{e_t}} \\
&= \left[-\alpha'_{uip}\frac{E(e)}{e_t} - (1-\alpha)\right]\frac{1}{1-\alpha} = -\left[\frac{\alpha'_{uip}}{1-\alpha}\frac{E(e)}{e_t}+1\right] < 0 \\
\epsilon_e^{FL} &= \frac{\partial FL}{\partial e}\frac{e_t}{FL_t} = \left[e_t W_t^*(\alpha^{*'}_{uip^*}\frac{E(e)}{e_t^2}) + (1-\alpha^*)W_t^*\right]\frac{e_t}{(1-\alpha^*)e_t W_t^*} \\
&= \left[\frac{\alpha^{*'}_{uip^*}}{1-\alpha^*}\frac{E(e)}{e_t}+1\right] > 0 \\
\epsilon_i^{FA} &= \frac{\partial FA^*}{\partial i}\frac{i_t}{FA_t} = \frac{W_t}{e_t}(-\alpha'_{uip})\frac{i_t}{(1-\alpha)\frac{W_t}{e_t}} \\
&= -\frac{-\alpha'_{uip}}{1-\alpha}\cdot i < 0 \\
\epsilon_i^{FL} &= \frac{\partial FL^*}{\partial i}\frac{i_t}{FA_t} = e_t W_t^*(\alpha^{*'}_{uip^*})\frac{i_t}{(1-\alpha^*)e_t W_t^*} \\
&= \frac{\alpha^{*'}_{uip^*}}{1-\alpha^*}\cdot i_t > 0 \\
\epsilon_{i^*}^{FA} &= -\epsilon_i^{FA} \text{ and } \epsilon_{i^*}^{FL} = -\epsilon_i^{FL}
\end{aligned}
$$

C An Exchange Regime Appropriate Weighting of Reserves

The exchange regime related bias of earlier metrics in the literature is likely to be strongest when currencies are within de facto floating exchange rate regimes. An alternative weighting scheme, more in the flavor of the prior literature, relies on an exchange rate regime proxy. This approach yields quite different conclusions compared with precision weights. We used the observed behavior of the components of the EMP index, which does not require updating information on exchange rate regime classifications when regimes change or require identification of causality.[26] When the observed variation in reserves scaled by $\Pi_{e,t}$ is high *relative to* the observed variation in relative changes in the exchange rate, this is likely to reflect a pegged or managed exchange rate; high variation in changes in the exchange rate relative to the variation in changes in scaled reserves better describes a flexible exchange rate regime. In the extreme case of a hard peg, the variation of changes in the exchange rate will be absent, while variation in changes in foreign reserves constitute the entire variation reflecting pressures on the peg. Intermediate regimes will be described by a combination of the two. Based on similar observations, Tanner [1999] proposes the ratio of the variance of changes in reserves to the sum of the variances of changes in reserves and changes in the exchange rate as a de facto index of the degree to which a country manages its exchange rate. Following this line of reasoning, we propose the following empirical weight, which we denote by Ω, for scaled changes in reserves:

$$\Omega_t = \frac{var\left(\frac{d\hat{R}_t}{\Pi_{e,t}}\right)}{var\left(\frac{d\hat{R}_t}{\Pi_{e,t}}\right) + var\left(\frac{de_t}{e_t}\right)} \tag{12}$$

Defining $\Omega_t \in (0, 1)$ as an indication of the exchange rate regime in place in period t, with $\Omega_t = 0$ as a fully flexible rate regime and $\Omega_t = 1$ when the exchange rate is firmly pegged, the adjusted EMP accounting for potential valuation effects is given by:[27] $\Omega_t \in (0, 1)$ has the property required by theory that if the exchange rate is pegged, there is no valuation adjustment as $\Omega_t = 1$, while the correction is complete in case of zero variation in reserves and/or very high variation in the exchange rate (in which case we should not pay attention to reserve changes as a reflection of capital flow pressures in the first place). This weighting approach has some of the flavor of the precision weights in the existing literature, but with the opposite direction of

[26] Examples of classifications of exchange rate regimes are Klein and Shambaugh [2008] and Ilzetzki et al. [2017].

[27] The de facto exchange rate regime is distinct from the de jure exchange rate regime (Shambaugh [2004], Ilzetzki et al. [2017]). Valuation effects of reserves that are effectively noise and not correlated with foreign exchange interventions play a very small to no role in countries with fully flexible exchange rates, but may play a larger role for countries with managed exchange rates. The resulting EMP index can have a heteroscedastic error process which depends on the exchange rate regime as captured by Ω, and on the amount of reserves held in third currencies that vary independently with the bilateral exchange rate choice in the EMP construction and reserve portfolio units.

weighting and a different scaled reserves term.

This empirical variant of the EMP is described by:

$$EMP_{c,t} = \frac{de_{c,t}}{e_{c,t}} - \Omega_{c,t}\frac{d\hat{R}_{c,t}}{\Pi_{e,c,t}} \tag{13}$$

where $\frac{de_{c,t}}{e_{c,t}}$ refers to changes in the value of the KS base currency of country c at time t, $d\hat{R}_{c,t}$ is measured in KS base currency equivalents, and

$$\begin{aligned} \Pi_{e,c,t} &= \frac{FL_{c,t-1}}{e_{c,t}} i + \epsilon_{e,c}^{FL}\frac{FL_{c,t}}{e_{c,t}} - \epsilon_{e,c}^{FA} FA_{c,t} \\ \Omega_{c,t} &= \frac{var\left(\frac{d\hat{R}_{c,t}}{\Pi_{e,c,t}}\right)}{var\left(\frac{d\hat{R}_{c,t}}{\Pi_{e,c,t}}\right) + var\left(\frac{de_{c,t}}{e_{c,t}}\right)} \end{aligned} \tag{14}$$

The computation of the rolling standard deviations used for constructing Ω require the availability of five years of data before the first observation of the EMP can be produced. For countries with data available back to 1990, the monthly construction of the EMP thus spans 1995m1 through 2017m10. The sample starts later for many countries, however.

D Exchange Rate Elasticities from Panel Regressions

This appendix presents a panel regression of foreign assets and liabilities positions on exchange rates, with the aim of assessing the size of the elasticity of foreign investment positions to exchange rate changes, and discussed in Section (4.2).

Estimating the response of capital flows to the exchange rate is complicated because of the endogeneity of capital flows and exchange rates to each other as well as to the exchange rate regime in place in the country in question. For example, we would expect an exchange rate appreciation to initially cause a capital outflow as international portfolios rebalance. However, we would expect a capital outflow shock to cause an exchange rate depreciation, or foreign exchange interventions (see also Klaassen [2011]). We only observe the equilibrium outcome for flows and the exchange rate, but not the partial responses that we are interested in assessing. We attempt to address these issues with a panel regression analysis of gross capital flows that produces empirical estimates of $\epsilon_{e,c}^{FA}$ and $\epsilon_{e,c}^{FL}$ based on equations (3) and (4). In this setup, endogeneity would tend to bias the estimates of the capital flow response to the exchange rate downward. Thus, if we find the right signs, we should be capturing the direction qualitatively and gain insight into the lower bound for the size of the response.[28] To reduce the endogeneity

[28] A downward bias in the elasticities would increase $\Pi_{e,t}$ and hence place too high a weight on reserves changes relative to exchange rate changes in the modified EMP.

bias, we lag all explanatory variables by one quarter, keeping in mind that lagging may not fully address concerns in case of persistence in the regression variables. Allowing an exchange rate shock to affect capital flows over the following three months is consistent with the timing of the effect estimated in Hau and Rey [2004].

With a broad panel of countries, the country specific variation in the exchange rate depends on the exchange rate regime. Countries with hard pegs, such as Hong Kong, will have minimal exchange rate variation, effectively preventing empirical measurement of the impact of exchange rate variation on private capital flows.[29] For this reason, we estimate the regression as a panel and impose the restriction that the elasticity of gross positions to the exchange rate is the same across groups of countries, as further discussed below. The panel approach allows us to produce predictions for exchange rate elasticities for countries that do not exhibit sufficient variation in the exchange rate to estimate the country specific elasticity. The panel approach also allows us to control for variation in gross positions due to common global shocks by including time fixed effects.

It is possible that the average elasticities of international investment positions depend on the composition of gross foreign asset and liabilities (e.g. Cerutti et al. [2015]), which may change over time. It is beyond the scope of this paper to estimate elasticities individually for all sub-items of international investment positions. As a short-cut, we exclude foreign direct investments (FDI) from the gross foreign investment positions. The share of FDI in gross positions has grown strongly in recent years (Milesi-Ferretti and Lane [2017]), but this type of investment is less likely to respond to exchange rate changes.[30] Portfolio and bank related international investment positions are more likely to be responsive to changes in prospective returns, absent capital controls.

Global financial factors such as US monetary policy, risk aversion and global liquidity and financial wealth accumulation are clearly of importance in driving global capital flows and should be controlled for, but these variables are very difficult to correctly measure empirically, in particular since the advent of the ZLB period.[31] Since such factors are not the focus of this exercise, we instead control for all common global factors in the variation by including time effects in the regressions. We control for country specific time invariant effects by including country fixed effects. Finally, growth in local wealth is approximated by local GDP growth. The estimating equations become:

[29] Patnaik et al. [2017] face a similar problem and carry out estimations only for countries where variation allows for identification of the parameter they are focusing on. They then use the estimation equation to predict the parameter estimates for the countries that do not have sufficient variation to allow direct estimation, based on the characteristics that turn out to matter for the size of the parameter estimate.

[30] A further refinement of the approach would be to exclude long-term bank positions, if these could be consistently identified in the data.

[31] Avdjiev et al. [2017] consider such factors as drivers of capital flows explicitly.

	$dlog(FA)$		$dlog(FL)$	
	I	II	III	IV
$dlog(e)$	-0.052**	-0.039	-0.006	0.033
$dlog(e) \cdot EM$		-0.037		-0.103**
$d(i)$	0.008***	0.007***	0.0003	-0.0006
$d(i) \cdot EM$		0.001		0.003
$dlog(GDP)$	-0.041	0.067**	-0.041	-0.023
$dlog(GDP) \cdot EM$		-0.048		-0.041
R^2	0.48	0.48	0.20	0.20
No. Obs	1969	1969	1981	1981
No. countries	49	49	49	49

Table 6: **Regression Results For Gross International Investment Positions**
Results for estimating regression equations (15) and (16). All specifications contain time and fixed effects (not shown). Regressions are based on quarterly data from 2000Q1 to 2016Q4 excluding the financial crisis quarters between 2008Q3 and 2009Q2. Asterisks *, ** and *** indicate significance at the 10, 5 percent and 1 percent levels, respectively, using clustered standard errors.

$$dlog(FA_{c,t}) = \epsilon^{FA}_{e,c} dlog(e_{c,t-1}) + \epsilon^{FA}_{i,c} d(i_{c,t-1}) + \epsilon^{FA}_{w,c} dlog(GDP) + \varphi_c + \tau_t + \varepsilon_{c,t} \tag{15}$$

$$dlog(FL_{c,t}) = \epsilon^{FL}_{e,c} dlog(e_{c,t-1}) + \epsilon^{FL}_{i,c} d(i_{c,t-1}) + \epsilon^{FL}_{w,c} dlog(GDP) + \varphi_c + \tau_t + \varepsilon_{c,t} \tag{16}$$

where φ_c are country fixed effects that capture time invariant country specific factors influencing gross capital flows, and τ_t are time fixed effects that capture global factors including risk sentiment, global liquidity, and interest rates, financial conditions and growth in center countries. c is the country grouping for which the elasticity is estimated. In the baseline regression we restrict the elasticities to be the case for all countries, but we also allow for the elasticities to deviate between advanced economies and emerging and developing countries, by interacting all explanatory variables with a dummy taking the value one for emerging and developing countries. The expected signs according to the portfolio rebalancing hypothesis are $\epsilon^{FA}_{e,c} < 0$ and $\epsilon^{FL}_{e,c} > 0$.

The regression results are presented in Table (6), for the sample period from 2000Q1 to 2016Q4, excluding the crisis quarters of 2008Q3 and 2009Q2.[32]

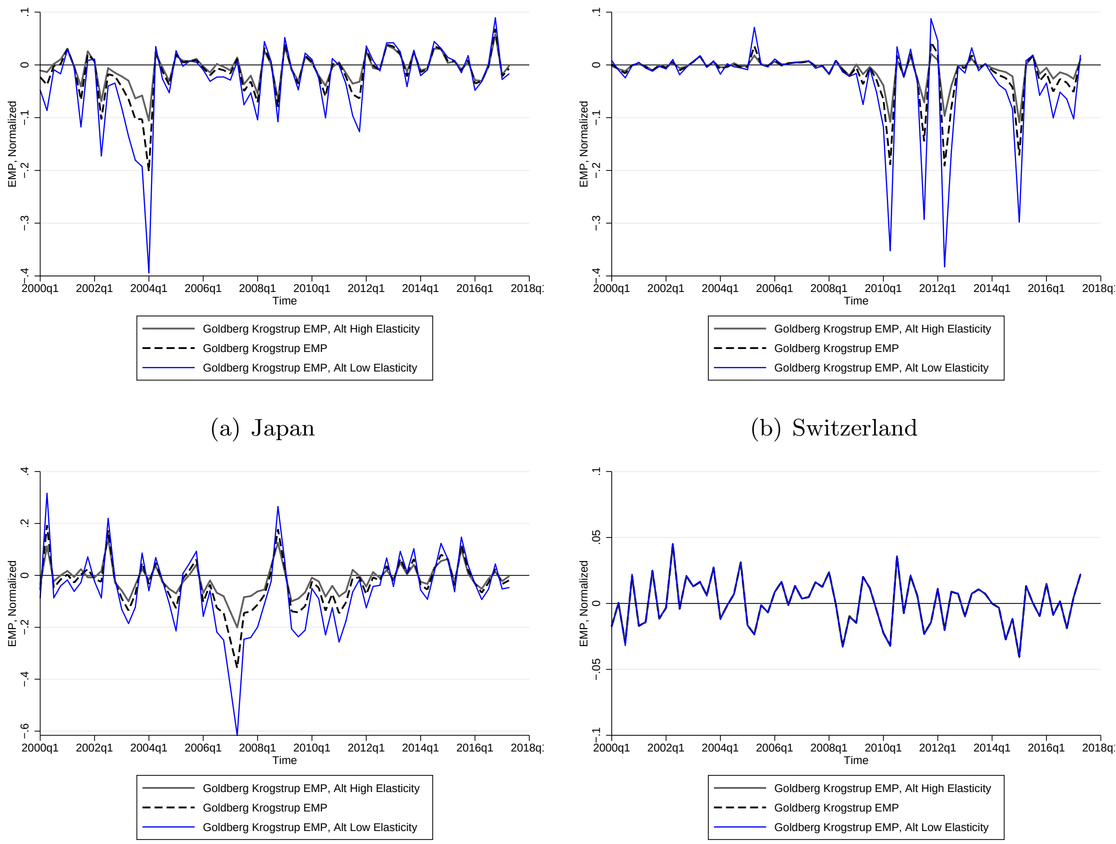
First note that the fit of the regression (R^2) are relatively high for the foreign asset regressions. This primarily reflects a large portion of the variation explained by country and time fixed effects, in turn reflecting structural flows as well as global factors. The domestic interest rate is significant, but with the wrong sign, whereas GDP growth is significant and with the right sign for advanced economies (column II). Moreover, the exchange rate elasticity is significantly negative (column I), suggesting that a 1% exchange rate depreciation against the US dollar

[32] Avdjiev et al. [2017] present evidence of a structural break in the link between capital flows and global factors around the time of the global financial crisis. We have additionally run the regressions for another three sample periods, namely the pre-crisis period, the post-crisis period, and the full sample including the crisis period, with results differing across these subsamples. Not shown but can be obtained from the authors.

should lead to a 0.05% reduction in foreign asset holdings (i.e. a capital inflow due to domestic resident retrenchment). When allowing for the elasticity to differ between advanced countries and emerging and developing countries (column II), significance drops, but the size and sign remain, suggesting that the elasticity is higher for emerging and developing countries.

The R^2s for the foreign liabilities regressions (columns III and IV) are substantially lower, and local interest rate and GDP are both insignificant in these regressions. Moreover, the exchange rate elasticity is only significant for emerging and developing countries (column IV), and with the wrong sign.

Future explorations could compare with the using valuation adjusted capital flows as dependent variable.



(a) Japan

(b) Switzerland

(c) Brazil

(d) USA

Figure 8: **Goldberg Krogstrup Baseline EMP And Alternative Elasticity Assumptions** The three EMP series are based on different assumptions about the size of the elasticity of gross foreign positions to changes in the exchange rate for constructing the scaling factor $\Pi_{e,t}$. Baseline is 0.05, the low alternative elasticity is set to 0.005 and the high alternative elasticity is set to 1. EMPs are displayed in quarterly averages of monthly values.

E Sensitivity of EMP to Elasticity Choices

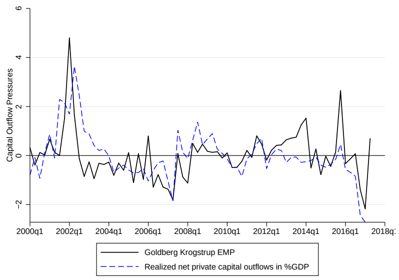
As discussed in Section (4.2) and in Appendix (D), there is considerable uncertainty as to the empirical size of the exchange rate elasticity used to compute $\Pi_{e,t}$ changes. Our baseline EMP is constructed using an elasticity of 0.05. If the true empirical elasticity is lower, the baseline will lead to excessive scaling of reserves changes, and exchange rate changes will unduely denominate the index. If instead the true empirical elasticity is higher, our baseline will tend to underscale reserves changes and lead to excessive dominance of reserves changes in the index. We find that the extent to which the exchange rate elasticity matters for the EMP depends on the exchange rate regime. Under a floating regime, reserves changes are weighted very low through the valuation adjustment, in which case the scaling of reserves will not matter as the exchange rate component of the index dominates. If the currency is pegged and only reserve changes matter for the EMP, the elasticity does not matter either, as it simply increases or decreases the amplitude of movements in the EMP, which cancel out if the index is normalized. It matters, however, in intermediate regimes, but mainly through changes in amplitudes during specific episodes.

Switzerland is one of the countries for which the elasticity matter the most. We illustrate this in Figure (8), displaying the baseline $EMPs$ and two alternative EMP constructed using half the baseline elasticity size of 0.025 and double the elasticity size of 0.1, respectively for Switzerland. In 2012, when a lower bound for the exchange rate was in place, the Swiss National Bank was intervening strongly in response to exceptional capital inflow pressures associated with the European debt crisis, as suggested by the baseline EMP and the EMP based on an even lower elasticity. The high-elasticity EMP, however, suggests that the capital inflow pressure during that episode was important, but less exceptional than the other measures.

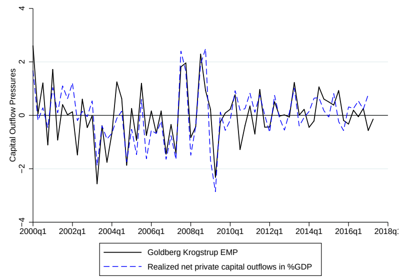
The EMP for the US is not sensitive to the elasticity assumption. This is because the elasticity matters for how reserves are scaled, and hence their amplitude, but reserves play no role in exchange market pressures in the US, where the exchange rate is freely floating.

As we have no objective measure to compare with, we cannot determine which of these elasticities are more likely to be correct, but are comforted by the fact that they all point to pressures in the same direction.

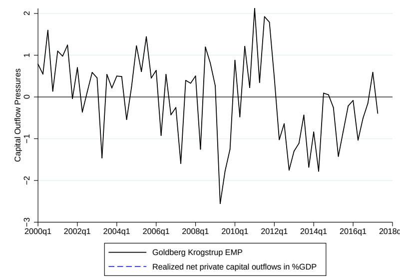
F Individual Country Charts



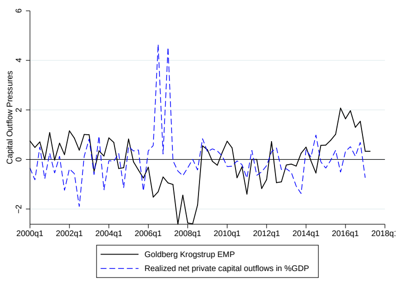
(a) Argentina



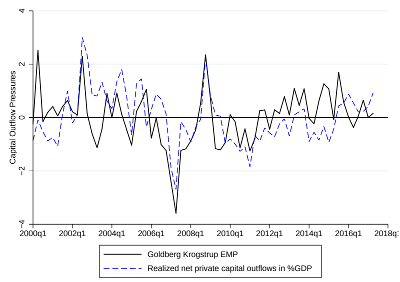
(b) Australia



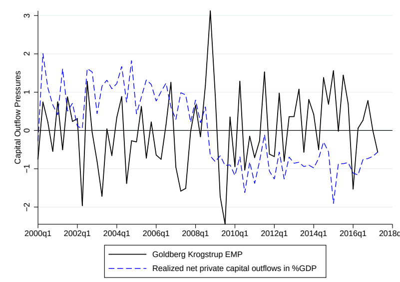
(c) Bangladesh



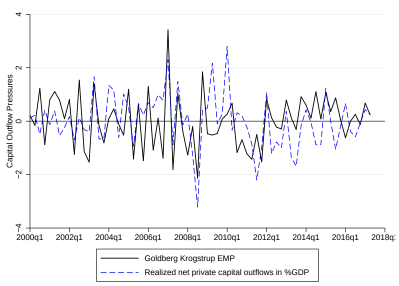
(d) Bolivia



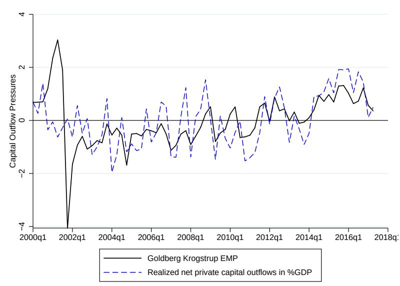
(e) Brazil



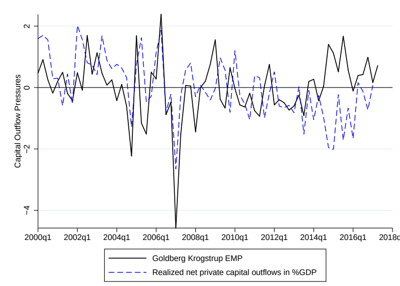
(f) Canada



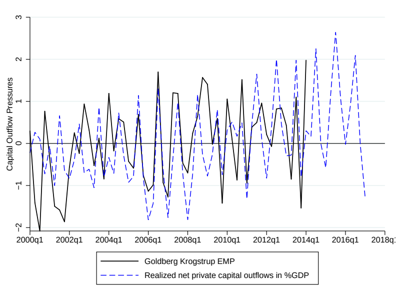
(g) Chile



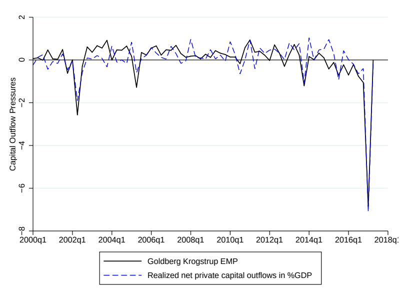
(h) China



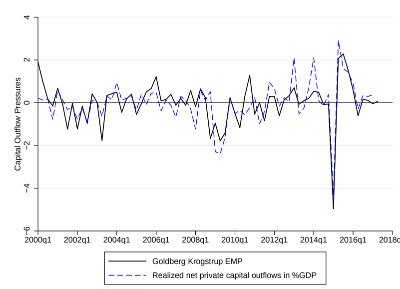
(i) Columbia



(j) Croatia

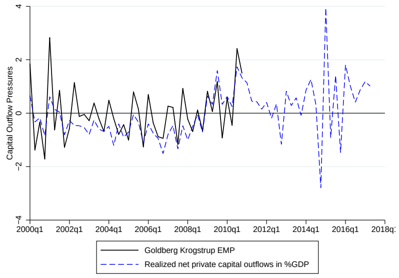


(k) Czech Republic

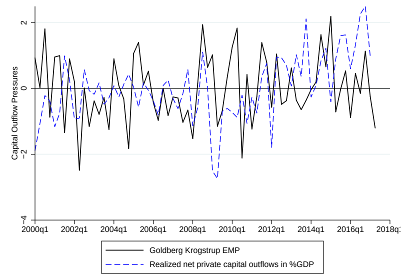


(l) Denmark

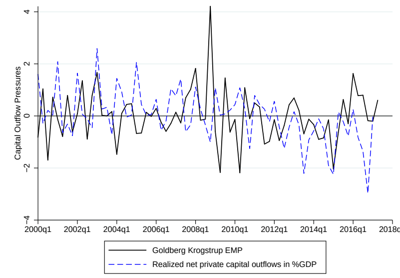
Figure 9: **Net Private Capital Flows and The Goldberg Krogstrup** EMP
Quarterly averages of monthly values of the baseline EMP. Net private capital flows in percent of GDP from IMF Financial Flows Analytics Database. Both series are demeaned and normalized by their full sample standard deviation. Net capital flow data for Bangladesh not included in the IMF Financial Flows Analytics database.



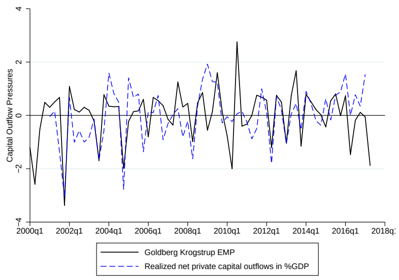
(a) Estonia



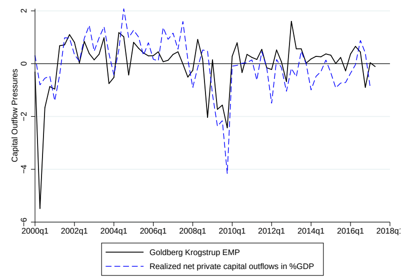
(b) euro area



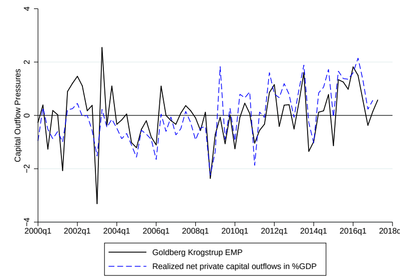
(c) Great Britain



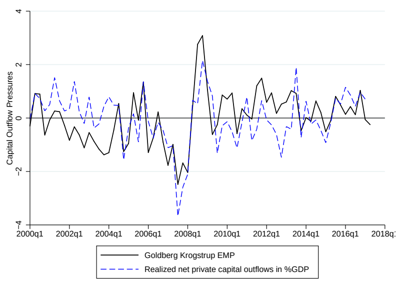
(d) Guatemala



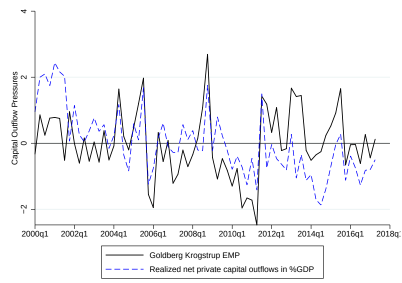
(e) Hong Kong



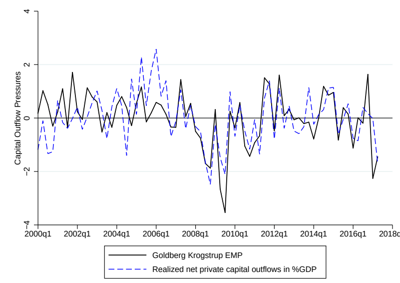
(f) Hungary



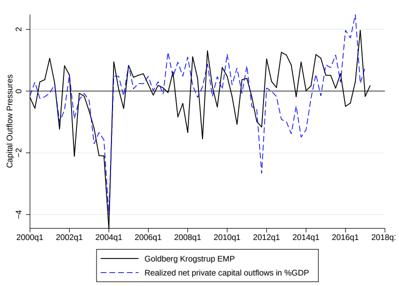
(g) India



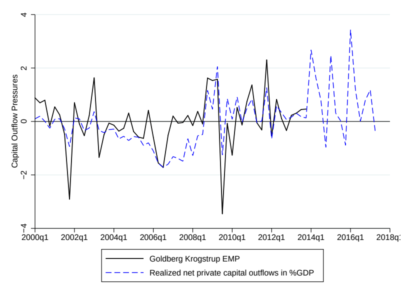
(h) Indonesia



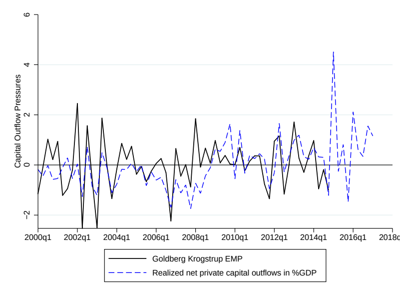
(i) Israel



(j) Japan

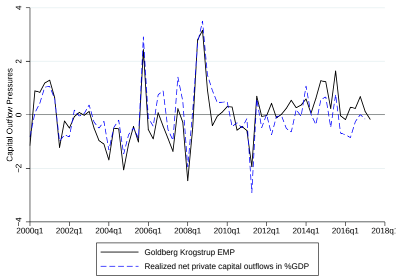


(k) Latvia

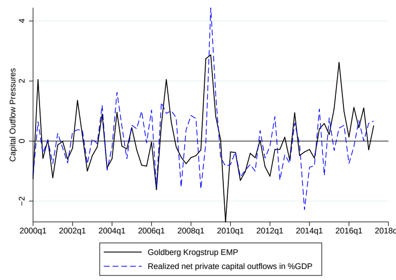


(l) Lithuania

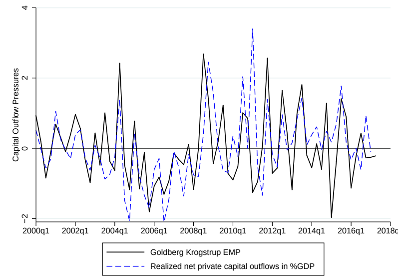
Figure 9: **Net Private Capital Flows and The Goldberg Krogstrup** EMP (continued)
Quarterly averages of monthly values of the baseline EMP. Net private capital flows in percent of GDP from IMF Financial Flows Analytics Database. Both series are demeaned and normalized by their full sample standard deviation.



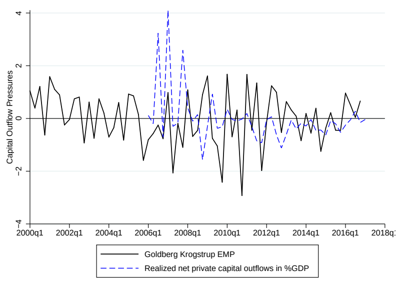
(m) Malaysia



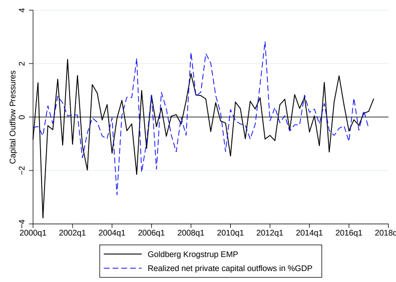
(n) Mexico



(o) New Zealand



(p) Nicaragua



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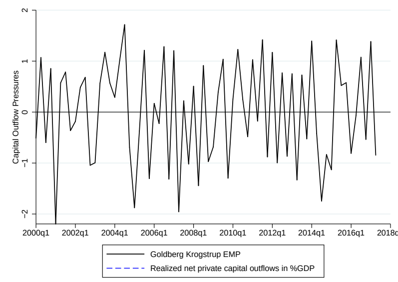
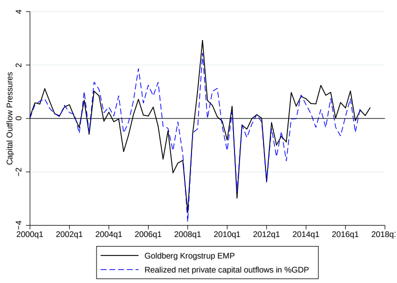
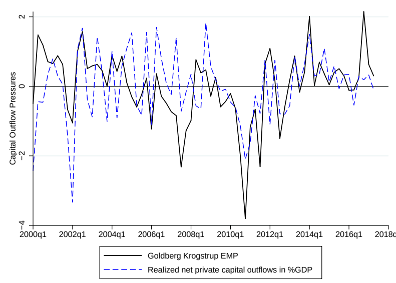


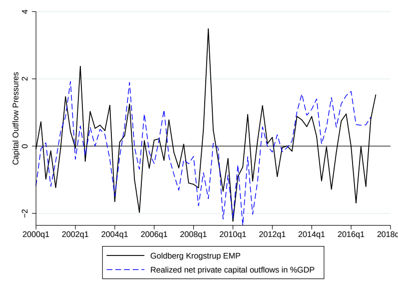
(r) Panama



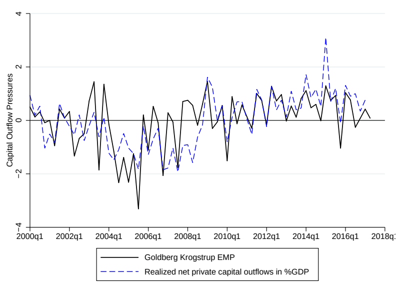
(s) Peru



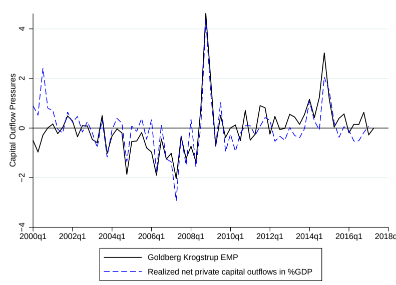
(t) Philippines



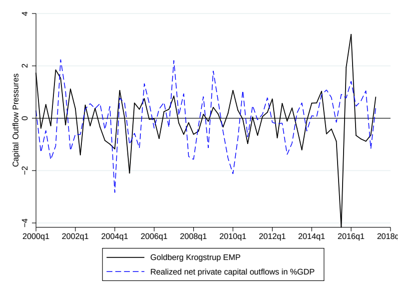
(u) Poland



(v) Romania

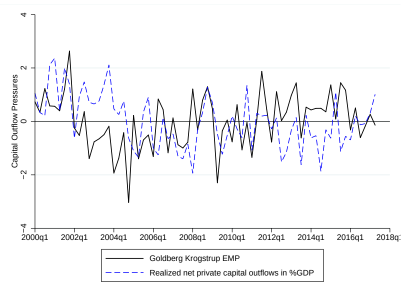


(w) Russia

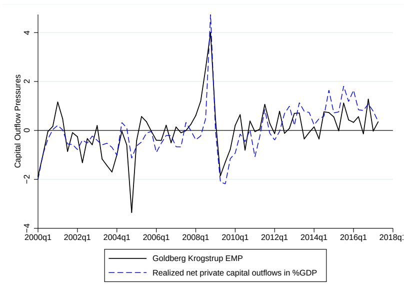


(x) Singapore

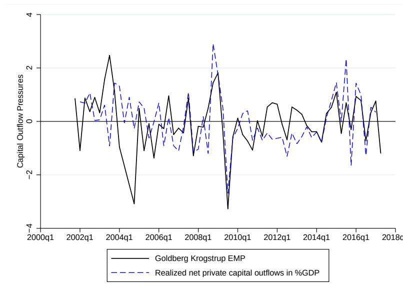
Figure 9: **Net Private Capital Flows and The Goldberg Krogstrup** EMP (continued)
Quarterly averages of monthly values of the baseline EMP. Net private capital flows in percent of GDP from IMF Financial Flows Analytics Database. Both series are demeaned and normalized by their full sample standard deviation. Net capital flow data for Panama not included in the IMF Financial Flows Analytics database.



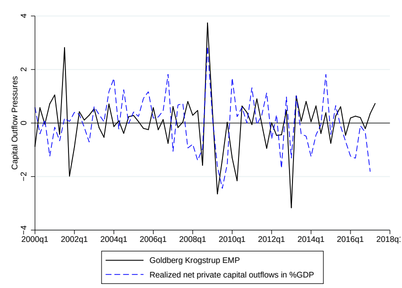
(a) South Africa



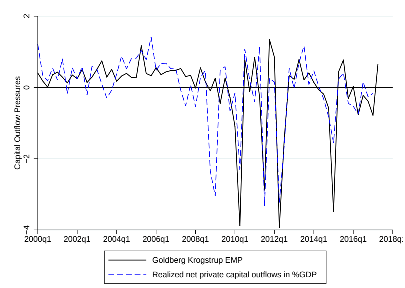
(b) South Korea



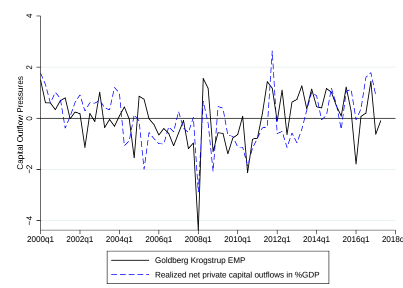
(c) Sri Lanka



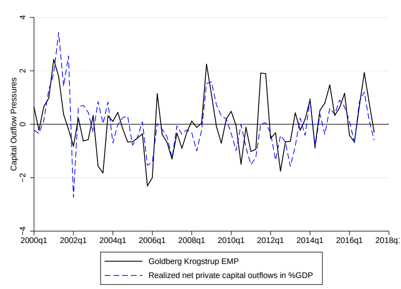
(d) Sweden



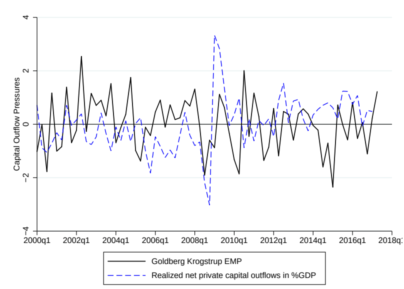
(e) Switzerland



(f) Thailand



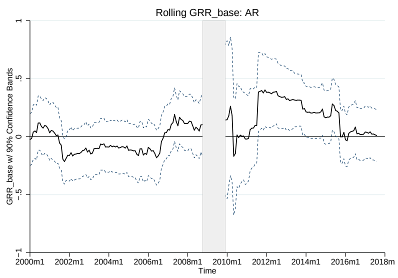
(g) Turkey



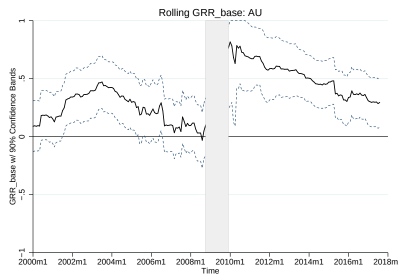
(h) USA

Figure 9: **Net Private Capital Flows and The Goldberg Krogstrup** EMP(continued)
Quarterly averages of monthly values of the baseline EMP. Net private capital flows in percent of GDP from IMF Financial Flows Analytics Database. Both series are demeaned and normalized by their full sample standard deviation.

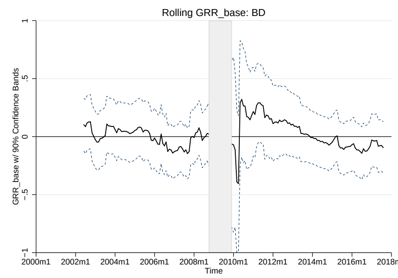
F.1 The GRR



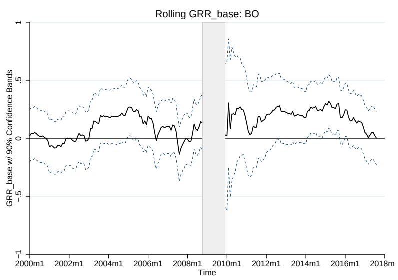
(i) Argentina



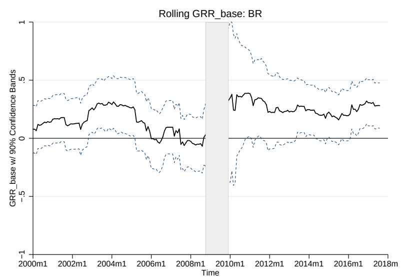
(j) Australia



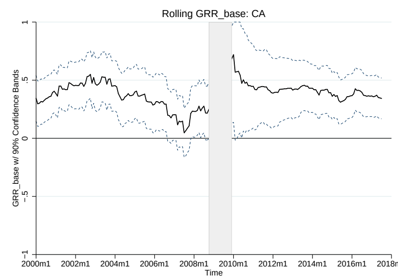
(k) Bangladesh



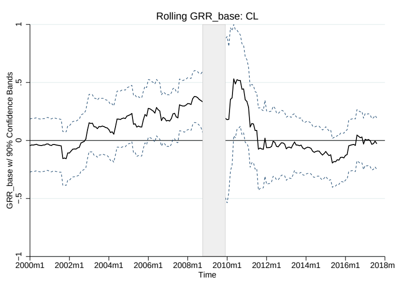
(l) Bolivia



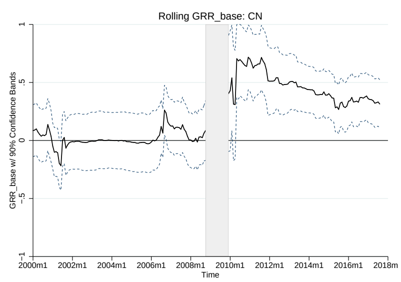
(m) Brazil



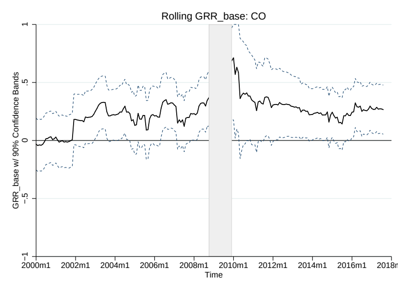
(n) Canada



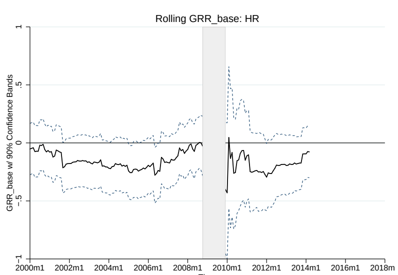
(o) Chile



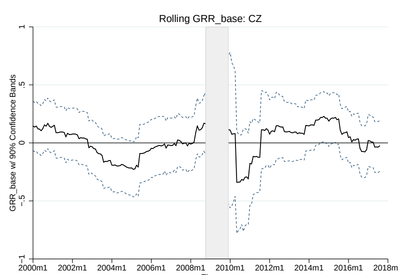
(p) China



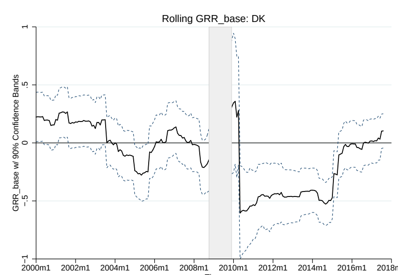
(q) Columbia



(r) Croatia

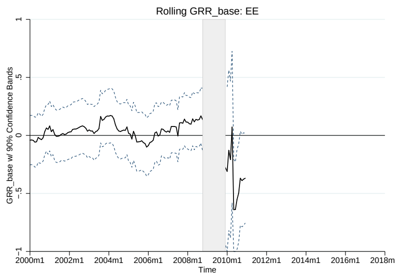


(s) Czech Republic

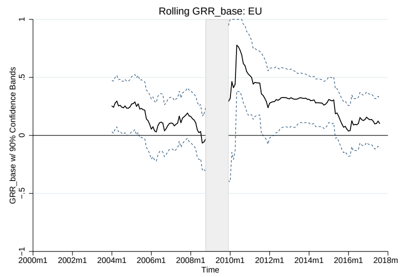


(t) Denmark

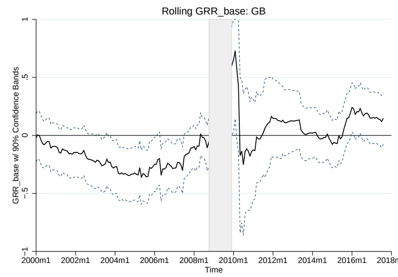
Figure 10: **Global Risk Response (GRR)**
Computation uses the Goldberg Krogstrup baseline EMP and the VIX as a measure of global risk sentiment. Global financial crisis period structural break assumed. Solid lines depict mean GRR estimates by date, and dashed lines indicate the associated one standard error band.



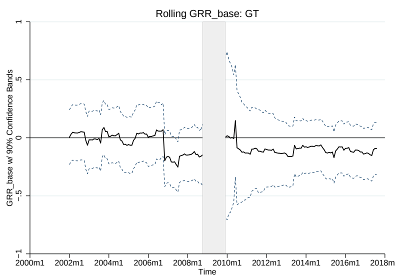
(a) Estonia



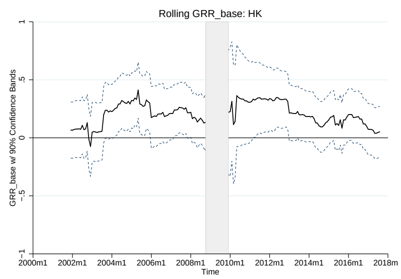
(b) euro area



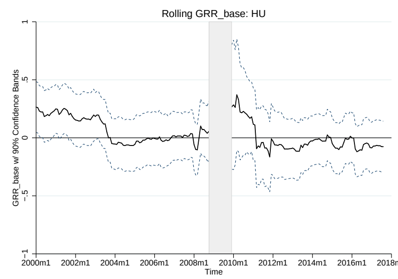
(c) Great Britain



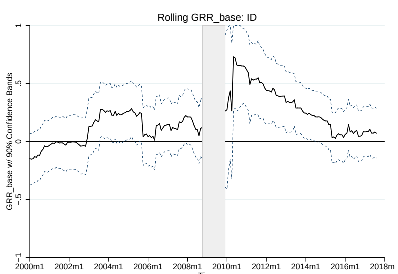
(d) Guatemala



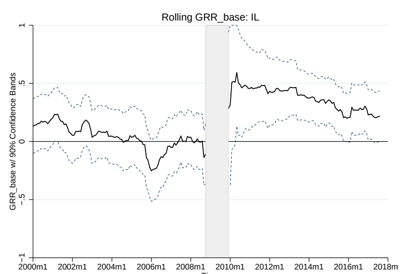
(e) Hong Kong



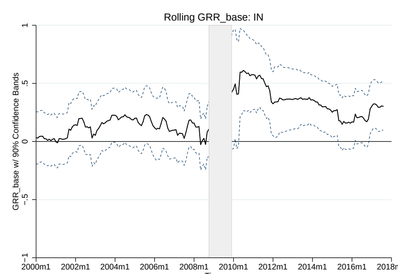
(f) Hungary



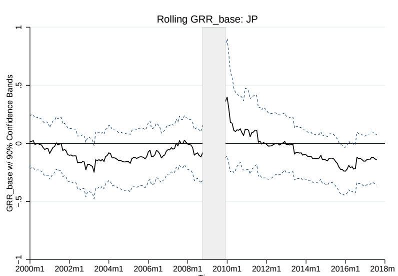
(g) Indonesia



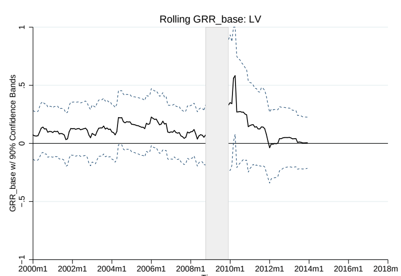
(h) Israel



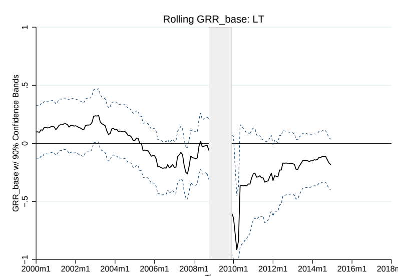
(i) India



(j) Japan



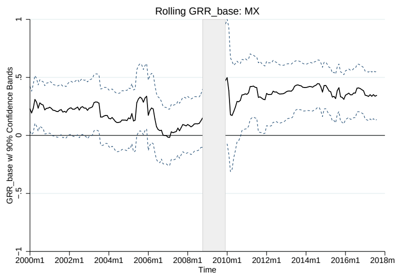
(k) Latvia



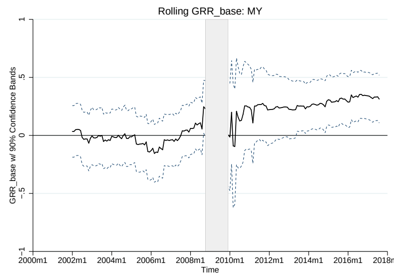
(l) Lithuania

Figure 10: **Global Risk Response (**GRR**)** (continued)

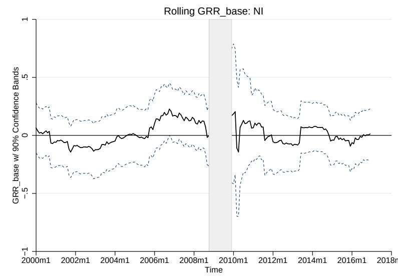
Computation uses the Goldberg Krogstrup baseline EMP and the VIX as a measure of global risk sentiment. Global financial crisis period structural break assumed. Solid lines depict mean GRR estimates by date, and dashed lines indicate the associated one standard error band.



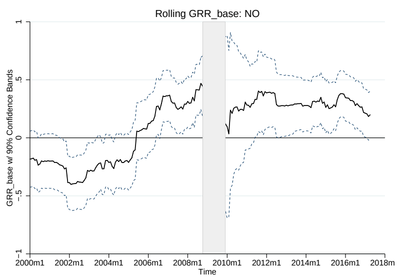
(m) Mexico



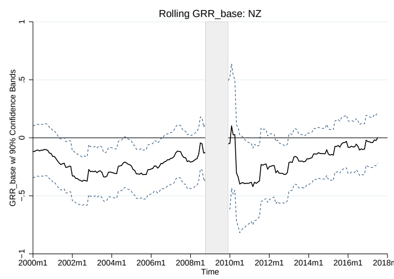
(n) Malaysia



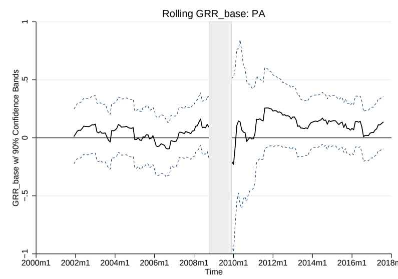
(o) Nicaragua



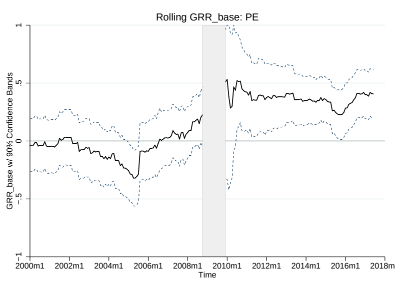
(p) Norway



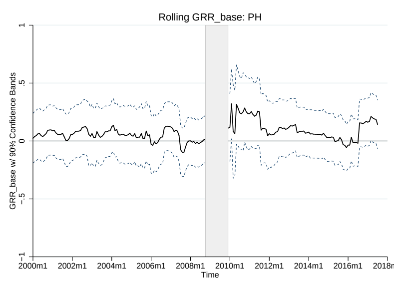
(q) New Zealand



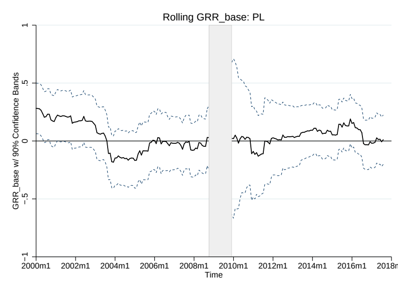
(r) Panama



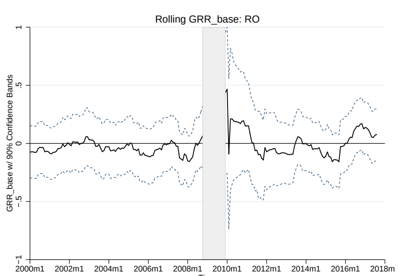
(s) Peru



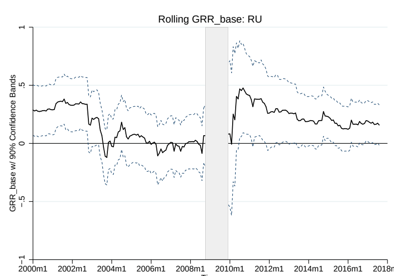
(t) Philippines



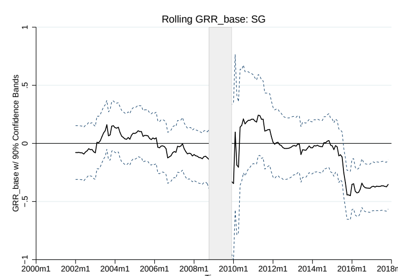
(u) Poland



(v) Romania



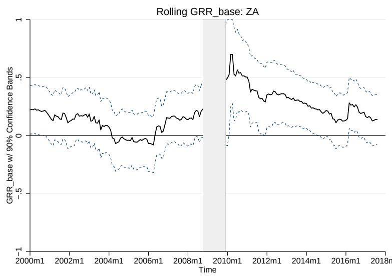
(w) Russia



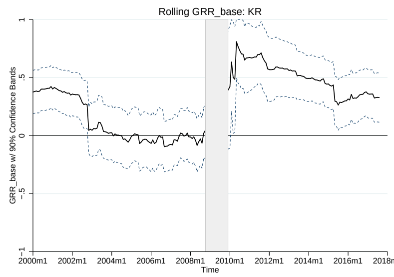
(x) Singapore

Figure 10: **Global Risk Response (*GRR*)** (continued)

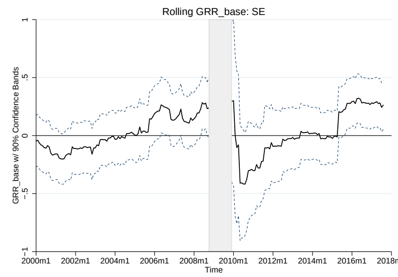
Computation uses the Goldberg Krogstrup baseline EMP and the VIX as a measure of global risk sentiment. Global financial crisis period structural break assumed. Solid lines depict mean GRR estimates by date, and dashed lines indicate the associated one standard error band.



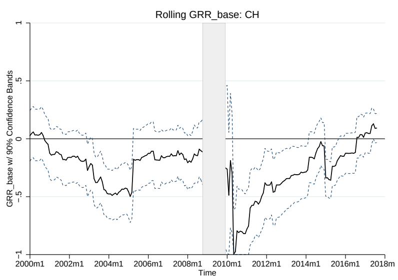
(a) South Africa



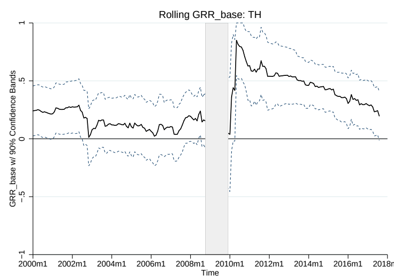
(b) South Korea



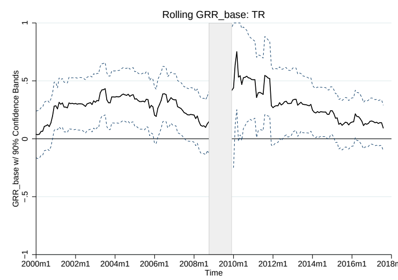
(c) Sweden



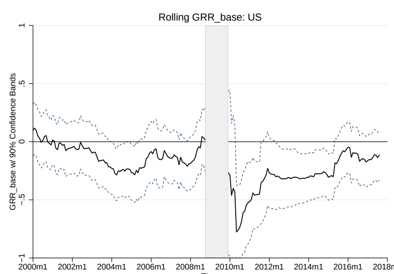
(d) Switzerland



(e) Thailand



(f) Turkey



(g) USA

Figure 10: **Global Risk Response (GRR)** (continued)
Computation uses the Goldberg Krogstrup baseline EMP and the VIX as a measure of global risk sentiment. Global financial crisis period structural break assumed. Solid lines depict mean GRR estimates by date, and dashed lines indicate the associated one standard error band.